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ОСНОВЫ ТЕХНИЧЕСКОГО ПЕРЕВОДА

Учебное пособие

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Учебное пособие предназначено для развития навыков чтения и перевода англоязычной научно-технической литературы и увеличению словарного запаса. Пособие состоит из трех разделов. В первом разделе пособия представлен теоретический материал по основным аспектам переводческой практики. Второй раздел включает в себя тексты для внеаудиторного чтения по специальности. Третий раздел содержит словарь-минимум.

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ОГЛАВЛЕНИЕ

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ВВЕДЕНИЕ

Учебное пособие предназначено для развития навыков чтения и перевода англоязычной научно-технической литературы и увеличения словарного запаса.

Пособие состоит из трех разделов. В первом разделе пособия представлен теоретический материал по основным аспектам переводческой практики и лексико-грамматическим трудностям перевода, а также даны рекомендации по созданию точного и последовательного процесса перевода. Второй раздел включает в себя тексты для аудиторного и внеаудиторного чтения по специальности, а именно, общенаучные тексты и научно-технические тексты по специальности, а также набор лексико-грамматических упражнений для активизации грамматических структур и лексики по специальности. Третий раздел содержит словарь-минимум с целью облегчить процесс перевода и реферирования научных текстов по специальности и может быть использован как справочник при самостоятельной работе. Кроме того, в пособии имеется три приложения. Приложение 1 содержит фразы-клише для реферирования текста. Приложение 2 – информацию об основных арифметических выражениях и правилах их чтения на английском языке. В Приложении 3 представлены англоязычные научно-технические ресурсы сети Интернет.

РАЗДЕЛ I: ТЕОРЕТИЧЕСКИЙ МАТЕРИАЛ

1.1. Основная задача научно-технического перевода

Научная специализация это яркий признак современного мира. В настоящее время существует необходимость в выделении научно-технического перевода не только как особого вида переводческой деятельности и специальной теории, исследующей этот вид деятельности, а также присвоении научно-техническому переводу статуса самостоятельной прикладной дисциплины. С точки зрения лингвистики, характерные особенности научно-технической литературы распространяются на ее стилистику, грамматику и лексику.

Основная задача научно-технического перевода состоит в предельно ясном и точном доведении до читателя сообщаемой информации. Автор научно-технической статьи стремится к тому, чтобы исключить возможность произвольного толкования переводимого предложения, вследствие чего в технической литературе почти не встречаются такие выразительные средства, как метафоры, метонимии и другие стилистические фигуры, которые широко используются в художественных произведениях для придания речи живого, образного характера.

1.2. Типы научно-технического перевода

Можно выделить следующие **типы научно-технического перевода:**

- <u>перевод научной литературы</u> – перевод фундаментальной литературы по науке и технике (монографии, книги, учебники, диссертации);
- <u>перевод научно-технической литературы</u> – перевод статей из научно-технических журналов и сборников, докладов на конференциях, патентных документов, отчетов;
- <u>перевод производственно-технической литературы</u> – перевод документов производственного назначения (инструкций по эксплуатации,

технических справочников, руководств, каталогов машин и приборов, документов);

- перевод научно-популярной литературы – перевод научно-технической литературы в адаптированном виде и популярном изложении для массового читателя.

1.3. Требования к переводу

Научно-технический перевод требует хорошего знания языка перевода и оригинала. Поскольку научно-технический перевод связан с определенной областью науки и техники, он требует хорошего знания предмета, описываемого в оригинале, а также знания методики и техники перевода.

Основные требования, которым должен удовлетворять перевод:

- точная передача текста оригинала;
- строгая ясность изложения смысла при максимально сжатой и лаконичной форме, присущей стилю русской научно-технической литературы.

1.4. Лексико-грамматические особенности научно-технической литературы

Необходимо четко понимать, что специфика научно-технического перевода заключается, прежде всего, в том, что он имеет дело с особой сферой человеческой деятельности – различными областями науки и техники, для выражения которых существуют определенные лексические, грамматические и стилистические средства языка.

Наиболее типичным лексическим признаком научно-технической литературы является насыщенность текста терминами и терминологическими словосочетаниями, а также наличие служебных и вводных слов и сокращений, лексических новообразований и реалий.

Термины – это слова или словосочетания, которые имеют строго определенное значение в той или иной области науки и техники. Они точно выражают понятия, процессы и названия вещей, присущие какой-либо отрасли производства. Провести четкую грань между терминами и словами обиходного языка не всегда возможно вследствие многозначности многих слов. Например, такие общеизвестные понятия, как *electricity*, *temperature*, *steam locomotive*, *motor vehicle*, и часто употребляемые слова *atom*, *plastics*, *vitamin*, *antibiotic*, *penicillin*, *space*, не являются терминами в обиходном языке, где техническое начало играет второстепенную (подчиненную) роль. С другой стороны, такие простые слова, как *water*, *earth*, *flame*, *liquid*, *power*, *clay*, *silver* являются терминами в техническом контексте, когда несут первостепенную (основную) смысловую нагрузку.

Что касается классификации терминов, все термины делятся на простые, сложные и словосочетания. Выделяют общенаучные и общетехнические термины, отраслевые и узкоспециальные термины. Общенаучные термины – это термины, которые используются в нескольких областях науки и техники. Отраслевые термины – это термины, присущие только одной какой-либо отрасли знания. Узкоспециальные термины – это термины, имеющие значения, характерные для какой-либо специальности данной отрасли.

При работе с лексикой английской научно-технической литературы наибольшую трудность для понимания составляют многокомпонентные термины, созданные лексическим и синтаксическим способом, т.е. представляющие собой словосочетания, образованные по определенным моделям. Термины в виде цепочки слов очень распространены. При их переводе необходимо уяснить, в каком порядке следует раскрывать значение данного словосочетания.

В беспредложном терминологическом словосочетании главным словом является последнее слово. Все слова, стоящие слева от него играют второстепенную роль – роль определения. Перевод беспредложных терминологических словосочетаний надо начинать с главного слова.

Пример: *life test* – испытание на срок службы.

Существует большое количество терминов, состоящих из нескольких компонентов. Рассмотрим наиболее распространенные модели образования терминологических словосочетаний.

Наиболее продуктивными являются следующие модели:

1. Терминологические словосочетания, состоящие из существительных.

Пример: *cathode ray tube* – электронно-лучевая трубка
gravitation force – сила гравитации
crystal growth method – метод выращивания кристаллов
frequency changer set – агрегат преобразования частоты
power station basis regime – базисный режим электростанции

2. Терминологические словосочетания, состоящие из прилагательных и существительных.

Пример: *magnetomotive force* – магнитодвижущая сила
qualitative difference – качественное различие
direct current – постоянный ток
asynchronous machine – асинхронная машина
energetical system power balance – баланс мощности энергосистемы

3. Терминологические словосочетания, состоящие из причастий и существительных.

Пример: *alternating current* – переменный ток
carrying capacity – пропускная способность
attracting ability – свойство притяжения
fixing device – арматура изолятора
switching device recovery – возврат коммутационного аппарата

4. Терминологические словосочетания, состоящие из трех компонентов:

- наречие + причастие (или прилагательное) + существительное

Пример: *directly heated cathode* – катод прямого накала

highly doped semiconductor – сильнолегированный полупроводник

highly redundant hologram – голограмма с высокой избыточностью

positively charged particle – положительно заряженная частица

- причастие + прилагательное + существительное

Пример: *discentralized electrical supply* – децентрализованное электроснабжение

united energetic system – единая энергосистема

protected electrical device – защищенное электротехническое изделие

insulated energetical system – изолированная энергосистема

- существительное + прилагательное + существительное

Пример: *voltage-sensitive device* – прибор, реагирующий на напряжение

transformer accidental regime – аварийный режим трансформатора

explosion-proof motor – взрывозащищенный электродвигатель

transformer secondary winding – вторичная обмотка трансформатора

transformer higher voltage – высшее напряжение трансформатора

- существительное + причастие + существительное

Пример: *computer-aided design* – автоматизированное проектирование

safety isolating transformer – безопасный разделительный трансформатор

oil-filled cable – маслонаполненный кабель

pole-mounted substation – мачтовая (трансформаторная) подстанция

5. Терминологические словосочетания, включающие инфинитив

Пример: *ready-to-assemble product* – изделие, готовое к сборке

ready-to-change position – позиция готовности к смене (напр. инструмента)

Кроме того, значительную роль в технической литературе играют **служебные (функциональные) слова**, создающие логические связи между отдельными элементами высказываний. Это предлоги и союзы (в основном составные) типа: *on* (по), *upon* (относительно), *in* (на), *after* (после), *before* (до), *besides* (кроме того), *instead of* (вместо), *in preference to* (по отношению к), *apart (aside) from* (кроме), *except (for)* (за исключением), *in addition (to)* (в дополнение к), *together with* (вместе с), *owing to* (вследствие), *due to* (из-за), *thanks to* (благодаря), *according to* (в соответствии с), *because of* (по причине), *by means of* (посредством), *in accordance with* (в соответствии с), *in regard to* (в отношении), *in this connection* (в связи с этим), *for the purpose of* (с целью), *in order to* (для того, чтобы), *as a result* (в результате), *rather than* (скорее чем), *provided* (при условии), *either... or* (или ... или), *neither… nor* (ни … ни), *in fact* (фактически).

И наречия типа: *however* (однако), *also* (также), *again* (снова), *now* (в настоящее время), *thus* (таким образом), *alternatively* (поочередно*), on the one/other hand* (с одной/другой стороны), *virtually* (фактически) являющиеся неотъемлемыми элементами развития логического рассуждения.

Сокращения, или Аббревиатура, т.е. буквенные сокращения словосочетаний также являются важным компонентом научно-технического текста: *e.m.f. – electromotive force* (электродвижущая сила). Сокращению может подвергнуться часть словосочетания: *D.C.amplifier – direct current amplifier* (усилитель постоянного тока). Слоговые сокращения, превратившиеся в самостоятельные слова: *loran (long range navigation)* (система дальней радионавигации), «Лоран», *radar (radio detection and ranging)* (радиолокация).

Литерные термины, в которых атрибутивная роль поручается определенной букве вследствие графической формы: *T-antenna* (Т-образная антенна), *V-belt* (клиновидный ремень). Иногда эта буква является лишь условным, немотивированным символом: *X-гays* (рентгеновские лучи).

Что касается еще одного немаловажного лексического признака научно-технической литературы, а именно **реалий**, необходимо отметить, что реалия является частью исходного текста, поэтому ее передача в текст перевода является одним из условий адекватности перевода. Из этого следует, что слова-реалии являются своеобразной и вместе с тем довольно сложной и неоднозначной категорией лексической системы языка. Под реалиями научно-технической литературы принято называть названия фирм, предприятий, марок оборудования, местонахождения предприятий. Реалии, как правило, не переводятся, а даются в тексте перевода в их оригинальном написании или в транслитерации. Географические названия и общеизвестные имена собственные приводятся в русской транскрипции. Приведем несколько примеров: *Bessemer process/ Bessemer steel* (Бессемеровский процесс / бессемеровская сталь – названы в честь Генри Бессемера, английского инженера-изобретателя, известного своими изобретениями и революционными улучшениями в области металлургии), *Glauber's salt* (глауберова соль – сульфата натрия, впервые обнаружена химиком И. Р. Глаубером, немецким алхимиком, химиком, аптекарем и врачом), *Allan variance* (дисперсия Аллана), *Voltaic pile* (Вольтов столб), *Diesel engine* (дизельный двигатель), *Turing machine* (машина Тьюринга) и т.д.

Интернациональные слова и «ложные друзья переводчика»

Значения большого числа слов, в частности обозначающих общественно-политические и научные понятия, можно угадать, так как эти слова совпадают по звучанию и по значению. Их называют интернациональными словами. Так, слово *metal* значит «металл», слово *gas* – «газ», слово *constitution* – «конституция» и т. д. Однако в число интернациональных слов входят и так называемые «ложные друзья переводчика». Они являются ложными эквивалентами сходных по звучанию слов другого языка. Так, английское слово *artist* обозначает человека искусства и художника (живописца). В русском языке артист – это актер; значение «художник в широком смысле слова, человек искусства» несколько устарело и гораздо более редко, чем основное значение. Основное значение английского слова *accuracy* не «аккуратность», а «точность, правильность», а слова *occupant* не «оккупант», а «жилец, житель, обитатель». Перевод таких слов ближайшим по звучанию словом может привести к грубой ошибке и к искажению смысла предложения. Но есть ряд слов, которые переводятся двояко, например: *realize* – осознавать (а не только реализовать), *record* – запись, отчет (а не только рекорд), *occupation* – род занятий, профессия (а не только оккупация, захват). На эту тему существует множество анекдотов с игрой слов. Например: *Приезжает русский в Эстонию. Пограничник спрашивает его: «Occupation?» «No, – успокаивает его русский, – just visiting».*

Приводим краткий список английских слов, созвучных русским словам, которые отличаются от них по значению:

accuracy ['ækjurəsi] – точность (а не аккуратность)
accurate ['ækjurit] – точный (а не аккуратный)
audience [ɔ:djəns] – аудитория, слушатели, публика (реже аудиенция)
brilliant ['briljənt] – блестящий, сверкающий (а не бриллиант)

data ['deita] (pi. от datum) – данные, сведения (ни в коем случае не дата)

decade [di'keid] – десятилетие (не декада)

delicate ['delikit] – изящный, хрупкий, тонкий (о работе); затруднительный (о положении); чувствительный (о приборе); (редко деликатный)

Dutch [dʌtʃ] – голландский (не датский)

list [list] п – список, перечень (а не лист)

magazine [mægə'zi:n] – журнал; склад боеприпасов (а не магазин)

manufacture [mænju'fæktʃə] – изготовление, производство; pl. изделия, фабрикаты (но не мануфактура)

momentum [məu'mentəm] – инерция, толчок, импульс, механический момент (а не момент как мгновение)

personal ['pз:sənəl] – личный (не персонал)

pretend [pri'tend] – делать вид, притворяться (в значении «претендовать» почти не употребляется)

production [prə'dʌkʃn] – производство, выработка, добыча (угля, руды) (не продукция; это понятие передается словами product или output)

Грамматические особенности

Английские научно-технические тексты содержат целый ряд грамматических особенностей. Конечно, не существует какой-либо «научно-технической грамматики». В научно-технической речи используются те же самые синтаксические структуры и морфологические формы, как и в других функциональных стилях. Однако ряд грамматических явлений отмечается в данном стиле чаще, чем в других, некоторые явления, напротив, встречаются в нем сравнительно редко, другие – используются лишь с характерным лексическим «наполнением».

Глагол-связка и именная часть (использование структур типа А есть Б)

Общие свойства научно-технического изложения могут не отражаться на синтаксической структуре высказывания. Так, мы уже отмечали, что для подобных материалов особенно характерны определения понятий и описание реальных объектов путем указания на их свойства. Это предопределяет широкое использование структур типа А есть Б, т.е. простых двусоставных предложений с составным сказуемым, состоящим из глагола-связки и именной части (предикатива): *The barn is a unit of measure of nuclear cross sections* (Барн это внесистемная единица измерения сечения ядерного процесса); *Electromotive force is the force or pressure that causes electric current to flow* (Электродвижущая сила это сила или давление, вызывающие движение тока), etc. В качестве предикатива часто выступает прилагательное или предложный оборот: *The pipe is steel* (трубопровод стальной); *The surface is copper* (поверхность медная); *Control is by a foot switch* (контроль осуществляется за счет педального переключателя).

Основные способы перевода страдательного залога

Если сказуемое выражено глаголом в страдательном залоге, то подлежащее не выполняет действия, а подвергается действию, выраженному этим глаголом. При переводе на русский язык страдательную конструкцию можно передать следующими способами.

- Русской формой страдательного залога данного глагола в соответствующем времени, лице и числе: *The paper was written last year.* Статья была написана в прошлом году.

- Возвратной формой глагола на *«-ся», «-сь»* в соответствующем времени, лице и числе: *Many power stations are built in the world today.* Много электростанций строится сегодня по всему миру.

- Неопределенно-личной формой глагола действительного залога в соответствующем времени в 3-м л. мн. ч.: *The excavation was made with great care.* Раскопку производили с большой осторожностью.

- Личной формой глагола в действительном залоге (такой перевод возможен только в том случае, если указано лицо, производящее действие, т.е. если в предложении есть дополнение с предлогом *by*): *These papers were written by one and the same author.* Эти работы писал один и тот же автор.

Особенности перевода безличных конструкций в страдательном залоге

Наиболее употребительны следующие модели безличной страдательной конструкции:

It is said that... Говорят, что ...

It is expected that... Ожидают (ожидается), что ...

It is known that... Известно, что ...

It must be stressed that... Следует (нужно) подчеркнуть, что ...

It cannot be denied that... Нельзя отрицать (того), что ...

It should be remembered that... Следует помнить, что ...

Использование эллиптических конструкций

Важная характеристика английского научно-технического стиля, которая отражается в отборе и использовании языковых средств, заключается также в его стремлении к краткости и компактности изложения, что выражается, в частности, в довольно широком использовании эллиптических конструкций. Неправильное понимание этих конструкций нередко приводит к нелепым ошибкам в переводе. Встретив в тексте сочетание, *a remote crane* или *a liquid rocket*, переводчик должен распознать в них эллиптические формы сочетаний *a remote-operated crane* (кран с дистанционным управлением) и *a liquid-fuelled rocket* (ракета на жидком топливе). Прочитав, что *A non-destructive testing college is to open in London this October*, он должен помнить, что открывающийся колледж вовсе не будет неразрушающимся (*non-destructive*) или испытательным (*testing*), а будет готовить специалистов в области неразрушающих методов испытания материалов. Аналогичным образом *low-pressure producers* могут оказаться производителями полиэтилена методом низкого давления.

Неопределенно-личные и безличные предложения

В современной научной и технической литературе принято вести изложение не от первого, а от третьего лица и часто применяются неопределенно-личные и безличные предложения. В неопределенно-личных предложениях подлежащее, как правило, выражается неопределенно-личным местоимением ONE.

На русский язык такие предложения следует переводить неопределенно-личными или безличными предложениями.

One believes that... Считают, что...

One knows that... Известно, что...

One must expect that... Следует ожидать, что...

One is faced with (the difficulty, trouble,problem) Возникает трудность (встает задача)

One may well (ask) Есть все основания (спросить, задать вопрос)

One has to be careful while testing the new machine. Нужно быть внимательными при испытании новой машины.

В безличных предложениях в английском языке всегда имеется подлежащее, выраженное местоимением «*it*», которое на русский язык не переводится, так как не имеет смыслового значения и выполняет только функцию формального подлежащего.

It was easy to understand the speaker. Было легко понять докладчика.

In ancient times it was believed that the earth was flat. В древности думали что земля плоская.

It is important that the test be repeated. Важно, чтобы опыт повторили.

Основные способы перевода инфинитивных конструкций

В английском языке имеется четыре формы инфинитива, которые соответствуют четырем группам времен: Infinitive Indefinite, Infinitive Continuous, Infinitive Perfect и Infinitive Perfect Continuous. Инфинитивы Indefinite и Perfect имеют, кроме того, форму страдательного залога.

В научной литературе наиболее употребительны формы Indefinite и Perfect действительного и страдательного залога.

Перевод каждой формы инфинитива в отдельности затруднителен, а иногда и просто невозможен, так как полное соответствие в русском языке имеют только формы *to read* – читать и *to be read* – быть прочитанным (читаемым). Однако и эти формы не всегда могут быть переведены инфинитивом. Точные видовременные значения сложных форм инфинитива полностью выявляются лишь в контексте.

Частица to, почти постоянно предшествующая инфинитиву, может служить удобным признаком для отыскания его в предложении, например, в тех случаях, когда инфинитив по форме совпадает с существительным или прилагательным, например;

experiment – to experiment (эксперимент – экспериментировать); *fashion – to fashion* (вид, форма – придавать форму).

В ряде случаев, однако, инфинитив употребляется без *to*:

- после модальных и вспомогательных глаголов *must, can, could, may, might, shall, should, will, would, need, dare*;
- в обороте «объектный падеж с инфинитивом» после глаголов чувства и восприятия (например: *I heard him speak.* Я слышал, как он говорит);
- после сочетаний *had better* – лучше бы, *would rather (sooner)* – предпочел бы (например: *You had better begin now.* – Начните лучше сейчас);
- после глаголов *to let* - разрешать, позволять, давать и *to make* – заставлять (например: *Let me pass, please.* – Позвольте мне пройти, пожалуйста; *It made him laugh.* – Это заставило его рассмеяться).

Инфинитив в предложении может быть подлежащим, обстоятельством, определением, дополнением, а также входить как составная часть в сказуемое – именное и глагольное.

Инфинитив в функции подлежащего. Инфинитив является подлежащим, если стоит в начале предложения, отвечает на вопрос *«что? что делать?»*, а непосредственно за подлежащим или за относящимися к нему словами следует сказуемое*:* *To understand this author is not easy.* – Понять этого автора нелегко. Инфинитив в функции подлежащего переводится инфинитивом или соответствующим отглагольным существительным: *To accomplish this work requires great skill.* – Выполнение этой работы требует большого уменья.

Инфинитив в функции обстоятельства цели отвечает на вопрос *для чего? для какой цели?* Он расположен в начале или в конце предложения и иногда вводится союзами *in order (to)* – чтобы, для того чтобы; *so as (to)* – с тем чтобы: *He has gone to England (in order) to perfect his knowledge of English.*

Инфинитив в функции обстоятельства следствия обычно стоит в конце предложения. Характерным признаком его служат наречия (*too* – слишком, *enough, sufficiently* – достаточно), расположенные перед прилагательным или наречием, за которыми следует инфинитив с частицей *to*. Инфинитив следствия переводится союзом «чтобы» с последующим инфинитивом. Все предложение нередко приобретает модальное значение возможности (или невозможности), которое в русском языке выражается употреблением слов «можно», «может» и т.п.: *The finds are too few to be spoken about.* – Находок слишком мало, чтобы о них (можно было) говорить.

Инфинитив следствия может также вводиться союзом as с предшествующими наречиями so или such: *The rule has been so formulated as to be easily observed by everybody.* – Правило было сформулировано таким образом, чтобы все могли легко его соблюдать.

Инфинитив в функции определения следует за определяемым словом (обычно это существительное), имеет форму действительного или страдательного залога и отвечает на вопрос *какой?*. В русском языке инфинитиву в функции определения соответствует определительное придаточное предложение, начинающееся словами «который», «кто». Инфинитив в функции определения чаще всего имеет модальный оттенок необходимости, возможности или приобретает значение будущего времени и переводится с добавлением слов «необходимо», «следует», «можно (нельзя)» или глаголом в будущем времени: *This is the main difficulty to be taken into consideration.* – Это основная трудность, которую нужно учитывать. *This is a rule not to be forgotten.* – Это правило, которое не следует (нельзя) забывать.

При переводе следует обращать внимание на форму предшествующего глагола и на форму самого инфинитива. Infinitive Indefinite переводится глаголом в настоящем или прошедшем времени, Infinitive Perfect – прошедшем временем глагола.

Трансформации в процессе перевода

Главная цель перевода – достижение адекватности. Адекватный, или как его еще называют, эквивалентный перевод – это такой перевод, который осуществляется на уровне, необходимом и достаточном для передачи неизменного плана содержания при соблюдении соответствующего плана выражения, т.е. норм переводящего языка.

Структурные и лексико-семантические расхождения между двумя языками требуют при переводе с одного языка на другой перестройки синтаксической структуры предложения либо лексической замены английского слова, не имеющего эквивалента в русском языке. Для достижения адекватности перевода применяют различные трансформации, т.е. преобразования, превращения. Каждый случай неэквивалентности структур требует определенной трансформации, которая обычно рассматривается как трудность перевода. Основная задача при достижении адекватности перевода – умело произвести различные переводческие трансформации, для того чтобы текст перевода как можно более точно передавал всю информацию, заключенную в тексте оригинала, при соблюдении соответствующих норм переводящего языка.

Типы трансформаций в процессе перевода:

- Перестановки – изменение порядка слов при несовпадении смыслового центра предложения.
- Замены, которым могут подвергаться как части речи, так и члены предложения. Часто замены сопровождаются перестройкой всего

предложения при передаче английской пассивной конструкции действительным залогом в русском языке. К замене относится и антонимический перевод, при котором отрицательная структура заменяется утвердительной. Лексико-семантические замены – это способ перевода лексических единиц иностранного языка путем использования единиц языка перевода, которые не совпадают по значению с начальными, но могут быть выведены логически. Прием смыслового развития заключается в замене словарного соответствия при переводе контекстуальным, логически связанным с ним.

- Опущения – во всех случаях семантического дублирования при переводе парных синонимов опускается повтор.
- Добавления – это не добавление смысла, а добавление слов для сохранения смысла предложения.

Виды перевода: Перевод путем использования русских эквивалентов, т.е. постоянных и равнозначных соответствий в двух данных языках, в большинстве случаев, не зависящих от контекста.

- Перевод с помощью аналогов, т.е. слов синонимичного ряда. В этом случае одному иностранному слову соответствует несколько русских слов. Необходимо выбрать вариант, наиболее подходящий по контексту.
- Калькирование или дословный перевод состоит в переводе английского слова или выражения путем точного воспроизведения их средствами русского языка, при этом сохраняется структура предложения, каждое слово переводится так, как оно дано в словаре. Калькирование – воспроизведение незвукового, а комбинаторного состава слова или словосочетания, когда составные части слова (морфемы) или фразы (лексемы) переводятся соответствующими элементами переводящего языка. Дословный перевод используется при совпадении в английском и русском языке структуры предложения и порядка слов. Перевод является дословным, если в нем сохранены те же члены предложения и тот же порядок их следования, как и в оригинале. От дословного перевода

необходимо отличать недопустимый в переводческой практике буквальный перевод, т.е. простой механический перевод слов иноязычного текста в таком порядке в каком они следуют в нем, без учета их синтаксических и логических связей. В буквальном переводе встречается наиболее распространенное значение слова или грамматической конструкции без учета всего контекста. Синтаксическое уподобление или дословный перевод – такой перевод, при котором синтаксическая структура оригинала преобразуется в абсолютно аналогичную структуру переводного языка.

- Описательный перевод используется для перевода английских слов, не имеющих лексических соответствий в русском языке. Передача значения английского слова при помощи более или менее распространенных объяснений используется для объяснения неологизмов. Описательный перевод имеет место, когда полностью расходятся грамматические структуры английского и русского языков, вызван особенностями сочетаемости слов английского языка.
- Транслитерация – передача буквами русского письма букв английского письма, независимо от произношения английского слова. Иными словами, транслитерация – формальное побуквенное воссоздание исходной лексической единицы с помощью алфавита переводящего языка, буквенная имитация формы исходного слова. При этом исходное слово в переводном тексте представляется в форме, приспособленной к произносительным характеристикам переводящего языка. Прием транслитерации можно использовать в тех случаях, когда передаваемая реалия вызывает у читателя твердо укрепившиеся ассоциации, в противном случае транслитерация должна сопровождаться соответствующим примечанием, раскрывающим смысл данной реалии. Транслитерация целесообразна тогда, когда желательно воспроизвести лаконизм подлинника и сохранить специфическую характеристику данной реалии в иностранном языке.

- Транскрибирование – передача произношения английского слова русскими буквами. Это основной прием перевода при передаче имен и названий. Переводческая транскрипция – это формальное пофонемное воссоздание исходной лексической единицы с помощью фонем переводящего языка, фонетическая имитация исходного слова.
- Членение и объединение предложений используется при переводе специфических конструкций, не имеющих соответствия в русском языке. Различают внутреннее членение (замена простого предложения сложным) или внешнее членение (превращение развернутого предложения в два или более предложения).
- Конкретизация – это способ перевода, при котором происходит замена слова или словосочетания иностранного языка с более широким предметно-логическим значением на слово в переводе с более узким значением.
- Генерализация (процесс, обратный конкретизации) исходного значения имеет место в тех случаях, когда мера информационной упорядоченности исходной единицы выше меры упорядоченности соответствующей ей по смыслу единицы в переводящем языке и заключается в замене частного общим, видового понятия родовым. При переводе с английского на русский этот прием применяется гораздо реже, чем конкретизация. Достаточно широко этот прием используется при переводе таких слов, как: *to be, to have, to get, to do, to take, to give, to make, to come, to go* и т.д.

Грамматические трансформации заключаются в преобразовании структуры предложения в процессе перевода в соответствии с нормами переводного языка. Если рассматривать отдельные виды грамматических трансформаций, то, пожалуй, наиболее распространенным приемом следует считать замену английских существительных русскими глаголами. Это явление связано с богатством и гибкостью глагольной системы русского языка. Чисто грамматическая замена применяется, когда единица иностранного языка преобразуется в единицу языка перевода с иным грамматическим значением, однако, имеющим тоже самое логическое. Например, замена глагола на существительное множественного числа на единственное и т.д.

Таким образом, перевод научно-технических текстов должен верно передавать смысл оригинала в форме, по возможности близкой к форме оригинала. Отступления должны быть оправданы особенностями русского языка, требованиями стиля. Перевод в целом не должен быть ни буквальным, ни вольным пересказом оригинала, хотя элементы того и другого обязательно присутствуют. Важно не допускать потери существенной информации оригинала и учитывать все особенности и аспекты научно-технического стиля, который характеризуется логической последовательностью изложения, упорядоченной системой связей между частями высказывания, стремлением авторов к точности, сжатости, однозначности при сохранении насыщенности содержания.

1.5. Рекомендации по созданию точного и последовательного процесса перевода

При переводе необходимо средствами одного языка выразить как можно более точно и полно то, что уже выражено средствами другого языка. Всегда нужно помнить, что перевод должен в полной мере соответствовать нормам того языка, на который он сделан. Если перевод производится с английского на русский, нужно помнить нормы правила русского языка и для получения адекватного перевода прибегать к различным переводческим трансформациям, не бояться перестраивать синтаксическую структуру предложения, использовать антонимический перевод и прочее.

<u>Для создания точного и последовательного процесса перевода необходимо выполнить несколько несложных правил</u>:

1. Первый раз необходимо прочитать текст без словаря и попытаться понять смысл текста, его строение и наличие в нём незнакомых слов.

2. Найти адекватные средства выражения в переводящем языке (слова, термины, словосочетания, грамматические формы), необходимые для правильного истолкования переводимого текста.

3. Выделить в предложении смысловые группы.

Немного поясним: предложения обычно делятся на объединенные по смыслу группы слов, в которых невозможно отделить одно слово от другого, не нарушая смысла. Такие группы слов называются смысловыми группами. Смысловая группа может состоять из одного слова, группы слов, придаточного предложения или простого нераспространенного предложения. Это достаточно распространенная ошибка, когда смысловая группа выделена неправильно или разделена ещё на какие-нибудь отрезки. Это приводит к нарушению смысла данного предложения. Например: *On reading the article he made a short summary of it.* – Прочитав статью, он кратко изложил ее содержание. Очевидно, что здесь две смысловые группы: 1я – *On reading the article*, 2я – *he made a short summary of it.* Выделив смысловые группы иначе или поделив их еще на отрезки, смысл предложения исказится.

4. Выделить главные члены предложения.

Для правильного понимания исходного английского текста необходимо научиться анализировать предложение, и этот анализ нужно начинать с нахождения главных членов предложения – подлежащего и сказуемого – и установления связей между всеми остальными членами предложения. Предложения в английском языке строятся иначе, чем в русском, и если не учитывать это, то можно неправильно истолковать услышанную или прочитанную информацию.

Первое, что следует запомнить как «дважды два» – в английском предложении всегда есть подлежащее и сказуемое. ВСЕГДА! Как бы предложение не звучало по-русски, английское предложение без подлежащего и сказуемого не существует. В русском языке можно употребить такие предложения: «Холодно» или «Темнеет». В английском языке это обязательно прозвучит, как *It is cold;* It is getting dark. (It – подлежащее, is – сказуемое или часть сказуемого).

Английские предложения подчиняются особой стилистике. Если в русском языке можно играть со словами в предложении, например: Я обычно смотрю телевизор по вечерам, или, Я по вечерам обычно смотрю телевизор, или, Я смотрю обычно телевизор по вечерам т.д., то на английском это будет гораздо сложнее, или вообще невозможно. Правильно будет сказать: *I usually watch TV in the evenings.* Также в русском языке много неполных предложений, т.е. без подлежащего, или без сказуемого. Например: Мне холодно. Уже поздно. Не получится. Это часы. А в английском это невозможно, потому что во всех английских предложениях есть подлежащее и сказуемое. Посмотрим на перевод тех же неполных предложений: *It is cold.* (It – подлежащее, is – сказуемое).

Основными членами предложения являются подлежащее и сказуемое.

- Подлежащее (Subject) обозначает предмет, о котором идёт речь и отвечает на вопрос *кто? что?* может быть выражено существительным, местоимением, герундием, числительным и даже инфинитивом.

- Сказуемое (Predicate) также является основным членом предложения, обозначающим действие, которое совершает подлежащее. Сказуемое отвечает на вопрос *что делает(ся)?*, и выражается личным глаголом в разных временах, залогах и наклонениях.

5. Обязательно выписать и перевести все незнакомые слова. Нет слов – нет адекватного, правильного перевода.

РАЗДЕЛ II: ЧТЕНИЕ И ПЕРЕВОД НАУЧНО-ТЕХНИЧЕСКОЙ ЛИТЕРАТУРЫ

2.1. Тексты для аудиторного чтения

Text 1: Inventions Throughout the Ages

Middle Ages

Historians differ in their opinions of when the Middle Ages began and ended, most sources define the Middle Ages as an historical period from 500 AD to 1450 AD.

The Middle Ages was a period full of discovery and inventing:

1023 – First paper money printed in China.

1045 – Movable type printing by Bi Sheng in China

Circa 1050 – Crossbow invented in France.

1182 – Magnetic compass invented.

Circa 1200 – Clothing buttons invented.

1202 – The Hindu-Arabic numbering system introduced to the west by Italian mathematician, Fibonacci.

1249 – Rodger Bacon invented his gunpowder formula.

Circa 1250 – Gun invented in China.

Circa 1268 – 1289 – Invention of eyeglasses.

Circa 1280 – Mechanical clocks invented.

Circa 1285 – 1290 – Windmills invented.

1295 – Modern glassmaking begins in Italy.

1328 – First sawmill.

1326 – First mention of a handgun.

1366 – Scales for weighing invented.

15th Century

The 15th century gave birth to three major events: the beginning of the Renaissance Era (circa 1453); the birth of the Age of Discovery with increased exploration and improved naval ships and navigation methods that created new trade routes and trade partners; and the birth of modern printing marked by the 15th century master printer Johann Gutenberg’s invention of movable type presses (1440) that made the inexpensive mass-printing of books possible.

16th Century

The 16th century was a time of unprecedented change, the very beginning of the modern era of science, a time of great exploration, religious and political turmoil, and extraordinary literature.

In 1543 Copernicus published his theory that the Earth was not the center of the universe, rather, the Earth and the other planets orbited around the Sun. Called the Copernican Revolution, his theory forever changed astronomy, and ultimately changed all of science.

During the 16th century advancements were made in the theories of mathematics, cosmography, geography and natural history. The 16th century inventions related to the fields of engineering, mining, navigation and the military arts were prominent.

17th Century

During the 17th century major changes in philosophy and science took place. Before the 17th century began, science and scientists were not truly recognized. In fact, at first people like the 17th century genius Isaac Newton were called natural philosophers, since there was no concept of the word scientist for most of the 17th century.

The intrusion of newly invented machines became part of the daily and economic lives of 17th century folk. During the 17th century the science of chemistry developed from medieval alchemy and the 17th century science of astronomy evolved from astrology.

By the end of the 17th century a scientific revolution had occurred and science had become an established mathematical, mechanical, and empirical body of knowledge. Galileo Galilei, René Descartes, Blaise Pascal, Isaac Newton, and others had become noted scientists.

18th Century

The 18th century began the first Industrial Revolution. Modern manufacturing began with steam engines replacing animal labor. The 18th century saw the widespread replacement of manual labor by new inventions and machinery.

The 18th century was also a part of «The Age of Enlightenment», a historical period characterized by a change away from traditional religious sources of authority, and a move towards science and rational thought.

The effects of 18th century enlightenment led to the American Revolutionary War and the French Revolution. The 18th century saw the spread of capitalism and the increased availability of printed materials.

19th Century

The invention of useable electricity, steel, and petroleum products during the 19th century led to a second Industrial Revolution (1865–1900), that featured the growth of railways and steam ships, faster and wider means of communication, and inventions with names we all know today.

The 19th century was the age of machine tools – tools that made tools – machines that made parts for other machines, including interchangeable parts. The assembly line was invented during the 19th century, speeding up the factory production of consumer goods.

The 19th century gave birth to professional scientists, the word scientist was first used in 1833 by William Whewell. Inventors began to design practical internal combustion engines. The light bulb, telephone, typewriter, sewing machine, all came of age during the 19th century.

20th Century

Technology, science, and inventions have progressed at an accelerated rate during the hundred years of the 20th century.

We began the 20th century with the infancy of airplanes, automobiles, and radio, when those inventions dazzled us with their novelty and wonder.

We end the 20th century with spaceships, computers, cell phones, and the wireless Internet all being technologies we can take for granted.

The 50s have always been described as a conservative period socially, however, advancements in technology were about to change all that. During the 50s, television became the dominant media. The 50s saw nearly every family buying a television set, and nearly everyone watching television for longer and longer periods of time. Television broadcasts became our number one source of news, information, and entertainment during the 50s.

The 60s have been described by historians as the ten years having the most significant changes in history. By the end of the 60s humanity had entered the space age by putting a man on the moon. The 60s were influenced by the youth of the post-war baby boom – a generation with a fondness for change and far-out gadgets.

The 70s began the age of the practical computer made possible by the invention of the floppy disk and the microprocessor that occurred during the 70s.

Many of the most popular consumer products still around today were invented in the 80s (for example, cell phones and home computers). The 80s saw the rise of the multi-national corporations, while the growth rate during the 80s was 3.2% per year, the highest 9 year rate in American history, a complex combination of causes (economic, financial, legislative and regulatory) led to the extraordinary number of bank failures in the 80s.

The 90s saw the invention of the internet and the rise of Microsoft, the invention of genetic engineering and cloning, as well as, stem cell research.

Задания к тексту

I. Дайте ответы на следующие вопросы:

1. What major events took place in the 15th century?
2. What theory did Copernicus publish in 1543?
3. What were the 17th century genii like Isaac Newton called?
4. When did the first Industrial Revolution begin?
5. What was the Age of Enlightenment characterized by?
6. How long did the second Industrial Revolution last?
7. What inventions has the beginning of the 21st century seen?

II. Соедините части предложений по смыслу:

1. The 15th century gave birth to three major events:	a. mathematics, cosmography, geography and natural history.
2. The 16th century was a time of unprecedented change,	b. the infancy of airplanes, automobiles, and radio.
3. During the 16th century advancements were made in the theories of	c. the beginning of the Renaissance Era; the birth of the Age of Discovery; and the birth of modern printing.
4. During the 17th century major changes in	d. machine tools.
5. The 18th century began	e. philosophy and science took place.
6. The effects of 18th century enlightenment led to	f. the very beginning of the modern era of science, a time of great exploration, religious and political turmoil, and extraordinary literature.
7. The 19th century was the age of	g. the American Revolutionary War and the French Revolution.
8. We began the 20th century with	h. the first Industrial Revolution.

III. Подберите определения к следующим словам:

advancement, intrusion, to evolve, to feature, to speed up, assembly line, internal combustion engine, consumer goods, turmoil, alchemy

1. To include someone or something as an important part.
2. A state of confusion, uncertainty, or disorder.
3. Products that people buy for their own use.
4. An occasion when someone goes into a place or situation where they are not wanted or expected to be.
5. To develop gradually, or to cause something or someone to develop gradually.
6. An act of developing or improving something.

7. To increase in the rate of change or growth.
8. A form of chemistry and speculative philosophy practiced in the Middle Ages and the Renaissance and concerned principally with discovering methods for transmuting base metals into gold and with finding a universal solvent and an elixir of life.
9. A line of machines and workers in a factory that a product moves along while it is being built or produced.
10. An engine that produces energy by burning fuel within itself.

IV. Переведите предложения на английский язык:

1. Механические часы были изобретены примерно в 1280 году.
2. Магнитный компас был изобретен в 1182 году.
3. 16 век ознаменовался большими потрясениями в религиозной и политической жизни.
4. Химия берет свое начало из средневековой алхимии.
5. Появление сборочного конвейера значительно ускорило фабричное производство потребительских товаров.
6. Слово «ученый» впервые использовал английский философ Уильям Уэвелл в 1833.
7. В 50-е годы двадцатого века телевидение стало главным источником информации.

V. Используя информацию из текста, составьте предложения в страдательном залоге. Какие способы перевода предложений в страдательном залоге вы знаете? Переведите полученные предложения.

Например: 1023 – First paper money printed in China. – The first paper money was printed in China in 1023.

1. Circa 1050 – Crossbow invented in France.
2. Circa 1200 – Clothing buttons invented.
3. 1249 – Rodger Bacon invented his gunpowder formula.
4. Circa 1268 – 1289 – Invention of eyeglasses.

5. 1328 – First sawmill.
6. 1326 – First mention of a handgun.
7. 1366– Scales for weighing invented.

VI. Переведите следующие предложения. Какие трансформации необходимо использовать при переводе?

1. The 18th century saw the widespread replacement of manual labor by new inventions and machinery.
2. The 50s saw nearly every family buying a television set, and nearly everyone watching television for longer and longer periods of time.
3. The 90s saw the invention of the internet and the rise of Microsoft, the invention of genetic engineering and cloning, as well as, stem cell research.
4. The 80s saw the rise of the multi-national corporations.

Text 2: Top 10 British Inventions That Changed the World

Great Britain produced many of the most influential scientists, mathematicians and inventors in modern history. With influential people, come influential ideas, theories and inventions, some of which have the potential to change the world forever.

10. United States of America

The USA was formed when British colonies in North America declared independence after continued and growing disputes with the Kingdom of Great Britain (as it was then known) over taxation of the colonies without representation in British parliament. The Revolutionary War lasted 8 years from 1775 to 1783, resulting in victory and independence for the USA.

However, the fact remains that the colonists were British subjects until the point of victory in 1783, at which time they became independent Americans. By that reasoning, the USA was, at its inception, a British invention.

9. Nearly Every Modern Sport

Most popular sports in the modern world trace their history to Britain, the most notable being Football, Cricket, Rugby and Tennis. Of course, the British weren’t the first to think of kicking a ball around in a field, but the British standardized the structure and rules of most modern competitive sports as we know them today.

8. Newton’s Laws

Isaac Newton was a British physicist and mathematician. Born in 1642, Newton discovered and documented for the first time three laws of motion in regard to physics. Newton’s work is some of the most influential in the history of modern science.

7. Programmable Computer

The first programmable computer was invented by British mathematician and scientist Charles Babbage in the 1820s. Babbage began work on a mechanical computer he called the Difference Engine in 1822, working for more than ten years with government funding. The project was eventually abandoned after losing funding and Babbage went on to invent the Analytical

Engine, a far more complex machine than the Difference Engine, it could be programmed using punched cards. The Analytical Engine, although not built in full until 2011 by British researchers, was the first ever working programmable computer, and was the first step in the history of computing as we know it.

6. World Wide Web

Not to be confused with the Internet (a global system of networked computers invented in the USA), the World Wide Web, invented by British computer scientist Tim Berners-Lee, is the system of interlinked hypertext documents accessed via the Internet. The World Wide Web is most commonly experienced as the system of web pages and websites. Interestingly, Berners-Lee, although realizing the potential for immense personal profit from his invention, chose instead to gift the idea to the world, requesting no payment.

5. Television

The world's first publicly demonstrated television was invented by British inventor John Logie Baird in 1925. The first public demonstration was performed before members of the Royal Institution on 26th January 1926. He also later demonstrated the first color television on 3rd July 1928. Logie Baird's invention paved the way for what is now nearly a century of work on the development of television technology, which remains one of the most influential inventions in history.

4. Steam Locomotive

The first steam locomotive was invented by Richard Trevithick, a British inventor and mining engineer. Trevithick's steam locomotive was built in 1804 in Pen-y-Darren in South Wales to carry cargo. In one of the earliest public demonstrations, the locomotive successfully carried an impressive load of 10 tons of iron, 5 wagons and 70 men 9.75 miles between Penydarren and Abercynon in 4 hours and 5 minutes. Trevithick continued to work with steam locomotives for many more years until his death in April 1833. A full-scale working replica of his first steam locomotive was built in 1981 for the Welsh Industrial and Maritime Museum. The locomotive is run several times a year along a short length of rail outside the museum.

3. Theory of Evolution

Charles Darwin was a British naturalist born in 1809. He was the first person to propose the now popular theories of evolution, natural selection and common descent. After a 5 year voyage around the globe aboard the HMS Beagle, Darwin returned to Britain finding himself a celebrity in scientific circles following distribution of his letters to various scientists at home while he had been away studying geology aboard the Beagle. Darwin formed his theory of evolution over much of his life, only publishing it in his later years in his book «On The Origin of Species» for fear of how the public would respond to what was, at the time, a highly controversial theory.

2. Telephone

The telephone was invented by British inventor Alexander Graham Bell and patented in 1876. His early experiments with sound began when he was taken to see a “speaking” automaton designed by Baron Wolfgang von Kempelen and built by Sir Charles Wheatstone.

Fascinated by the machine, Bell purchased a copy of a book written in German by Baron Wolfgang von Kempelen and built a similar automaton with his brother. Many years later, while working at Boston University School of Oratory, Bell became interested in technology to transmit sound. Leaving his job at the university, he made the decision to pursue his personal research on the subject. In 1875, Bell created an acoustic telegraph which he patented in March 1876.

1. English Language

English is the second most widely spoken language in the world behind Mandarin. However, it is the official language of more countries worldwide than any other, and the most common second language globally. English is generally used as the intermediary language of choice at global events and international summits. The English language is also the most far reaching language in the world, with native speakers as far spread as Australia, New Zealand, the USA, Canada and, of course, Great Britain, where the language was born. Every great speech in the long history of the English speaking world, every theory, paper, proposal and design too, share one common thing: the English language. That is why it must be Britain's most influential invention.

Задания к тексту

I. Дайте ответы на следующие вопросы:

1. When was the USA formed?
2. Why was the USA a British invention?
3. What sports trace the history to Britain?
4. What is Isaac Newton famous for?
5. When was the first programmable computer invented?
6. What is the difference between the World Wide Web and the Internet?
7. Who invented the world's first publicly demonstrated television?
8. Who invented the first steam locomotive? When?
9. What does HMS stand for?
10. What theory did Charles Darwin form?
11. Who is the inventor of the telephone?
12. Why do you think it is important to study English?

II. Закончите предложения:

1. The USA was formed when…
2. The Revolutionary War lasted…
3. The British standardized the structure and rules of…
4. Newton discovered and documented for the first time three…
5. The first programmable computer was invented by…
6. The World Wide Web is the system of…
7. The first public demonstration of television was performed in…
8. The first steam locomotive was built to…
9. Charles Darwin was the first person to propose…
10. Bell created an acoustic telegraph in…
11. English is the official language of…

III. Подберите русские эквиваленты к следующим словам и словосочетаниям

to trace the history, government funding, punched card, to pave the way, natural selection, common descent, to pursue the research, mining engineer, inception, cargo, replica

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перфокарта, начало, проводить исследование, брать начало, прокладывать путь, общий предок, модель, правительственные субсидии, горный инженер, естественный отбор, груз

IV. а) Подберите определения к следующим словам:

influential, independence, taxation, motion, to abandon, complex, cargo, evolution, controversial, locomotive, to access

1. A railway engine.
2. To leave a place, thing, or person, usually forever.
3. Causing disagreement or discussion.
4. Freedom from being governed or ruled by another country.
5. To obtain (stored information) from a computer memory.
6. The system of taxing people.
7. Having a lot of influence.
8. The act or process of moving.
9. Involving a lot of different but related parts.
10. The goods carried by a ship, aircraft, or other large vehicles.
11. A gradual process of change and development.

б) Дайте определения следующим словам и словосочетаниям, используя предыдущее задание в качестве образца:

Revolutionary War, World Wide Web, Internet, celebrity, steam locomotive, theory of evolution, laws of motion.

V. Найдите предложения с инфинитивом. Определите форму инфинитива. Переведите предложения.

1. With influential people, come influential ideas, theories and inventions, some of which have the potential to change the world forever.

2. The Revolutionary War lasted 8 years from 1775 to 1783, resulting in victory and independence for the USA.
3. Of course, the British weren’t the first to think of kicking a ball around in a field.
4. Newton discovered and documented for the first time three laws of motion in regard to physics.
5. The project was eventually abandoned after losing funding and Babbage went on to invent the Analytical Engine.
6. Not to be confused with the Internet, the World Wide Web is the system of interlinked hypertext documents accessed via the Internet.
7. Charles Darwin was the first person to propose the now popular theories of evolution, natural selection and common descent.
8. That is why it must be Britain’s most influential invention.

VI. Проведите анализ предложений. Выделите подлежащее и сказуемое.

1. Most popular sports in the modern world trace their history to Britain.
2. Born in 1642, Newton discovered and documented for the first time three laws of motion in regard to physics.
3. The Analytical Engine, although not built in full until 2011 by British researchers, was the first ever working programmable computer.
4. Not to be confused with the Internet (a global system of networked computers invented in the USA), the World Wide Web, invented by British computer scientist Tim Berners-Lee, is the system of interlinked hypertext documents accessed via the Internet.
5. In one of the earliest public demonstrations, the locomotive successfully carried an impressive load of 10 tons of iron, 5 wagons and 70 men 9.75 miles between Penydarren and Abercynon in 4 hours and 5 minutes.
6. Many years later, while working at Boston University School of Oratory, Bell became interested in technology to transmit sound.

Text 3: 10 Bizarre Forgotten Inventions from Famous Inventors

When you're an inventor, you can't just stop at one. A real inventor can't help seeing new opportunities in places where others just see day-to-day trivial banalities. So the inventor makes another thing, and then another. They might not all work, and some might end up being significantly more successful than the rest, but it gives us something to talk about later.

1. Swim Fins (Benjamin Franklin)

Benjamin Franklin has a long list of accomplishments in numerous fields, so it should come as no surprise that he was an inquisitive child. In fact, he started his career as an inventor at the ripe age of 11 when he invented a pair of swim fins.

Franklin was an avid swimmer and was looking for ways to improve his technique. His solution was a set of wooden fins which were worn on the hands instead of the feet. They didn't make it to popular use, but according to Franklin, the swim fins were a success in the sense that they improved his speed. Unfortunately, they also fatigued his wrists.

2. The Giant Crossbow (Leonardo Da Vinci)

Leonardo da Vinci managed to garner quite a reputation as an inventor despite the fact that most of his creations were confined to drawings and plans. Some of those designs became quite iconic despite never being built. Examples include his various flying machines. Leonardo also dabbled a little in warfare. He designed a tank-like armored vehicle and a more bizarre giant crossbow. The design was similar to that of a ballista, but on a massive scale.

3. The Metal Detector (Alexander Graham Bell)

In addition to Alexander Graham Bell's invention of the telephone, he also created one of the very first metal detectors. His intention was to save the life of President James Garfield.

On July 2, 1881, James Garfield was shot in an assassination attempt. Medical experts from all over the country lent their expertise in order to recover the bullet lodged in Garfield's body.

Bell’s contribution to the effort was his suggestion to use an electromagnetic device in order to find the bullet. The detector emitted an electromagnetic field which was disturbed by the presence of metal, which in turn caused a clicking noise. It worked during tests but when it was brought near President Garfield, it started clicking all over his body. He found no fault with the device, but when he brought it back to Garfield, it clicked all over the place again.

Most modern historians agree that Bell’s device didn’t work because nobody realized that the metal coils in the president’s mattress, a new innovation at the time, were interfering with the detector.

4. The Teleautomaton Boat (Nikola Tesla)

Despite Tesla’s deep association with electricity, the man was also a radio pioneer in a time when the general public still considered it witchcraft. In 1898 Tesla presented his latest creation, a small radio-controlled boat. Officially named a “teleautomaton” boat, Tesla’s design was intended to showcase his new patent, a “method of and apparatus for controlling mechanism of moving vessels and vehicles.” It had a tiny rudder, a tiny propeller, and two antennas.

5. The Copier (James Watt)

James Watt spent most of his life inventing. One of Watt’s noteworthy contributions was a copying press. In 1780, he invented a device which was able to copy documents by pressing them onto a thin strip of paper, creating a reversed copy from the back. It was small, simple, and portable, and the principle behind it stayed in use up until the appearance of the modern photocopiers we use today.

6. Soda Water (Joseph Priestley)

Joseph Priestley was a renowned theologian, philosopher, and chemist. His crowning achievement came when he discovered oxygen, but he also discovered other gases – or “airs,” as he called them.

Priestley also gave us another thing which most of us still enjoy on a regular basis: soda water. This happened while Priestley was living next to a brewery and would often perform experiments there. On one occasion, he discovered his method of infusing water with carbon dioxide by suspending a bowl of water above a beer vat which was fermenting. He then discovered that the water gained a pleasant, acidic taste.

7. The Bouillon Cube (Justus Von Liebig)

Now regarded as one of the greatest chemists of the 19th century, Justus von Liebig is one of the founders of organic chemistry. When he wasn't busy with that, he invented the bouillon cube.

Liebig developed a method to process the meat and in 1864 the Liebig's Extract of Meat Company was born.

However, when Liebig started his own company, others also started to sell their own versions of "meat teas" and referred to their own products as Liebig's Extract of Meat. Eventually, Liebig had to change his brand to LEMCO and later to Oxo cubes, which are still available at grocery stores today.

8. The Life Table (Edmond Halley)

Edmond Halley was a renowned astronomer, physicist, and mathematician who is primarily remembered today for calculating the arrival of the famous comet that shares his name. What is often forgotten is his outstanding work in actuarial science. Halley revolutionized the study of demographics by coming up with the first life table based on accurate demographic data. Halley's table became an essential part of calculating life annuities from then on.

9. The Electric Piano (Walther Nernst)

Walther Nernst was primarily known for his work in chemistry, including the third law of thermodynamics, which earned him the Nobel Prize in Chemistry in 1920. However, in 1930 he teamed up with two companies, Bechstein and Siemens, to create something completely different – the Neo-Bechstein-Flugel, aka the first electric piano. This piano had no sounding board and used very thin strings and a small hammer to create music.

10. The Talking Doll (Thomas Edison)

Edison is regarded not only as a talented inventor, but also a skilled businessman. As opposed to many other inventors, Edison made a fortune off his creations because he knew how to find a lucrative market for the products.

Thomas Edison's phonograph was a big hit, so he naturally tried to stick one wherever possible. The result was the Edison phonograph doll.

Задания к тексту

I. Дайте ответы на следующие вопросы:

1. What did Benjamin Franklin invent at the age of 11? Was it a success?
2. What is Leonardo da Vinci famous for?
3. Who invented one of the very first metal detectors? What was the purpose of the invention?
4. What was the operating principle of the metal detector?
5. What invention did Nikola Tesla present in 1898? What other Tesla's inventions do you know?
6. What does LEMCO stand for?
7. Who formulated the third law of thermodynamics?
8. Who made a fortune off his creations?
9. Do you agree with the Thomas Edison's statement: «Genius is one percent inspiration and ninety-nine percent perspiration»? Give your reasons.

II. Укажите, являются утверждения верными (true) или неверными (false).

1. Franklin was an avid swimmer and was looking for ways to improve his technique. His solution was a set of wooden fins which were worn on the feet.
2. In addition to Alexander Graham Bell's invention of the telephone, he also created one of the very first crossbows.
3. Tesla is regarded not only as a talented inventor, but also a skilled businessman.
4. In 1898 Tesla presented his latest creation, a small radio-controlled boat.
5. Joseph Priestley was a renowned theologian, philosopher, and chemist.
6. Now regarded as one of the greatest chemists of the 19th century, Justus von Liebig is one of the founders of radio engineering.

III. Заполните пропуски в предложениях, используя следующие слова и словосочетания:

inquisitive, (to) fatigue, (to) dabble, renowned, wrist, drawing, bizarre, contribution, (to) disturb, fault, (to) interfere, outstanding

1. It's your _______ we're late.
2. I am proud of my _______ in advancing the project.
3. She had a gold watch on her _______.
4. Although he's young, he's an _______ doctor.
5. She _______ with acting when she was at the university.
6. You mustn't allow them to _______ with your business.
7. Our museum is among the ten most _______ in the country.
8. My morning's work has _______ me.
9. It was _______ that we ran into each other in such a remote corner of the world.
10. I'd have asked more questions, but I didn't want to seem _______.
11. The ______is done in crayon.
12. Snakes will only attack if you _______ them.

IV. Переведите предложения на английский язык:

1. Бенджамин Франклин был заядлым пловцом и пытался найти способы усовершенствования своего мастерства.
2. В 1881 году было совершено покушение на президента Джеймса Гарфилда.
3. Александр Белл использовал изобретенный им металлоискатель для спасения жизни президента.
4. В конце XIX века широкая общественность все еще считала радиотехнику магией.
5. Одним из выдающихся изобретений Джеймса Уатта является портативный копировальный пресс.
6. Известный философ и химик Джозеф Пристли во время своих опытов на пивоваренном заводе нашел способ получения газированной воды.

V. Что такое «ложные друзья» переводчика? Найдите пример данной лексики в следующем предложении:

Halley revolutionized the study of demographics by coming up with the first life table based on accurate demographic data.

VI. Найдите безличные предложения. Переведите.

1. They might not all work, and some might end up being significantly more successful than the rest, but it gives us something to talk about later.
2. Benjamin Franklin has a long list of accomplishments in numerous fields, so it should come as no surprise that he was an inquisitive child.
3. It worked during tests but when it was brought near President Garfield, it started clicking all over his body.
4. It had a tiny rudder, a tiny propeller, and two antennas.
5. It was small, simple, and portable.

Text 4: 10 American Inventions That Aren't

With the largest GDP in the world, it's not hard to imagine most of the inventions of the modern day coming from the United States. But the truth is, some of the most common things we use today were invented neither in America nor by an American.

1. Batteries. The battery is a staple of modern life. They've changed a lot over the years, but the core principle is still the same – and it's probably about 100 years older than you'd think. It was invented in 1800, by Alessandro Volta (an Italian). His «battery» was called the Voltaic Pile and combined layers of copper, zinc, and cardboard soaked in saltwater.

2. Decaffeinated Coffee. The process of decaffeination was invented by a German named Ludwig Roselius in 1903. It was later widely marketed in the U.S. under the brand name Sanka. In addition to caffeine, coffee also has more than 400 other chemicals, all of which add their own personality to the overall taste, texture, and smell. So removing one specific chemical while keeping everything else intact isn't the easiest thing in the world. Roselius's process involved steaming the coffee beans with acid and then soaking them in benzene, which pulled out the caffeine. Since benzene has an annoying tendency to cause bone marrow cancer, modern decaffeination is slightly different.

3. Answering Machine. Once the telephone was invented, it didn't take long for someone to invent a way to screen calls from unwanted callers. In all honesty, the history of the answering machine is confusing, but one thing is for sure – it was not invented in America.

That's because it was a Danish inventor named Valdemar Poulsen who built the first device that was able to record a message and play it back later, all the way back in 1898. It was just too bulky and cumbersome to be practical. As far as modern machines go, it wasn't until 1960 that answering machines were even sold in America – the Ansafone, brainchild of Japanese inventor Kazuo Hashimoto and the first digital answering machine in the world.

4. Notepad. The notepad is one of those things that are so common we just take it for granted. But this one tiny innovation ended up setting the standard for nearly a century of paper binding. The same process was later used to bind books, especially the American pulp fiction novels of the 30's and 40's.

Before the 1900's, most papers were just stacked in a pile and kept that way. But in 1902, Australian J.A. Birchall decided to put a thin strip of glue across the top of a stack of paper and slap a sheet of cardboard on the back. And just like that, the notepad was born.

5. Contact Lenses. Thirty-eight million Americans wear contact lenses instead of eyeglasses every day. The first contact lenses were invented in 1887 by a German named Adolf Fick. They were huge – 21mm (0.8 inches) wide and made from blown glass, with a sugar solution between the lens and the eye to cut down on friction. They were bulky and uncomfortable, but they were replaced with plastic ones only in 1936.

Even though Adolf Fick was the first person to make a practical (well, semi-practical) contact lens, he certainly wasn't the first to try. Leonardo da Vinci is said to have invented a type of contact lens in 1508 made out of a bowl of water. Similarly, Rene Descartes supposedly built a water-filled tube that was designed to go into the eye, but the idea never took off because it stuck out so far you couldn't blink.

6. DDT. When you think of pesticides, you probably picture something like DDT. Currently banned in 170 countries, DDT was for a time one of the most common pesticides in the U.S., with thousands of farms using tens of thousands of pounds of the chemical to spray their crops. DDT was especially common during WWII, when Allied soldiers used it to fight off typhus.

But it wasn't invented in the same country that brought it to such global prominence. That honor goes to Othmar Zeidler, a German chemist who first synthesized dichlorodiphenyltrichloroethane (that's DDT) in 1874. Even so, it wasn't until another chemist in Switzerland named Paul Hermann Muller discovered that it could be used to kill insects in 1939. For his discovery, Muller was awarded the Nobel Prize.

7. CDs. Compact discs, or CDs were one of the defining technologies of the 1990's and 2000's. They successfully killed cassette tapes, and they're probably the last physical audio technology that we'll ever have.

CDs had a longer lifespan than most people might realize. They were invented in 1974, nearly a decade before they even became available to the public market. And the inventors were the Dutch company Philips and the Japanese company Sony. In the mid 70's, both companies independently began working on technologies that could imprint digital sound onto a small plastic disc. But soon they decided to join forces to develop the technology as fast as possible. The first album ever recorded on CD was ABBA's *The Visitors* in 1981.

8. Television. If America can't claim decaf, DDT, and contact lenses, at least we have the TV going for us, the most American invention of all time. Well, wrong again. TV is actually a Russian invention. Specifically, it was a Russian engineer named Boris Rosing who, in 1907, used a cathode ray tube to receive images, creating the earliest framework for transmitting light and pictures to a receiving screen. The invention was born, but like most technologies it took a few years and several participants to make it happen.

9. Aerosol Cans. Aerosol spray cans are fairly common all over the world, but the first ones were sold in the U.S. in 1931. Since then, the core idea has remained relatively unchanged.

If they were introduced to the world in America, then it makes sense that they were invented by an American company. In reality, an American company bought the patent for 100,000 kroner from a Norwegian scientist named Erik Rotheim, who had patented his aerosol invention in Oslo, Norway five years earlier.

10. Telephone. Ask any Canadian where the telephone was invented, and they'll proudly point right down at the permafrost under their feet. Ask an American, and you'll get the same answer – a finger pointed straight down at American soil. Despite the fact that Alexander Graham Bell filed the patent for the first electric telephone in the U.S. Patent Office in 1876, his work in the early 1870's took place mostly at his family home in Brantford, Ontario. That's where he and his assistant, Thomas Watson, first transmitted an audio tone over a wire. This was the first time a sound had ever been sent from one place to another electronically—the framework of the telephone was born.

Задания к тексту

I. Дайте ответы на следующие вопросы:

1. Why is it easy to imagine that most of the inventions of the modern day come from the USA?
2. What was the structure of the Voltaic Pile?
3. Describe the Roselius's process of decaffeination? Is it used now?
4. When was the first digital answering machine invented?
5. What was paper keeping like before the invention of the notepad?
6. Who was the first person to make a practical contact lens?
7. What is DDT? Who was it invented by?
8. What was the first album ever recorded on CD?
9. Where was the telephone invented?
10. What the US inventions do you know?

II. Закончите предложения:

1. It's not hard to imagine most of the inventions of the modern day coming from…
2. The process of decaffeination was invented by…
3. It was a Danish inventor named Valdemar Poulsen who built the first device that was able to record a message and play it…
4. Before the 1900's, most paper was just stacked in…
5. Thirty-eight million Americans wear contact lenses instead of…
6. Compact discs, or CDs, were one of the defining technologies of…
7. It was a Russian engineer named Boris Rosing who, in 1907, used a cathode ray tube to…
8. Despite the fact that Alexander Graham Bell filed the patent for the first electric telephone in the U.S. Patent Office, his work in the early 1870's took place at…

III. Подберите русские эквиваленты к следующим словам и словосочетаниям:

voltaic pile, copper, decaffeination, brand name, caffeine, to remove, confusing, unwanted, bulky, pile, friction, to cut down (on), to blink, banned, crop, allied soldiers, lifespan, decade

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товарный знак, союзники, продолжительность жизни, куча, посев, медь, удалять, нежелательный, гальваническая батарея, десятилетие, кофеин, громоздкий, трение, снижать, моргать, запрещенный, удаление кофеина, запутанный

IV. Заполните пропуски в предложениях, используя слова и словосочетания из предыдущего упражнения:

1. The composition of brass includes _______ and zinc.
2. The drug was _______ a _______ ago.
3. Putting oil on both surfaces reduces _______.
4. It was a very _______ situation.
5. _______ packages might cost more to mail.
6. A TV set has an average _______ of 11 years.
7. A _______ of sandbags held the bridge.
8. Rapid tests may result in _______ test results.
9. _______ is the process of removing caffeine from coffee beans and tea leaves.
10. _______ the knife from the child!

V. Проведите анализ предложений. Выделите подлежащее и сказуемое. Переведите.

1. Some of the most common things we use today were invented neither in America nor by an American.
2. So removing one specific chemical while keeping everything else intact isn’t the easiest thing in the world.
3. In all honesty, the history of the answering machine is confusing.

4. Currently banned in 170 countries, DDT was for a time one of the most common pesticides in the U.S.

5. The first album ever recorded on CD was ABBA's *The Visitors* in 1981.

6. That's where he and his assistant, Thomas Watson, first transmitted an audio tone over a wire.

VI. Найдите безличные предложения. Переведите.

1. Batteries have changed a lot over the years, but the core principle is still the same – and it's probably about 100 years older than you'd think.

2. It was later widely marketed in the U.S. under the brand name Sanka.

3. Once the telephone was invented, it didn't take long for someone to invent a way to screen calls from unwanted callers.

4. But it wasn't invented in the same country that brought it to such global prominence.

5. The invention was born, but like most technologies it took a few years and several participants to make it happen.

6. If they were introduced to the world in America, then it makes sense that they were invented by an American company.

Text 5: Power Engineering problems and prospects

Electricity became a subject of scientific interest in the late 17th century with the work of William Gilbert. Over the next two centuries a number of important discoveries were made including the incandescent light bulb and the voltaic pile. Probably the greatest discovery with respect to power engineering came from Michael Faraday who in 1831 discovered that a change in magnetic flux induces an electromotive force in a loop of wire – a principle known as electromagnetic induction that helps explain how generators and transformers work.

Power engineering is a network of interconnected components which convert different forms of energy to electrical energy. Modern power engineering consists of three main subsystems: the generation subsystem, the transmission subsystem, and the distribution subsystem. In the generation subsystem, the power plant produces the electricity. The transmission subsystem transmits the electricity to the load centers. The distribution subsystem continues to transmit the power to the customers.

Energy conservation is an issue with many aspects that continue to evolve. There have been major areas of technical improvement. There are also important areas in which there has been virtually no improvement, and hence, most of the potential of energy conservation still remains to be tapped. In the architectural arena, there has been serious efficiency regression, primarily related to the use of glass box exterior design. The United States was the primary target of the oil embargo, and in the United States, popular opinion drives politics.

A modern energy concept is a wholesale distributor of innovative commercial lighting products with over 23 years of practical lighting experience in a wide variety of applications. On the cutting edge of the lighting industry, we always have a clear vision of a brighter future. Eventually, we see LED (light-emitting diode) and induction lighting replacing the less efficient HID (High-Intensity Discharge lamp) and fluorescent lamps throughout the world. To further our vision, MEC is constantly testing and adopting new lighting technology to provide our customers with the latest products.

Nuclear power has been championed as a source of cheap energy. But this was undermined at the end of the 20th century by high-profile reactor accidents, the problems of radioactive waste disposal, competition from more-efficient electricity sources and unavoidable links to nuclear weapons proliferation. Nonetheless, growing evidence for global warming had led some to argue that nuclear power is the only way to generate power without emitting greenhouse gases. The economics of new nuclear power plants is a controversial subject, and multi-billion dollar investments ride on the choice of an energy source. Nuclear power plants typically have high capital costs, but low direct fuel costs (with much of the costs of fuel extraction, processing, use and long term storage externalized). Therefore, comparison with other power generation methods is strongly dependent on assumptions about construction timescales and capital financing for nuclear plants. Cost estimates also need to take into account plant decommissioning and nuclear waste storage costs. On the other hand, measures to mitigate global warming such as a carbon tax or carbon emissions trading may favor the economics of nuclear power.

In recent years there has been a slowdown of electricity demand growth and financing has become more difficult, which has an impact on large projects such as nuclear reactors with very large upfront costs and long project cycles which carry a large variety of risks. Where cheap gas is available and its future supply relatively secure, this also poses a major problem for nuclear projects.

Analysis of the economics of nuclear power must take into account that bears the risks of future uncertainties. To date all operating nuclear power plants were developed by state-owned or regulated utility monopolies where many of the risks associated with construction costs, operating performance, fuel price, and other factors were borne by consumers rather than suppliers. Many countries have now liberalized the electricity market where these risks, and the risk of cheaper competitors emerging before capital costs are recovered, are borne by plant suppliers and operators rather than consumers, which leads to a significantly different evaluation of the economics of new nuclear power plants. Following the 2011 Fukushima I nuclear accidents, costs are likely to go up for currently operating and new nuclear power plants, due to increased requirements for on-site spent fuel management and elevated design basis threats.

There is probably one thing that we can all agree on: the world's energy reserves are not unlimited. Actually that's not strictly true, there is a near unlimited supply of energy coming from the sun but we are pretty bad at converting it into useful energy. Look around and ask yourself how much things will change in the near future.

It is pretty certain that we will run out of gas in your lifetime. Quite when it will happen is up for debate but a guess of around twenty years would probably be pretty close. That's not long considering that, certainly in the UK, a good portion of houses have only gas powered heating and cooking.

But even if we can get exclusive access to that oil, and that's unlikely, it's a rather sort amount of time before people start getting cold and hungry. Make no mistakes, when the oil runs out the western culture will collapse and we will be sent hurtling back to the middle ages. Starvation will become a real problem, medicine will become scarce and transport will be by your own two feet or not at all. Winter will be the worst time for us because there will be nothing to burn. The first winter with no gas or oil will see every tree cut down for firewood even though burning unseasoned wood is nearly pointless. Our houses will start to fail as there will be no materials to maintain them with and rats will breed in their masses because we can't transport out waste away. Basic raw materials like wood and steal will become valuable commodities because we won't be able to produce them ourselves but they won't last anywhere near as long as we are used to because we won't have lacquers, paints and varnishes to protect them with.

It is fairly clear that we need to do something about this problem now and not in twenty years when it start to really cause us problems. It takes huge amounts of money and a long time to develop a new energy technology to the point where it is useful. Look how long it took to develop the coal fired power station for instance – maybe one hundred years to get something really useful. We need to invest a good portion of our countries GDP in researching renewable energy sources so that we don't get caught out. There is no way on

Earth the government will put even one percent of the countries GDP into research, let alone into researching alternative energy sources. This is bizarre because one of the few things that we will always need is power. If we could become the world leaders in renewable energy technology we would have the world eating out of our hand in the near future.

As a result, there were many government initiatives toward energy conservation, including massive spending on research, major new laws, and incentives for favored energy conservation activities. Energy conservation continues to be a national imperative. These are significant generalizations that we can make about the modern era of energy conservation, thus far: The 1970’s were a time of great ferment and rapid learning. The 1980’s was a period in which many bad ideas from the 1970 are collapsed. The 1990’s was a time of stagnation and information loss. The new millennium restores interest in energy conservation, largely under the banner of environmental protection. By far the greatest advances came from equipment manufacturers. Most new concepts were introduced during the 1970’s. By the 1990’s, the equipment had become reliable. Remaining technical development is slow. Architects have disregarded efficiency in building design. Engineers, who are subordinates to architects in building design, continue to improve efficiency in a desultory manner. Most government programs failed. Important exceptions were information programs and equipment efficiency standards. Energy conservation codes for construction were enacted into law, but they remain widely ignored. The industrial sector achieved much better efficiency improvement than the commercial sector, achieving most improvement during the years 1974 to 1985. Progress since then has been minor. Facility owners and managers do not yet recognize energy efficiency as a normal aspect of management, but as an episodic issue. During the first part of the modern era, energy conservation was independent of environmental protection. Then, they were seen as conflicting issues. Now, they are seen as complementary issues. Information mushroomed during the 1970’s, and slowed substantially thereafter. The Energy Efficiency Manual finally appeared at the beginning of the new millennium, filling the need for a complete and easily usable guide to the main areas of energy conservation. All this development and turmoil has created strong currents of issues within the modern era of energy conservation.

Задания к тексту

I. Найдите в тексте ответы на следующие вопросы:

1. What is power engineering?
2. How many subsystems are there in modern power engineering? What are they?
3. Who made a great contribution to the development of power engineering?
4. What is an electromagnetic induction?
5. What ate the achievements in the field of lighting industry?
6. Is it true that nuclear power is a source of cheap and safe energy?
7. What measures were made to develop energy conservation?

II. Укажите, являются утверждения верными (true) или неверными (false).

1. In 1890 Michael Faraday discovered that a change in magnetic flux induces an electromotive force in a loop of wire.
2. In the generation subsystem, the power plant produces the electricity.
3. Nuclear power has been championed as a source of expensive energy.
4. The world's energy reserves are limited.
5. Nuclear power plants typically have low capital costs, but high direct fuel costs.

III. Подберите русские эквиваленты к следующим словам и словосочетаниям:

incandescent light bulb, voltaic pile, with respect to, power engineering, magnetic flux, generation, transmission, distribution, energy conservation, virtually, nuclear power, light-emitting diode, high-intensity discharge lamp, nuclear weapons proliferation

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разрядная лампа высокой интенсивности, магнитный поток, передача, сохранение энергии, лампа накаливания, распространение ядерного *оружия, гальваническая батарея, ядерная энергия, что касается, производство (выработка), светодиод, энергетика, распределение, фактически*

IV. Сравните предложения в действительном и страдательном залоге, переведите их.

1. Scientists made a number of great discoveries in the field of electricity. – A number of great discoveries in the field of electricity were made by scientists.
2. The transmission subsystem transmits the electricity to the load centers. – Electricity is transmitted to the load centers in the transmission subsystem.
3. Light-emitting diode and induction lighting have replaced the less efficient high-intensity discharge lamp and fluorescent lamps throughout the world. – The less efficient high-intensity discharge lamps and fluorescent lamps have been replaced by light-emitting diodes and induction lighting throughout the world.
4. We must take into account the analysis of the economics of nuclear power. – The analysis of the economics of nuclear power must be taken into account.
5. Today we are making significant generalizations about the modern era of energy conservation. – Significant generalizations about the modern era of energy conservation are being made today.

V. Назовите типовые формы образования терминов в приведенных ниже примерах, переведите их.

light-emitting diode, high-intensity discharge lamp, high-profile reactor accidents, nuclear weapons proliferation, state-owned or regulated utility monopolies, magnetic flux

VI. Что такое «ложные друзья» переводчика? Какой пример данной лексики присутствует в приведенном ниже предложении?

There are also important areas in which there has been virtually no improvement, and hence, most of the potential of energy conservation still remains to be tapped.

Text 6: The Structure of Matter

There is a large overlap of the world of static electricity and the everyday world that you experience. Clothes tumble in the dryer and cling together. You walk across the carpeting to exit a room and receive a door knob shock. You pull a wool sweater off at the end of the day and see sparks of electricity. During the dryness of winter, you step out of your car and receive a car door shock as you try to close the door. Sparks of electricity are seen as you pull a wool blanket off the sheets of your bed. You stroke your cat's fur and observe the fur standing up on its end. Bolts of lightning dash across the evening sky during a spring thunderstorm. And most tragic of all, you have a bad hair day. These are all static electricity events - events that can only be explained by an understanding of the physics of electrostatics.

Not only do electrostatic occurrences permeate the events of everyday life, without the forces associated with static electricity, life as we know it would be impossible. Electrostatic forces - both attractive and repulsive in nature - hold the world of atoms and molecules together in perfect balance. Without this electric force, material things would not exist. Atoms as the building blocks of matter depend upon these forces. And material objects, including us Earthlings, are made of atoms and the acts of standing and walking, touching and feeling, smelling and tasting, and even thinking is the result of electrical phenomenon. Electrostatic forces are foundational to our existence.

One of the primary questions to be asked is: How can an object be charged and what affect does that charge have upon other objects in its vicinity? The answer to this question begins with an understanding of the structure of matter. Understanding charge as a fundamental quantity demands that we have an understanding of the structure of an atom.

History of Atomic Structure. The search for the atom began as a philosophical question. It was the natural philosophers of ancient Greece that began the search for the atom by asking such questions as: What is stuff composed of? What is the structure of material objects? Is there a basic unit from which all objects are made? As early as 400 B.C., some Greek philosophers proposed that matter is made of indivisible building blocks known as atomos. (*Atomos* in Greek means indivisible.) To these early Greeks, matter could not be continuously broken down and divided indefinitely. Rather, there was a basic unit or building block that was indivisible and foundational to its structure. This indivisible building block of which all matter was composed became known as the atom.

All matter such as solids, liquids, and gases, is composed of atoms. Therefore, the atom is considered to be the basic building block of matter. However, atoms are almost always grouped together with other atoms to form what is called a molecule. Only a few gases such as helium are composed of individual atoms as the structural unit. Atoms are extremely small. The radius of a typical atom is on the order of 0.0000000001 meter and cannot be studied without very powerful microscopes.

The early Greeks were simply philosophers. They did not perform experiments to test their theories. In fact, science as an experimental discipline did not emerge as a credible and popular practice until sometime during the 1600s. So the search for the atom remained a philosophical inquiry for a couple of millennia. From the 1600s to the present century, the search for the atom became an experimental pursuit. Several scientists are notable; among them are Robert Boyle, John Dalton, J.J. Thomson, Ernest Rutherford, and Neils Bohr.

Boyle's studies (middle to late 1600s) of gaseous substances promoted the idea that there were different types of atoms known as elements. Dalton (early 1800s) conducted a variety of experiments to show that different elements can combine in fixed ratios of masses to form compounds. Dalton subsequently proposed one of the first theories of atomic behavior that was supported by actual experimental evidence.

English scientist J.J. Thomson's cathode ray experiments (end of the 19th century) led to the discovery of the negatively charged electron and the first ideas of the structure of these indivisible atoms. Thomson proposed the Plum Pudding Model, suggesting that an atom's structure resembles the favorite English dessert – plum pudding. The raisins dispersed amidst the plum pudding are analogous to negatively charged electrons immersed in a sea of positive charge.

Nearly a decade after Thomson, Ernest Rutherford's famous gold foil experiments led to the nuclear model of atomic structure. Rutherford's model suggested that the atom consisted of a densely packed core of positive charge known as the nucleus surrounded by negatively charged electrons. While the nucleus was unique to the Rutherford atom, even more surprising was the proposal that an atom consisted mostly of empty space. Most the mass was packed into the nucleus that was abnormally small compared to the actual size of the atom.

Neils Bohr improved upon Rutherford's nuclear model (1913) by explaining that the electrons were present in orbits outside the nucleus. The electrons were confined to specific orbits of fixed radius, each characterized by their own discrete levels of energy. While electrons could be forced from one orbit to another orbit, it could never occupy the space between orbits.

Bohr's view of quantized energy levels was the precursor to modern quantum mechanical views of the atoms. The mathematical nature of quantum mechanics prohibits a discussion of its details and restricts us to a brief conceptual description of its features. Quantum mechanics suggests that an atom is composed of a variety of subatomic particles. The three main subatomic particles are the proton, electron and neutron. The proton and neutron are the most massive of the three subatomic particles; they are located in the nucleus of the atom, forming the dense core of the atom. The proton is charged positively. The neutron does not possess a charge and is said to be neutral. The protons and neutrons are bound tightly together within the nucleus of the atom. Outside the nucleus are concentric spherical regions of space known as electron shells. The shells are the home of the negatively charged electrons. Each shell is characterized by a distinct energy level. Outer shells have higher energy levels and are characterized as being lower in stability. Electrons in higher energy shells can move down to lower energy shells; this movement is accompanied by the release of energy. Similarly, electrons in lower energy shells can be induced to move to the higher energy outer shells by the addition of energy to the atom.

If provided sufficient energy, an electron can be removed from an atom and be freed from its attraction to the nucleus.

Application of Atomic Structure to Static Electricity. This brief excursion into the history of atomic theory leads to some important conclusions about the structure of matter that will be of utmost importance to our study of static electricity. Those conclusions are summarized here:

- All material objects are composed of atoms. There are different kinds of atoms known as elements; these elements can combine to form compounds. Different compounds have distinctly different properties. Material objects are composed of atoms and molecules of these elements and compounds, thus providing different materials with different electrical properties.
- An atom consists of a nucleus and a vast region of space outside the nucleus. Electrons are present in the region of space outside the nucleus. They are negatively charged and weakly bound to the atom. Electrons are often removed from and added to an atom by normal everyday occurrences.
- The nucleus of the atom contains positively charged protons and neutral neutrons. These protons and neutrons are not removable or perturbable by usual everyday methods. It would require some form of high-energy nuclear occurrence to disturb the nucleus and subsequently dislodge its positively charged protons. One sure truth of this unit is that the protons and neutrons will remain within the nucleus of the atom. Electrostatic phenomenon can never be explained by the movement of protons.

Задания к тексту

I. Найдите в тексте ответы на следующие вопросы:

1. Why are electrostatic forces foundational to our existence?
2. Who began the search for the atom?
3. What does *Atomos* mean?
4. Who proposed one of the first theories of atomic behavior?
5. What did Rutherford's nuclear model of the atom structure suggest?
6. What are all material objects composed of?

7. How many subatomic particles are there? What are they? Speak about main features of these particles.

II. Соедините части предложений по смыслу.

1. Electrostatic forces both attractive and repulsive in nature	a. a vast region of space outside the nucleus.
2. This indivisible building block of which all matter was composed	b. the proton, electron and neutron.
3. An atom consists of a nucleus and	c. hold the world of atoms and molecules together in perfect balance.
4. The proton and neutron, the most massive of the three subatomic particles, are located in the nucleus of the atom,	d. does not possess a charge and is said to be neutral.
5. The three main subatomic particles are	e. became known as the atom.
6. The neutron	f. forming the dense core of the atom.

III. Подберите русские эквиваленты к следующим словам и словосочетаниям:

attractive, gaseous substance, structural unit, vicinity, compound, to conduct experiments, electron shells, negatively/ positively charged, repulsive, cathode ray, a variety of, indivisible, electrical properties, a building block, weakly/ tightly bound

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соседство, стандартный элемент, поток электронов, газообразное вещество, притягивающий, соединение, разнообразие, проводить эксперименты, слабо /тесно связанный, отрицательно/положительно заряженный, электрические свойства, электронная оболочка, отталкивающий, структурный элемент, неделимый

IV. Составьте предложения из следующих слов в соответствии с порядком слов в английском предложении.

1. atoms, all matter, liquids, such as, solids, is composed, and, gases, of.
2. together, atoms, with, are grouped, to form, a molecule, other atoms.
3. cathode ray experiments, the discovery, led to, J.J. Thomson's, of, electron, the negatively charged.
4. are bound, the protons, within, and, tightly, neutrons, the nucleus, together, of the atom.
5. neutrons, positively charged, and, contains, the atom, of, the nucleus, protons, neutral.

V. Переведите предложения, обращая внимание на особенности перевода безличных конструкций в страдательном залоге.

1. It is known that atoms as the building blocks of matter depend upon electrostatic forces both attractive and repulsive
2. It cannot be denied that all static electricity events can only be explained by an understanding of the physics of electrostatics.
3. It must be stressed that the three main subatomic particles are the proton, electron and neutron.
4. It should be remembered that electrostatic phenomenon can never be explained by the movement of protons.
5. It is said that matter is made of indivisible building blocks known as atoms.

VI. Назовите типовые формы образования терминов в приведенных ниже примерах, переведите их.

cathode ray experiments, negatively charged electron, atomic structure, densely packed core, quantum mechanics, positively charged proton, tightly bound neutrons

Text 7: Electricity

Electricity is the set of physical phenomena associated with the presence and flow of electric charge. Electricity gives a wide variety of well-known effects, such as lightning, static electricity, electromagnetic induction and electric current. In addition, electricity permits the creation and reception of electromagnetic radiation such as radio waves.

In electricity, charges produce electromagnetic fields which act on other charges. Electricity occurs due to several types of physics:

- electric charge: a property of some subatomic particles, which determines their electromagnetic interactions. Electrically charged matter is influenced by, and produces electromagnetic fields.
- electric field: an especially simple type of electromagnetic field produced by an electric charge even when it is not moving (i.e., there is no electric current). The electric field produces a force on other charges in its vicinity.
- electric potential: the capacity of an electric field to do work on an electric charge, typically measured in volts.
- electric current: a movement or flow of electrically charged particles, typically measured in amperes.
- electromagnets: Moving charges produce a magnetic field. Electric currents generate magnetic fields, and changing magnetic fields generate electric currents.

In electrical engineering, electricity is used for:

- electric power where electric current is used to energize equipment;
- electronics which deals with electrical circuits that involve active electrical components such as vacuum tubes, transistors, diodes and integrated circuits, and associated passive interconnection technologies.

Electrical phenomena have been studied since antiquity, though progress in theoretical understanding remained slow until the seventeenth and eighteenth centuries. Even then, practical applications for electricity were few, and it would not be until the late nineteenth century that engineers were able to put it to industrial and residential use. The rapid expansion in electrical technology at this time transformed industry and society. Electricity's extraordinary versatility means it can be put to an almost limitless set of applications which include transport, heating, lighting, communications, and computation. Electrical power is now the backbone of modern industrial society.

Long before any knowledge of electricity existed people were aware of shocks from electric fish. Ancient Egyptian texts dating from 2750 BC referred to these fish as the «Thunderer of the Nile», and described them as the "protectors" of all other fish. Electric fish were again reported millennia later by ancient Greek, Roman and Arabic naturalists and physicians. Several ancient writers, such as Pliny the Elder and Scribonius Largus, attested to the numbing effect of electric shocks delivered by catfish and torpedo rays, and knew that such shocks could travel along conducting objects. Patients suffering from ailments such as gout or headache were directed to touch electric fish in the hope that the powerful jolt might cure them. Possibly the earliest and nearest approach to the discovery of the identity of lightning, and electricity from any other source, is to be attributed to the Arabs, who before the 15th century had the Arabic word for lightning (raad) applied to the electric ray.

Ancient cultures around the Mediterranean knew that certain objects, such as rods of amber, could be rubbed with cat's fur to attract light objects like feathers. Thales of Miletus made a series of observations on static electricity around 600 BC, from which he believed that friction rendered amber magnetic, in contrast to minerals such as magnetite, which needed no rubbing. Thales was incorrect in believing the attraction was due to a magnetic effect, but later science would prove a link between magnetism and electricity. According to a controversial theory, the Parthians may have had knowledge of electroplating, based on the 1936 discovery of the Baghdad Battery, which resembles a galvanic cell, though it is uncertain whether the artifact was electrical in nature.

Electricity would remain little more than an intellectual curiosity for millennia until 1600, when the English scientist William Gilbert made a careful study of electricity and magnetism, distinguishing the lodestone effect from static electricity produced by rubbing amber. He coined the New Latin word electricus («of amber» or «like amber», elektron, the Greek word for «amber») to refer to the property of attracting small objects after being rubbed. This association gave rise to the English words «electric» and «electricity», which made their first appearance in print in Thomas Browne's Pseudodoxia Epidemica of 1646.

Further work was conducted by Otto von Guericke, Robert Boyle, Stephen Gray and C. F. du Fay. In the 18th century, Benjamin Franklin conducted extensive research in electricity, selling his possessions to fund his work. In June 1752 he is reputed to have attached a metal key to the bottom of a dampened kite string and flown the kite in a storm-threatened sky. A succession of sparks jumping from the key to the back of his hand showed that lightning was indeed electrical in nature. He also explained the apparently paradoxical behavior of the Leyden jar as a device for storing large amounts of electrical charge in terms of electricity consisting of both positive and negative charges.

In 1791, Luigi Galvani published his discovery of bioelectricity, demonstrating that electricity was the medium by which nerve cells passed signals to the muscles. Alessandro Volta's battery, or voltaic pile, of 1800, made from alternating layers of zinc and copper, provided scientists with a more reliable source of electrical energy than the electrostatic machines previously used. The recognition of electromagnetism the unity of electric and magnetic phenomena, is due to Hans Christian Ørsted and André-Marie Ampère in 1819-1820; Michael Faraday invented the electric motor in 1821, and Georg Ohm mathematically analyzed the electrical circuit in 1827. Electricity and magnetism (and light) were definitively linked by James Clerk Maxwell, in particular in his "On Physical Lines of Force" in 1861 and 1862.

While the early 19th century had seen rapid progress in electrical science, the late 19th century would see the greatest progress in electrical engineering. Through such people as Alexander Graham Bell, Ottó Bláthy, Thomas Edison, Galileo Ferraris, Oliver Heaviside, Ányos Jedlik, Lord Kelvin, Sir Charles Parsons, Ernst Werner von Siemens, Joseph Swan, Nikola Tesla and George

Westinghouse, electricity turned from a scientific curiosity into an essential tool for modern life, becoming a driving force of the Second Industrial Revolution.

In 1887, Heinrich Hertz discovered that electrodes illuminated with ultraviolet light create electric sparks more easily. In 1905 Albert Einstein published a paper that explained experimental data from the photoelectric effect as being the result of light energy being carried in discrete quantized packets, energizing electrons. This discovery led to the quantum revolution. Einstein was awarded the Nobel Prize in 1921 for «his discovery of the law of the photoelectric effect». The photoelectric effect is also employed in photocells such as can be found in solar panels and this is frequently used to make electricity commercially.

The first solid-state device was the «cat's whisker» detector, first used in the 1900s in radio receivers. A whisker-like wire is placed lightly in contact with a solid crystal (such as a germanium crystal) in order to detect a radio signal by the contact junction effect. In a solid-state component, the current is confined to solid elements and compounds engineered specifically to switch and amplify it. Current flow can be understood in two forms: as negatively charged electrons, and as positively charged electron deficiencies called holes. These charges and holes are understood in terms of quantum physics. The building material is most often a crystalline semiconductor.

The solid-state device came into its own with the invention of the transistor in 1947. Common solid-state devices include transistors, microprocessor chips, and RAM. A specialized type of RAM called flash RAM is used in flash drives and more recently, solid state drives to replace mechanically rotating magnetic disc hard drives. Solid state devices became prevalent in the 1950s and the 1960s, during the transition from vacuum tubes to semiconductor diodes, transistors, integrated circuit (IC) and the light-emitting diode (LED).

Задания к тексту

I. Найдите в тексте ответы на следующие вопросы:

1. What is electricity?
2. When did electricity occur?

3. What is an electric field?
4. What is electricity used for in electrical engineering?
5. What are three phenomena that made up all of man’s knowledge of electrical effects?
6. What led to the quantum revolution?
7. What do common solid-state devices include?

II. Укажите, являются утверждения верными (true) или неверными (false).

1. Electricity is the set of physical phenomena associated with the presence and flow of electric potential.
2. In electricity, charges produce electromagnetic fields.
3. Electric potential is a movement or flow of electrically charged particles, typically measured in amperes.
4. Ancient cultures that certain objects, such as rods of copper, could be rubbed with cat's fur to attract light objects like feathers.
5. William Gilbert coined the new Latin word electricus («of amber» or «like amber», elektron, the Greek word for «amber») to refer to the property of attracting small objects after being rubbed.

III. Подберите русские эквиваленты к следующим словам и словосочетаниям:

lightning, electromagnetic induction, electric current, electromagnetic fields, integrated circuit, versatility, amber, friction, succession, scientific curiosity, driving force, solid-state device, contact junction, to amplify, semiconductor

полупроводниковое устройство, усиливать, универсальность, трение, молния, полупроводник, интегральная схема, электромагнитная индукция, последовательность, пятно контакта, движущая сила, янтарь, электрический ток, электромагнитные поля, научный интерес (любопытство)

IV. Переведите предложения, обращая внимание на использование структур типа А есть Б (глагол-связка и именная часть).

1. Electricity is the set of physical phenomena associated with the presence and flow of electric charge.
2. Electrically charged matter is a matter influenced by, and produces electromagnetic fields.
3. Electric potential is the capacity of an electric field to do work on an electric charge, typically measured in volts.
4. Electric current is a movement or flow of electrically charged particles, typically measured in amperes.
5. The first solid-state device is the «cat's whisker» detector, first used in the 1900s in radio receivers.

V. Переведите предложения, обращая внимание на неопределенно-личное местоимение *one*.

1. One knows that electrical phenomena have been studied since antiquity.
2. One must remember that electric potential is measured in volts.
3. One believes that moving charges produce a magnetic field.
4. One is faced with the difficulty to put electricity to industrial and residential use.
5. One must know that electricity’s extraordinary versatility means it can be put to an almost limitless set of applications which include transport, heating, lighting, communications, and computation.

VI. Найдите в предложениях интернациональные слова. Переведите предложения.

1. Electricity gives a wide variety of well-known effects, such as lightning, static electricity, electromagnetic induction and electric current.
2. Electricity permits the creation and reception of electromagnetic radiation such as radio waves.

3. A whisker-like wire is placed lightly in contact with a solid crystal (such as a germanium crystal) in order to detect a radio signal by the contact junction effect.
4. Electronics deals with electrical circuits that involve active electrical components such as vacuum tubes, transistors, diodes and integrated circuits, and associated passive interconnection technologies.
5. The rapid expansion in electrical technology at this time transformed industry and society.

Text 8: Electric circuits

An electric circuit is a path which electrons from a voltage or current source flow. Electric current flows in a closed path called an electric circuit. The point where those electrons enter an electrical circuit is called the «source» of electrons. The point where the electrons leave an electrical circuit is called the «return» or «earth ground». The exit point is called the «return» because electrons always end up at the source when they complete the path of an electrical circuit.

The part of an electrical circuit that is between the electrons' starting point and the point where they return to the source is called an electrical circuit’s «load». The load of an electrical circuit may be as simple as those that power electrical appliances like refrigerators, televisions, or lamps or more complicated, such as the load on the output of a hydroelectric power generating station.

Circuits use two forms of electrical power: alternating current (AC) and direct current (DC). AC often powers large appliances and motors and is generated by power stations. DC powers battery operated vehicles and other machines and electronics. Converters can change AC to DC and vice versa. High-voltage direct current transmission uses very big converters.

Electric circuits are considered to be made up of localized circuit elements connected by wires which have essentially negligible resistance. The three basic circuit elements are resistors, capacitors, and inductors.

There are various kinds of electric circuits such as: open circuits, closed circuits, series circuits, parallel circuits and short circuits. To understand the difference between the following circuit connections is not difficult at all. When electrical devices are connected so that the current flows from one device to another, they are said to be connected in series. Under such conditions the current flow is the same in all parts of the circuit, as there is only a single path along which it may flow. The electrical bell circuit is considered to be a typical example of a series circuit. The parallel circuit provides two or more paths for the passage of current. The circuit is divided in such a way that part of the current flows through one path, and part through another. The lamps in your room and your house are generally connected in parallel. Now we pay our attention to the short circuit sometimes called «the short». The short circuit is produced when the current is allowed to return to the source of supply without control and without doing the work that we want it to do. The short circuit often results from cable fault or wire fault.

An electronic circuit is a complete course of conductors through which current can travel. Circuits provide a path for current to flow. To be a circuit, this path must start and end at the same point. In other words, a circuit must form a loop. An electronic circuit and an electrical circuit have the same definition, but electronic circuits tend to be low voltage circuits.

For example, a simple circuit may include two components: a battery and a lamp. The circuit allows current to flow from the battery to the lamp, through the lamp, then back to the battery. Thus, the circuit forms a complete loop.

Of course, circuits can be more complex. However, all circuits can be distilled down to three basic elements:

- Voltage source: A voltage source causes current to flow like a battery, for instance.
- Load: The load consumes power; it represents the actual work done by the circuit. Without the load, there's not much point in having a circuit. The load can be as simple as a single light bulb. In complex circuits, the load is a combination of components, such as resistors, capacitors, transistors, and so on.
- Conductive path: The conductive path provides a route through which current flows. This route begins at the voltage source, travels through the load, and then returns to the voltage source. This path must form a loop from the negative side of the voltage source to the positive side of the voltage source.

Types of Circuits

When a circuit is complete and forms a loop that allows current to flow, the circuit is called a closed circuit. If any part of the circuit is disconnected or disrupted so that a loop is not formed, current cannot flow. In that case, the circuit is called an open circuit.

- Open circuit is an oxymoron. After all, the components must form a complete path to be considered a circuit. If the path is open, it isn't a circuit. Therefore, open circuit is most often used to describe a circuit that has become broken, either on purpose (by the use of a switch) or by some error, such as a loose connection or a damaged component.
- Short circuit refers to a circuit that does not have a load. For example, if the lamp is connected to the circuit but a direct connection is present between the battery's negative terminal and its positive terminal, too.

Current in a short circuit can flow at dangerously high levels. Short circuits can damage electronic components, cause a battery to explode, or maybe start a fire.

The short circuit illustrates an important point about electrical circuits: it is possible – common, even – for a circuit to have multiple pathways for current to flow. The current can flow through the lamp as well as through the path that connects the two battery terminals directly.

Current flows everywhere it can. If your circuit has two pathways through which current can flow, the current doesn't choose one over the other; it chooses both. However, not all paths are equal, so current doesn't flow equally through all paths.

For example, current will flow much more easily through the short circuit than it will through the lamp. Thus, the lamp will not glow because nearly all of the current will bypass the lamp in favor of the easier route through the short circuit. Even so, a small amount of current will flow through the lamp.

The part of the circuit bypassed by the short circuit ceases to function, and a large amount of current could start to flow. This can generate a lot of heat in the wires and cause a fire. As a safety measure, fuses and circuit breakers automatically open the circuit when there is an excessive current.

Under certain conditions, the short may cause fire because the current flows where it was not supposed to flow. If the current flow is too great, a fuse is used as a safety device to stop the current flow. The fuse must be placed in every circuit where there is a danger of overloading the line. Then all the current will pass through the fuse. When a short circuit or an overload causes more current to flow than the carrying capacity of the wire, the wire becomes hot and sets fire to the insulation. If the flow of current is greater than the carrying capacity of the fuse, the fuse melts and opens the circuit.

In a series circuit, the same current flows through all the components. The total voltage across the circuit is the sum of the voltages across each component, and the total resistance is the sum of the resistances of each component. In this circuit, V = V1 + V2 + V3 and R = R1 + R2 + R3. An example of a series circuit is a string of Christmas lights. If any one of the bulbs is missing or burned out, no current will flow and none of the lights will go on.

Parallel circuits are like the smaller blood vessels that branch off from an artery and then connect to a vein to return blood to the heart. Now think of two wires, each representing an artery and a vein, with some smaller wires connected between them. These smaller wires will have the same voltage applied to them, but different amounts of current flowing through them depending on the resistance of the individual wires.

An example of a parallel circuit is the wiring system of a house. A single electric power source supplies all the lights and appliances with the same voltage. If one of the lights burns out, current can still flow through the rest of the lights and appliances. However, if there is a short circuit, the voltage drops to almost zero, and the entire system goes down.

Circuits are generally very complex combinations of series and parallel circuits. The first circuits were very simple DC circuits.

History of Electrical Circuits. Early investigations of static electricity go back hundreds of years. Static electricity is a transfer of electrons produced by friction, like when you rub a balloon across a sweater. A spark or very brief flow of current can occur when charged objects come into contact, but there is no continuous flow of current. In the absence of a continuous current, there is no useful application of electricity.

The invention of the battery, which could produce a continuous flow of current, made possible the development of the first electric circuits. Alessandro Volta invented the first battery, the voltaic pile, in 1800. The very first circuits used a battery and electrodes immersed in a container of water. The flow of current through the water produced hydrogen and oxygen.

The first widespread application of electric circuits for practical use was for electric lighting. Shortly after Thomas Edison invented his incandescent light bulb, he sought practical applications for it by developing an entire power generation and distribution system. The first such system in the United States was the Pearl Street Station in downtown Manhattan. It provided a few square blocks of the city with electric power, primarily for illumination.

One classification of circuits has to do with the nature of the current flow. The earliest circuits were battery-powered, which made in a steady, constant current that always flowed in the same direction. This is direct current, or DC. The use of DC continued through the time of the first electric power systems. A major problem with the DC system was that power stations could serve an area of only about a square mile because of power loss in the wires.

In 1883, engineers proposed harnessing the tremendous hydroelectric power potential of Niagara Falls to supply the needs of Buffalo, N.Y. Although this power would ultimately go beyond Buffalo to New York City and even farther, there was an initial problem with distance. Buffalo was only 16 miles from Niagara Falls, but the idea was unworkable until Nikola Tesla made it possible.

Electronic Circuits. You may have heard the term chip, especially when the subject of computer hardware comes up. A chip is a tiny piece of silicon, usually around one centimeter square. A chip may be a single transistor (a piece of silicon that amplifies electrical signals or serves as an on/off switch in computer applications). It can also be an integrated circuit composed of many interconnected transistors. Chips are encapsulated in a hermetically sealed plastic or ceramic enclosure called a package. Sometimes people refer to the whole package as a chip, but the chip is actually inside the package.

There are two basic types of integrated circuit – monolithic and hybrid. Monolithic ICs include the entire circuit on a single silicon chip. They can range in complexity from just a few transistors to millions of transistors on a computer microprocessor chip. A hybrid IC has a circuit with several chips enclosed in a single package. The chips in a hybrid IC may be a combination of transistors, resistors, capacitors and monolithic IC chips.

A printed circuit board, or PCB, holds an electronic circuit together. The completed PCB with components attached is a printed circuit board assembly, or PCBA. A multilayer PCB may have as many as 10 stacked PCBs. Electroplated copper conductors passing through holes called vias connect the individual PCBs, which forms a three-dimensional electronic circuit.

The most important elements in an electronic circuit are the transistors. Diodes are tiny chips of silicon that act as valves to allow current flow in only one direction. Other electronic components are passive elements like resistors and capacitors. Resistors offer a specified amount of resistance to current, and capacitors store electric charge. The third basic passive circuit element is the inductor, which stores energy in the form of a magnetic field. Microelectronic circuits very rarely use inductors, but they are common in larger power circuits.

Most circuits are designed using computer-aided design programs, or CAD. Many of the circuits used in digital computers are extremely complex and use millions of transistors, so CADs are the only practical way to design them. The circuit designer starts with a general specification for the functioning of the circuit, and the CAD program lays out the complex pattern of interconnections.

The etching of the metal interconnection pattern on a PCB or IC chip uses an etch-resistant masking layer to define the circuit pattern. The exposed metal is etched away, leaving the pattern of connecting metal between components.

Why is AC used in electronic circuits? In electronic circuits, the distances and currents are very small, so why use AC? First of all, the currents and voltages in these circuits represent constantly changing phenomena, so the electrical representations, or analogs, are also constantly changing. The second reason is that radio waves (like those used by TVs, microwaves and cell phones) are high-frequency AC signals. The frequencies used for all types of wireless communication has steady advanced over the years, from the kilohertz (kHz) range in the early days of radio to the megahertz (MHz) and gigahertz (GHz) range today.

Electronic circuits use DC to provide power for the transistors and other components in electronic systems. A rectifier circuit converts AC power to DC from the AC line voltage.

Задания к тексту

I. Найдите в тексте ответы на следующие вопросы:

1. What is an electric circuit?
2. What types of electric circuits are mentioned in the text?
3. What is the difference between alternating current (AC) and direct current (DC)?
4. What are basic circuit elements?
5. What is a fuse? When do we use fuses?
6. When did the history of electric circuits start?
7. What are the main features of electronic circuits?

II. Соедините слова и словосочетания с их дефинициями.

1. A series circuit is	a. the circuit which is complete and forms a loop that allows current to flow.
2. A parallel circuit is	b. the point where the electrons leave an electrical circuit.
3. An open circuit is	c. the circuit components of which are connected along a single path, so the same current flows through all of the components.
4. A closed circuit is	d. the circuit which provides two or more paths for the passage of current so that part of the current flows through one path, and part through another.
5. The «return» or «earth ground» is	e. the point where electrons enter an electrical circuit.
6. The «source» of electrons is	f. the circuit any part of which is disconnected or disrupted so that a loop is not formed, current cannot flow.

III. Подберите русские эквиваленты к следующим словам и словосочетаниям:

electric circuit, appliance, alternating current, capacitor, open circuit, parallel circuit, short circuit, voltage source, closed circuit, load, direct current, conductive path, inductor, wiring system, printed circuit board, fuse, series circuit.

источник напряжения, система электропроводки, параллельная цепь, замкнутая цепь, последовательная цепь, токопроводящая дорожка (перемычка), конденсатор, нагрузка, переменный ток, короткое замыкание, печатная плата, электрическая цепь, плавкий предохранитель, разомкнутая цепь, индуктор, прибор, постоянный ток.

IV. Прочитайте и переведите предложения, обращая внимание на предлоги, союзы и наречия, создающие логические связи между отдельными элементами высказываний.

1. Thus high-voltage direct current transmission uses very big converters.
2. For the purpose of understanding what a series circuit is the electrical bell circuit is considered to be a typical example of this type of circuits.
3. In order to understand the difference between an electronic circuit and an electrical circuit, it is important to say that they have the same definition, but electronic circuits tend to be low voltage circuits rather than electric circuits.
4. In addition to simple circuits, there are complex ones, where the load is a combination of components, such as resistors, capacitors, transistors, and so on.
5. If your circuit has two pathways through which current can flow, the current doesn't choose one over the other; it chooses both. However, not all paths are equal; in this connection current doesn't flow equally through all paths.
6. If the current flow is too great, a fuse is virtually used as a safety device to stop the current flow.

V. Обратите внимание на буквенные сокращения словосочетаний, которые являются важным компонентом научно-технического текста. Переведите предложения, содержащие аббревиатуру.

1. *AC – alternating current; DC –direct current.*

Converters can change AC to DC and vice versa.

2. *IC – integrated circuit.*

The chips in a hybrid IC may be a combination of transistors, resistors, capacitors and monolithic IC chips.

3. *PCB – printed circuit board.*

PCB holds an electronic circuit together.

4. *PCBA – printed circuit board assembly.*

The completed PCB with components attached is a printed circuit board assembly, or PCBA.

5. *CAD – computer-aided design.*

Many of the circuits used in digital computers are extremely complex and use millions of transistors, so CADs are the only practical way to design them.

6. *kHz – kilohertz*; *MHz – megahertz; GHz – gigahertz.*

The frequencies used for all types of wireless communication has steady advanced over the years, from the kilohertz (kHz) range in the early days of radio to the megahertz (MHz) and gigahertz (GHz) range today.

VI. Назовите типовые формы образования терминов в приведенных ниже примерах, переведите их.

hydroelectric power generating station, alternating current, battery operated vehicle, conductive path, wiring system, incandescent light bulb, hermetically sealed relay, printed circuit board, printed circuit board assembly, computer-aided design.

2.2. Тексты для внеаудиторного чтения

Text 1: A look into the future: 21st century inventions

We live in a world of technology, and we can see new things invented by scientists and inventors every day. Just remember how in the past, things were done in hours; nowadays, it can take less than one minute for the same thing. We owe it to the technology, and to the latest inventions that are improving our lives considerably. We are talking here about the inventions of our century that help us live in a modern world.

Robotics. Robots have been around since the twentieth century in one form or another, but it won't be until the twenty-first century that they will become truly common and useful. Performing everything from fire-fighting to carpentry, by the end of the century every house will have at least one robot programmed to perform any number of tedious or dangerous chores humans would rather not deal with, and they will be perfect to leave at home to walk the dog and keep an eye on the house when you're away. Their military applications are even more promising, with robots being used to clear mine fields and perform missions deemed too dangerous for their human counterparts.

Genetic Engineering. It's difficult to imagine that we are on the threshold of being able to program our own DNA, but that is the next step in human evolution. By the end of the century, parents will be able to determine the sex, intelligence, and even hair and eye color of their child while turning off any possibly dangerous genetic defects their offspring might have been in line to inherit. This ability to "design" an embryo won't be confined to humans either; by the year 2100 we might well have the ability to breed elephants no larger than a Golden Retriever or make a mouse the size of a house-cat.

Hypersonic Transportation. Just as the airplane revolutionized travel in the twentieth century, there is no reason to believe that evolution to ever faster speeds is going to end anytime soon. As such, it is likely that before the dawn of the next century people will be able to fly between London and Tokyo at Mach 10 speeds and arrive at their destination in just over two hours.

Free Energy. The holy grail of science has been the acquisition of energy that comes from non-polluting sources (i.e. oil, natural gas, coal, etc.). By the end of the century it is likely that dream will become a reality. However, it will come from several sources and in very different ways. Apart from Geo-thermal, wind, biomass, clean coal, nuclear and solar energy, other more exotic technologies may also emerge.

Artificial Intelligence. It's one thing to make a robot do daily chores around the house; it's quite another to get it to think about how best to carry out its task. In the world of artificial intelligence machines will actually be capable of learning, planning, deciding, considering, comparing, aligning and even abstract thinking. They won't be quite on a par with the human brain—and their abilities will be largely confined to a specific area rather than broad-based—but A.I. will be the next big advance in technology, and it could appear at a primordial stage within the next few decades.

Nanotechnology. It sounds like something right out of Star Trek, but nanotechnology — those microscopically small, self-replicating machines — may well be a reality a few decades from now. Their ability to effect repairs on the human body on a microscopic level — as well as repair or enhance other non-organic technologies — might be the next great step in human evolution, while their self-replicating capabilities will be used to manufacture everything from microchips to potato chips.

Human Cloning. Actually, cloning has been known since the twentieth century, so it's nothing really new. However, if we can clone a sheep, it should be possible to clone a human being, which is probably going to become a common-place reality in the end of the twenty-first century. Of course, people won't necessarily make carbon copies of themselves just for fun, but as a means of replacing faulty organs and regenerating lost limbs.

Antigravity. It sounds unlikely, but the creation of monopoles (magnets that have only one pole) might be quite doable in another seventy years or so. Technically this wouldn't be true anti-gravity but magnetism. However, the effect would be similar. Once it is possible, wheels will be a thing of the past as everything will ride on a cushion of magnetic fields.

Automation. By the end of the 21st century, your house, car, refrigerator, etc. will be smarter than you and capable of carrying out nearly any task you might have in mind. Not only would your house be entirely automated, but so would just about everything else, from airliners and factories to fighter planes and warships. Even entire cities would have a central computer core that would be responsible for doing everything from turning on the park's sprinkler system when it detected dehydration in the lawns to operating the traffic grid and turning on the lights at dusk. Humans would still make all the big decisions and maintain these systems but for the most part people will be out of the equation, thereby giving them more time to watch their favorite programs on holographic televisions.

Hydrogen Powered Cars. Since people have such a love affair with their automobile, it's hard to imagine the car disappearing anytime soon. However, it is conceivable that by the middle of the twenty-first century, the good old internal combustion engine as we know it will be as obsolete as the steam engine. Electrical cars and hybrids will be the short-term norm, but they will find considerable competition coming from hydrogen-powered vehicles, that will have the same power as their twentieth century fossil-fuel sucking counterparts but run on hydrogen and leave only water vapor in their wakes. Not that you would get to drive the things, of course. That's where the traffic grid computers come into play; all you need to do is sit back and let your car take you wherever you tell it while you read a book (whatever that is.)

Text 2: Outstanding inventors: Thomas Alva Edison

Thomas Edison was the great genius inventor of the electrical age. His hundreds of inventions made him a giant public figure in American and around the world at the turn of the 20th century. Among Edison's most famous inventions are the first practical long-lasting light bulb and the phonograph; he also helped refine and develop other inventions like motion picture cameras, the stock ticker and the typewriter.

Birth of Thomas Alva Edison. Thomas Alva Edison was born to Sam and Nancy on February 11, 1847, in Milan, Ohio. Known as "Al" in his youth, Edison was the youngest of seven children, four of whom survived to adulthood. Edison tended to be in poor health when young.

Edison was a poor student. When a schoolmaster called Edison «addled» or slow his furious mother took him out of the school and proceeded to teach him at home. Edison said many years later, – «My mother was the making of me. She was so true, so sure of me, and I felt I had someone to live for, someone I must not disappoint». At an early age, he showed a fascination for mechanical things and for chemical experiments.

In 1859, Edison took a job selling newspapers and candy on the Grand Trunk Railroad to Detroit.

In the baggage car, he set up a laboratory for his chemistry experiments and a printing press, where he started the «Grand Trunk Herald», the first newspaper published on a train. An accidental fire forced him to stop his experiments on board.

Loss of Hearing. Around the age of twelve, Edison lost almost all his hearing. There are several theories as to what caused his hearing loss. Some attribute it to the aftereffects of scarlet fever which he had as a child. Others blame it on a conductor boxing his ears after Edison caused a fire in the baggage car, an incident which Edison claimed never happened. Edison himself blamed it on an incident in which he was grabbed by his ears and lifted to a train. He did not let his disability discourage him, however, and often treated it as an asset, since it made it easier for him to concentrate on his experiments and research. Undoubtedly, though, his deafness made him more solitary and shy in dealings with others.

Work as a Telegraph Operator. In 1862, Edison rescued a three-year-old from a track where a boxcar was about to roll into him. The grateful father, J.U. MacKenzie, taught Edison railroad telegraphy as a reward. That winter, he took a job as a telegraph operator in Port Huron. Between 1863 and 1867, Edison migrated from city to city in the United States taking available telegraph jobs.

Love of Invention. In 1868, Edison moved to Boston where he worked in the Western Union office and worked on his inventions. In January 1869 Edison resigned his job, intending to devote himself fulltime to inventing things. His first invention to receive a patent was the electric vote recorder, in June 1869.

Pope, Edison and Company. In October 1869, Edison formed with Franklin L. Pope and James Ashley the organization Pope, Edison and Co. They advertised themselves as electrical engineers and constructors of electrical devices. Edison received several patents for improvements to the telegraph.

Death, Marriage & Birth. His personal life during this period also brought much change. Edison's mother died in 1871, and later that year, he married a former employee, Mary Stilwell, on Christmas Day. Their first child, Marion, was born in February 1873, followed by a son, Thomas, Jr., born on January 1876. Edison nicknamed the two «Dot» and «Dash» referring to telegraphic terms. A third child, William Leslie was born in October 1878.

Menlo Park. Edison opened a new laboratory in Menlo Park, NJ, in 1876. This site later become known as an «invention factory» since they worked on several different inventions at any given time there. Edison would conduct numerous experiments to find answers to problems. He said, «I never quit until I get what I'm after. Negative results are just what I'm after. They are just as valuable to me as positive results». Edison liked to work long hours and expected much from his employees. He often slept no more than four hours per night and made the famous statement, «Genius is one percent inspiration and ninety-nine percent perspiration».

In 1877, Edison worked on a telephone transmitter that greatly improved on Alexander Graham Bell's work with the telephone. His transmitter made it possible for voices to be transmitted at higher volume and with greater clarity over standard telephone lines.

Phonograph. Edison's experiments with the telephone and the telegraph led to his invention of the phonograph in 1877. It occurred to him that sound could be recorded as indentations on a rapidly-moving piece of paper.

Electric Light System. Edison focused on the electric light system in 1878, setting aside the phonograph for almost a decade. With the backing of financiers, The Edison Electric Light Co. was formed on November 15 to carry out experiments with electric lights and to control any patents resulting from them. The lab attempted not only to devise an incandescent bulb, but an entire electrical lighting system that could be supported in a city.

Edison set up an electric light factory in East Newark in 1881, and then the following year moved his family and himself to New York and set up a laboratory there.

Lighting Becomes a Commercial Commodity. In order to prove its viability, the first commercial electric light system was installed on Pearl Street in the financial district of Lower Manhattan in 1882. Initially, only four hundred lamps were lit; a year later, there were 513 customers using 10,300 lamps. Edison formed several companies to manufacture and operate the apparatus needed for the electrical lighting system.

Remarriage. Edison's wife, Mary, died on August 9, 1884, possibly from a brain tumor. Edison remarried to Mina Miller on February 24, 1886, and, with his wife, moved into a large mansion named Glenmont in West Orange, New Jersey. In 1887, Edison had built a new, larger laboratory in West Orange, New Jersey. The facility included a machine shop, phonograph and photograph departments, a library, and ancillary buildings for metallurgy, chemistry, woodworking, and galvanometer testings.

Thomas Edison's Phonograph Company. In 1896, Edison started the National Phonograph Co. with the intent of making phonographs for home amusement. Over the years, Edison made improvements to the phonograph and to the cylinders which were played on them, the early ones being made of wax. Edison introduced an unbreakable cylinder record, at roughly the same time he entered the disc phonograph market in 1912.

The introduction of an Edison disc was in reaction to the overwhelming popularity of discs on the market in contrast to cylinders. In the 1920s, competition from radio caused business to sour, and the Edison disc business ceased production in 1929.

Motion Pictures. In 1888, Edison decided to work on his own motion picture camera at his laboratory. The task of inventing the machine fell to Edison's associate William K. L. Dickson. Dickson initially experimented with a cylinder-based device for recording images, before turning to a celluloid strip. In October of 1889, Dickson greeted Edison's return from Paris with a new device that projected pictures and contained sound. After more work, patent applications were made in 1891 for a motion picture camera, called a Kinetograph, and a Kinetoscope, a motion picture peephole viewer.

In 1913, Edison experimented with synchronizing sound to film. A Kinetophone was developed by his laboratory which synchronized sound on a phonograph cylinder to the picture on a screen. Although this initially brought interest, the system was far from perfect and disappeared by 1915. By 1918, Edison ended his involvement in the motion picture field.

In 1911, Edison's companies were re-organized into Thomas A. Edison, Inc. As the organization became more diversified and structured, Edison became less involved in the day-to-day operations, although he still had some decision-making authority. The goals of the organization became more to maintain market viability than to produce new inventions frequently.

October 18, 1931. For his last two years, a series of ailments caused his health to decline until he lapsed into a coma on October 14, 1931. He died on October 18, 1931, at his estate, Glenmont, in West Orange, New Jersey. By the end of his life Edison had registered 1093 patents and had made millions from his inventions and the businesses he built on them.

Text 3: James Watt

Inventor of the Modern Steam Engine. Steam engines used to pump water out of mines in England existed when James Watt was born. The discovery that steam could be harnessed and made to work is not credited to James Watt. We do not know exactly who made that discovery, but we do know that the ancient Greeks had crude steam engines. James Watt, however, is credited with inventing the first practical engine. And so the history of the "modern" steam engine often begins with James Watt.

James Watt. We can imagine a young James Watt, sitting by the fireplace in his mother's cottage, intently watching the steam rising from the boiling tea kettle, the beginning of a lifelong fascination with steam.

In 1763, when he was twenty-eight and working as a mathematical-instrument maker at the University of Glasgow, a model of Thomas Newcomen's steam pumping engine was brought into his shop for repairs. James Watt had always been interested in mechanical and scientific instruments, particularly those which dealt with steam. The Newcomen engine must have thrilled him.

James Watt set up the model and watched it in operation. He noted how the alternate heating and cooling of its cylinder wasted power. He concluded, after weeks of experimenting, that in order to make the engine practical, the cylinder had to be kept as hot as the steam which entered it. Yet in order to condense steam there had some cooling taking place. That was a challenge the inventor faced.

In his journal the inventor wrote that the idea came to him on a Sunday afternoon in 1765, as he walked across the Glasgow Green. If the steam was condensed in a separate vessel from the cylinder, it would be quite possible to keep the condensing vessel cool and the cylinder hot at the same time. The next morning Watt built a prototype and found that it worked. He added other improvements and built his now famous improved steam engine.

James Watt and Matthew Boulton. After one or two disastrous business experiences, James Watt associated himself with Matthew Boulton, an owner of the Soho Engineering Works, near Birmingham. The firm of Boulton and Watt became famous, and James Watt lived until August 19, 1819, long enough to see his steam engine become the greatest single factor in the upcoming new industrial era.

Rivals. Matthew Boulton and James Watt, however, though they were pioneers, were not the only ones working on the development of the steam engine. They had rivals, one was Richard Trevithick in England; another was Oliver Evans of Philadelphia. Independently, both Richard Trevithick and Oliver Evans invented a high-pressure engine (in contrast to Watt's steam engine, where the steam entered the cylinder at only slightly more than atmospheric pressure). Watt clung tenaciously to the low-pressure theory of engines all of his life. Matthew Boulton and James Watt, worried by Richard Trevithick's experiments in high-pressure engines, tried to have the British Parliament pass an act forbidding high pressure on the grounds that the public would be endangered by high-pressure engines exploding.

Text 4: Nikola Tesla

Nikola Tesla was born in 1856 in Smiljan Lika, Croatia. He was the son of a Serbian Orthodox clergyman. Tesla studied engineering at the Austrian Polytechnic School. He worked as an electrical engineer in Budapest and later emigrated to the United States in 1884 to work at the Edison Machine Works. He died in New York City on January 7, 1943.

During his lifetime, Tesla invented fluorescent lighting, the Tesla induction motor, the Tesla coil, and developed the alternating current (AC) electrical supply system that included a motor and transformer, and 3-phase electricity.

Tesla is now credited with inventing modern radio as well; since the Supreme Court overturned Guglielmo Marconi's patent in 1943 in favor of Nikola Tesla's earlier patents.

When an engineer (Otis Pond) once said to Tesla, «Looks as if Marconi got the jump on you» regarding Marconi's radio system, Tesla replied, «Marconi is a good fellow. Let him continue. He is using seventeen of my patents».

The Tesla coil, invented in 1891, is still used in radio and television sets and other electronic equipment.

Mystery Invention. Ten years after patenting a successful method for producing alternating current, Nikola Tesla claimed the invention of an electrical generator that would not consume any fuel. Tesla stated about his invention that he had harnessed the cosmic rays and caused them to operate a motive device.

In total, Nikola Telsa was granted more than one hundred patents and invented countless unpatented inventions.

Nikola Tesla and Thomas Edison. Nikola Tesla was Thomas Edison's rival at the end of the 19th century. In fact, he was more famous than Edison throughout the 1890's. His invention of polyphase electric power earned him worldwide fame and fortune.

Radio Pioneer. Nikola Tesla was also a radio pioneer in a time when the general public still considered it witchcraft. There’s no better example of this than an 1898 convention at Madison Square Garden where Tesla presented his latest creation, a small radio-controlled boat. Officially named a «teleautomaton» boat, Tesla's design was intended to showcase his new patent, a «method of and apparatus for controlling mechanism of moving vessels and vehicles». It had a tiny rudder, a tiny propeller, and two antennas. Tesla was able to control the boat in front of a bewildered crowd.

The people were amazed by what they were seeing. Despite Tesla's efforts to explain scientifically what was going on, the general consensus of the crowd was that Tesla was controlling the boat using telepathy. Others put forward slightly more plausible theories, such as a trained monkey secretly piloting the boat.

Ever the visionary, Tesla immediately saw the possible use of the teleautomaton boat as a weapon. He planned to develop a submersible version of the boat and sell the patent to the government. However, nobody else seemed to share Tesla's vision. According to him, the Washington official he met "burst out with laughter" when presented with the idea of armed, radio-controlled vehicles.

At his zenith Tesla was an intimate of poets and scientists, industrialists and financiers. Yet he died destitute, having lost both his fortune and scientific reputation.

Text 5: Henry Ford

Automobile manufacturer Henry Ford was born on July 30, 1863, on his family's farm in Dearborn, Michigan. From the time he was a young boy, Ford enjoyed tinkering with machines. Farm work and a job in a Detroit machine shop afforded him ample opportunities to experiment. He later worked as a part-time employee for the Westinghouse Engine Company. By 1896, Ford had constructed his first horseless carriage which he sold in order to finance work on an improved model.

Ford incorporated the Ford Motor Company in 1903, proclaiming, «I will build a car for the great multitude». In October 1908, he did so, offering the Model T for $950. In the Model T's nineteen years of production, its price dipped as low as $280. Nearly 15,500,000 were sold in the United States alone. The Model T heralds the beginning of the Motor Age; the car evolved from luxury item for the well-to-do to essential transportation for the ordinary man.

Ford revolutionized manufacturing. By 1914, his Highland Park, Michigan plant, using innovative production techniques, could turn out a complete chassis every 93 minutes. This was a stunning improvement over the earlier production time of 728 minutes. Using a constantly-moving assembly line, subdivision of labor, and careful coordination of operations, Ford realized huge gains in productivity.

In 1914, Ford began paying his employees five dollars a day, nearly doubling the wages offered by other manufacturers. He cut the workday from nine to eight hours in order to convert the factory to a three-shift workday.

Ford's mass-production techniques would eventually allow for the manufacture of a Model T every 24 seconds. His innovations made him an international celebrity.

Ford's affordable Model T irrevocably altered American society. As more Americans owned cars, urbanization patterns changed. The United States saw the growth of suburbia, the creation of a national highway system, and a population going anywhere anytime. Ford witnessed many of these changes during his lifetime, all the while personally longing for the agrarian lifestyle of his youth.

Henry Ford's Quotes

- I will build a car for the great multitude.
- If I had asked people what they wanted, they would have said «faster horses».
- A business that makes nothing but money is a poor business.
- To do more for the world than the world does for you – that is success.
- There is one rule for the industrialist and that is: Make the best quality of goods possible at the lowest cost possible, paying the highest wages possible.
- It is not the employer who pays the wages. Employers only handle the money. It is the customer who pays the wages.
- Quality means doing it right when no one is looking.
- Anyone who stops learning is old, whether at twenty or eighty. Anyone who keeps learning stays young. The greatest thing in life is to keep your mind young.
- Don't find fault, find a remedy.
- Failure is simply the opportunity to begin again, this time more intelligently.
- If money is your hope for independence you will never have it. The only real security that a man will have in this world is a reserve of knowledge, experience, and ability.
- If there is any one secret of success, it lies in the ability to get the other person's point of view and see things from that person's angle as well as from your own.

Text 6: Steve Wozniak

Steve Wozniak is the co-founder of Apple Computers. Wozniak has always been credited with being the main designer of the first Apples.

Wozniak is also a noted philanthropist who founded the Electronic Frontier Foundation, and was the founding sponsor of the Tech Museum, Silicon Valley Ballet and Children's Discovery Museum of San Jose.

His Role in the History of Computers. Steve Wozniak was the main designer on the Apple I and Apple II computers together with Steve Jobs (business brains) and others. The Apple II is noted as the first commercially successful line of personal computers, featuring a central processing unit, a keyboard, color graphics, and a floppy disk drive. In 1984, Steve Wozniak greatly influenced the design of the Apple Macintosh computer, the first successful home computer with a mouse-driven graphical user.

Awards. Steve Wozniak was awarded the National Medal of Technology by the President of the United States in 1985, the highest honor bestowed on America's leading innovators. In 2000, he was inducted into the Inventors Hall of Fame and was awarded the prestigious Heinz Award for Technology, The Economy and Employment for «single-handedly designing the first personal computer and for then redirecting his lifelong passion for mathematics and electronics toward lighting the fires of excitement for education in grade school students and their teachers».

Biography. Steve Wozniak was born on August 11, 1950, in Los Gatos, California and grew up in Sunnyvale, California. Wozniak's father was an engineer for Lockheed, who always inspired his son's curiosity for learning with a few science fair projects.

Wozniak studied engineering at the University of California at Berkeley, where he first met Steve Jobs, best friend and future business partner.

Steve Wozniak dropped out of Berkeley to work for Hewlett-Packard.

Steve Jobs was not the only interesting character in Wozniak's life. He also befriended famed hacker John Draper aka «Captain Crunch». Draper taught

Wozniak how to build a «blue box», a stealth device for making free long distance calls.

Apple Computers & Steve Jobs. Steve Wozniak sold his HP scientific calculator. Steve Jobs sold his Volkswagen van. The pair raised $1,300, to create their first prototype computer, the Apple I, which they debuted at a meeting of the Palo Alto-based Homebrew Computer Club.

On April 1, 1976, Jobs and Wozniak formed Apple Computer. Wozniak quit his job at Hewlett-Packard and became the vice president in charge of research and development at Apple.

Leaving Apple. On February 7, 1981, Steve Wozniak crashed his single engine aircraft, in Scotts Valley, California. The crash caused Wozniak to temporarily lose his memory, however, on a deeper level it certainly changed his life. After the accident, Wozniak left Apple and returned to college to finish his degree in electrical engineering and computer science. He also got married, and founded the "UNUSON" (Unite Us In Song) corporation and put on two rock festivals. The enterprise lost money.

Steve Wozniak did return to work for Apple Computers for a brief period between in 1983 and 1985.

Today, Steve Wozniak is the Chief Scientist for Fusion-io and is a published author with the release of his New York Times Best Selling autobiography, iWoz: From Computer Geek to Cult Icon.

He loves children and teaching, and provides many of his students in the Los Gatos school district with free computers.

Text 7: Electric charge

Electric charge is the physical property of matter that causes it to experience a force when placed in an electromagnetic field. There are two types of electric charges: positive and negative. Positively charged substances are repelled from other positively charged substances, but attracted to negatively charged substances; negatively charged substances are repelled from negative and attracted to positive. An object is negatively charged if it has an excess of electrons, and is otherwise positively charged or uncharged. The SI derived unit of electric charge is the coulomb (C), although in electrical engineering it is also common to use the ampere-hour (Ah), and in chemistry it is common to use the elementary charge (e) as a unit. The symbol Q is often used to denote charge. The early knowledge of how charged substances interact is now called classical electrodynamics, and is still very accurate if quantum effects do not need to be considered.

The electric charge is a fundamental conserved property of some subatomic particles, which determines their electromagnetic interaction. Electrically charged matter is influenced by, and produces, electromagnetic fields. The interaction between a moving charge and an electromagnetic field is the source of the electromagnetic force, which is one of the four fundamental forces.

Twentieth-century experiments demonstrated that electric charge is quantized; that is, it comes in integer multiples of individual small units called the elementary charge, e, approximately equal to 1.602×10^{-19} coulombs (except for particles called quarks, which have charges that are integer multiples of e/3). The proton has a charge of $+e$, and the electron has a charge of $-e$. The study of charged particles, and how their interactions are mediated by photons, is called quantum electrodynamics.

Charge is the fundamental property of forms of matter that exhibit electrostatic attraction or repulsion in the presence of other matter. Electric charge is a characteristic property of many subatomic particles. The charges of free-standing particles are integer multiples of the elementary charge e; we say that electric charge is quantized. Michael Faraday, in his electrolysis experiments, was the first to note the discrete nature of electric charge. Robert Millikan's oil-drop experiment demonstrated this fact directly, and measured the elementary charge.

By convention, the charge of an electron is −1, while that of a proton is +1. Charged particles whose charges have the same sign repel one another, and particles whose charges have different signs attract. Coulomb's law quantifies the electrostatic force between two particles by asserting that the force is proportional to the product of their charges, and inversely proportional to the square of the distance between them.

The charge of an antiparticle equals that of the corresponding particle, but with opposite sign. Quarks have fractional charges of either $-\frac{1}{3}$ or $+\frac{2}{3}$, but free-standing quarks have never been observed (the theoretical reason for this fact is asymptotic freedom).

The electric charge of a macroscopic object is the sum of the electric charges of the particles that make it up. This charge is often small, because matter is made of atoms, and atoms typically have equal numbers of protons and electrons, in which case their charges cancel out, yielding a net charge of zero, thus making the atom neutral.

An ion is an atom (or group of atoms) that has lost one or more electrons, giving it a net positive charge (cation), or that has gained one or more electrons, giving it a net negative charge (anion). Monatomic ions are formed from single atoms, while polyatomic ions are formed from two or more atoms that have been bonded together, in each case yielding an ion with a positive or negative net charge.

During formation of macroscopic objects, constituent atoms and ions usually combine to form structures composed of neutral ionic compounds electrically bound to neutral atoms. Thus macroscopic objects tend toward being neutral overall, but macroscopic objects are rarely perfectly net neutral.

Sometimes macroscopic objects contain ions distributed throughout the material, rigidly bound in place, giving an overall net positive or negative charge to the object. Also, macroscopic objects made of conductive elements, can more or less easily (depending on the element) take on or give off electrons, and then maintain a net negative or positive charge indefinitely. When the net electric charge of an object is non-zero and motionless, the phenomenon is known as static electricity. This can easily be produced by rubbing two dissimilar materials together, such as rubbing amber with fur or glass with silk. In this way non-conductive materials can be charged to a significant degree, either positively or negatively. Charge taken from one material is moved to the other material, leaving an opposite charge of the same magnitude behind. The law of conservation of charge always applies, giving the object from which a negative charge has been taken a positive charge of the same magnitude, and vice versa.

Even when an object's net charge is zero, charge can be distributed non-uniformly in the object (e.g., due to an external electromagnetic field, or bound polar molecules). In such cases the object is said to be polarized. The charge due to polarization is known as bound charge, while charge on an object produced by electrons gained or lost from outside the object is called free charge. The motion of electrons in conductive metals in a specific direction is known as electric current.

As reported by the ancient Greek mathematician Thales of Miletus around 600 BC, charge (or electricity) could be accumulated by rubbing fur on various substances, such as amber. The Greeks noted that the charged amber buttons could attract light objects such as hair. They also noted that if they rubbed the amber for long enough, they could even get an electric spark to jump. This property derives from the triboelectric effect.

In 1600, the English scientist William Gilbert returned to the subject in *De Magnete*, and coined the New Latin word *electricus* from *ηλεκτρον* (*elektron*), the Greek word for *amber*, which soon gave rise to the English words «electric» and «electricity». He was followed in 1660 by Otto von Guericke, who invented what was probably the first electrostatic generator. Other European pioneers were Robert Boyle, who in 1675 stated that electric attraction and repulsion can act across a vacuum; Stephen Gray, who in 1729 classified materials as conductors and insulators; and C. F. du Fay, who proposed in 1733 that electricity comes in two varieties that cancel each other, and expressed this in terms of a two-fluid theory. When glass was rubbed with silk, du Fay said that the glass was charged with vitreous electricity, and, when amber was rubbed with fur, the amber was said to be charged with resinous electricity. In 1839, Michael Faraday showed that the apparent division between static electricity, current electricity, and bioelectricity was incorrect, and all were a consequence of the behavior of a single kind of electricity appearing in opposite polarities. It is arbitrary which polarity is called positive and which is called negative. Positive charge can be defined as the charge left on a glass rod after being rubbed with silk.

One of the foremost experts on electricity in the 18th century was Benjamin Franklin, who argued in favour of a one-fluid theory of electricity. Franklin imagined electricity as being a type of invisible fluid present in all matter; for example, he believed that it was the glass in a Leyden jar that held the accumulated charge. He posited that rubbing insulating surfaces together caused this fluid to change location, and that a flow of this fluid constitutes an electric current. He also posited that when matter contained too little of the fluid it was «negatively» charged, and when it had an excess it was «positively» charged. For a reason that was not recorded, he identified the term «positive» with vitreous electricity and «negative» with resinous electricity. William Watson arrived at the same explanation at about the same time.

The SI unit of quantity of electric charge is the coulomb, which is equivalent to about 6.242×10^{18} e (e is the charge of a proton). Hence, the charge of an electron is approximately -1.602×10^{-19} C. The coulomb is defined as the quantity of charge that has passed through the cross section of an electrical conductor carrying one ampere within one second. The symbol Q is often used to denote a quantity of electricity or charge. The quantity of electric charge can be directly measured with an electrometer, or indirectly measured with a ballistic galvanometer.

After finding the quantized character of charge, in 1891 George Stoney proposed the unit «electron» for this fundamental unit of electrical charge. This was before the discovery of the particle by J.J. Thomson in 1897. The unit is today treated as nameless, referred to as «elementary charge», «fundamental unit of charge», or simply as «e». A measure of charge should be a multiple of the elementary charge *e*, even if at large scales charge seems to behave as a real quantity. In some contexts it is meaningful to speak of fractions of a charge; for example in the charging of a capacitor, or in the fractional quantum Hall effect.

In systems of units other than SI such as cgs, electric charge is expressed as combination of only three fundamental quantities such as length, mass and time and not four as in SI where electric charge is a combination of length, mass, time and electric current.

Text 8: How did Nikola Tesla change the way we use energy?

When you flip a switch and a lamp bathes the room in light, you probably don't give much thought to how it works or to the people who made it all possible. If you were forced to acknowledge the genius behind the lamp, you might name Thomas Alva Edison, the inventor of the incandescent light bulb. But just as influential perhaps more so – was a visionary named Nikola Tesla.

Tesla arrived in the United States in 1884, at the age of 28, and by 1887 had filed for a series of patents that described everything necessary to generate electricity using alternating current, or AC. To understand the significance of these inventions, you have to understand what the field of electrical generation was like at the end of the 19th century. It was a war of currents with Tesla acting as one general and Edison acting as the opposing general.

The State of Electricity in 1885. Edison unveiled his electric incandescent lamp to the public in January 1880. Soon thereafter, his newly devised power system was installed in the First District of New York City. When Edison flipped the switch during a public demonstration of the system in 1881, electric lights twinkled on and unleashed an unprecedented demand for this brand-new technology. Although Edison's early installations called for underground wiring, demand was so great that parts of the city received their electricity on exposed wires hung from wooden crossbeams. By 1885, avoiding electrical hazards had become an everyday part of city life; so much so that Brooklyn named its baseball team the Dodgers because its residents commonly dodged shocks from electrically powered trolley tracks.

The Edison system used direct current, or DC. Direct current always flows in one direction and is created by DC generators. Edison was a staunch supporter of DC, but it had limitations. The biggest was the fact that DC was difficult to transmit economically over long distances. Edison knew that alternating current didn't have this limitation, yet he didn't think AC a feasible solution for commercial power systems. Elihu Thomson, one of the principals of Thomson-Houston and a competitor of Edison, believed otherwise. In 1885, Thomson sketched a basic AC system that relied on high-voltage transmission lines to carry power far from where it was generated. Thomson's sketch also indicated the need for a technology to step down the voltage at the point of use. Known as a transformer, this technology would not be fully developed for commercial use until Westinghouse Electric Company did so in 1886.

Even with the development of the transformer and several successful tests of AC power systems, there was an important missing link. That link was the AC motor.

Tesla's Spark of Genius. While Edison toiled to commercialize his electric lamp, Tesla worked through a problem that had intrigued him since he was a student at the Joanneum Polytechnic School in Graz, Austria. While a student there, Tesla saw a demonstration of a Gramme dynamo. A dynamo is a generator that uses a commutator – contacts mounted on the machine's shaft - to produce direct current instead of alternating current. Tesla mentioned to his instructor that it might be possible to do away with the commutator, which sparked horribly as the dynamo operated. This suggestion brought ridicule from his teacher, but it captured Tesla's imagination.

In 1881, Tesla had an inspired idea: What if one were to change the magnetic field in the stator of a dynamo instead of altering the magnetic poles of the rotor? This was a revolutionary concept that turned convention on its head. In a traditional dynamo, the stationary stator provides a constant magnetic field, while a set of rotating windings – the rotor – turns within that field. Tesla saw that if this arrangement were reversed, the commutator could be eliminated.

Of course, bringing this idea to reality would take years of work. Tesla began in 1882 while employed at Continental Edison Company in Paris. During the day, he would install incandescent lighting systems based on Edison's DC power system. In his spare time, he would experiment with AC motor designs. This went on for two years, until Tesla transferred to the Edison Machine Works in New York City. By some accounts, Tesla described his ideas about AC to the famed American inventor, but Edison showed no interest. Instead, he had Tesla make improvements to existing DC generation plants. Tesla did so, only to be disappointed when Edison failed to pay him properly. Tesla quit, and the paths of the two men diverged permanently.

After digging ditches and getting caught in a bad business deal, Tesla finally received financial backing from Charles Peck, an attorney, and Alfred S. Brown, a superintendent at Western Union. Peck and Brown helped Tesla establish a laboratory just a few blocks away from Edison's lab in Manhattan, and encouraged the young engineer to perfect his AC motor. Tesla did just that, building what would become known as a polyphase induction motor. The term polyphase refers to a motor based on multiple alternating currents, not just one. The term induction refers to the process whereby the rotating stator magnets induce current flow in the rotor. Tesla's original motor was a two-phase version that featured a stator with two pairs of magnets, one pair for each of two phases of AC.

In 1887, Tesla filed for seven U.S. patents describing a complete AC system based on his induction motor and including generators, transformers, transmission lines and lighting. A few months later, Tesla delivered a lecture about his revolutionary new system to the American Institute of Electrical Engineers. The lecture caused a sensation and, despite an anti-AC campaign initiated by Edison, convinced many experts that an AC power system was more than just feasible - it was far superior to DC.

To bring a good idea to market, it takes some clout. In this case, the clout came from an inventor who made a fortune in the railroad industry.

AC/DC. Westinghouse carried Tesla's inventions back to Pittsburgh, Penn., where he hoped to use the technology to power the city's streetcars. Tesla followed, and as an employee of the Westinghouse Electric Company, consulted on the implementation. The project didn't proceed smoothly, and Tesla frequently battled with Westinghouse engineers. Eventually, however, everyone pulled together to come up with just the right formula: an AC system based on three-phase, 60-cycle current. Today, almost all power companies in the United States and Canada supply 60-cycle current, which means the AC completes 60 changes of direction in one second. This is known as the frequency of the system.

By the early 1890s, Edison and the supporters of DC felt genuinely threatened. They continued to make claims that AC was dangerous and pointed to a disastrous electrocution attempt in 1890 as evidence. But they suffered a severe blow in 1893, when Westinghouse won the bid to illuminate the Chicago World's Fair. His competition was General Electric (GE), the company formed by the merger between Edison General Electric and Thomson-Houston. GE was the leading torchbearer for DC-based power. Westinghouse won the bid on cost, but when President Grover Cleveland flipped a switch to light 100,000 incandescent lamps across the fairgrounds, very few doubted the superiority of AC power.

Westinghouse mollified many remaining doubters in 1895 by designing a hydroelectric plant at Niagara Falls that incorporated all of the advances made in AC. At first, the plant only supplied power to Buffalo, New York. But it wasn't long before power was being transmitted to New York City, helping to cement Broadway as the Great White Way in the public imagination.

By this time, Tesla had withdrawn from the day-to-day details of power plants and practical implementations of AC. He had moved back to New York City, where he opened a new lab in which he could explore other ideas, machines and devices. Many of these inventions were not related to power generation or electricity. But his impact on the field of electrical engineering was enormous. In fact, it can be said that Tesla's AC motor and polyphase AC system won the war of currents because they form the basis of all modern power generation and distribution. However, direct current – Edison's baby – didn't disappear completely. It still operates automobile electrical systems, locomotives and some types of motors.

Text 9: Electric Potential

The movement of a positive test charge within an electric field is accompanied by changes in potential energy. A gravitational analogy was relied upon to explain the reasoning behind the relationship between location and potential energy. Moving a positive test charge against the direction of an electric field is like moving a mass upward within Earth's gravitational field. Both movements would be like going against nature and would require work by an external force. This work would in turn increase the potential energy of the object. On the other hand, the movement of a positive test charge in the direction of an electric field would be like a mass falling downward within Earth's gravitational field. Both movements would be like going with nature and would occur without the need of work by an external force. This motion would result in the loss of potential energy. Potential energy is the stored energy of position of an object and it is related to the location of the object within a field. This article will introduce the concept of electric potential and relate this concept to the potential energy of a positive test charge at various locations within an electric field.

A gravitational field exists about the Earth that exerts gravitational influences upon all masses located in the space surrounding it. Moving an object upward against the gravitational field increases its gravitational potential energy. An object moving downward within the gravitational field would lose gravitational potential energy. Gravitational potential energy is defined as the energy stored in an object due to its vertical position above the Earth. The amount of gravitational potential energy stored in an object depended upon the amount of mass the object possessed and the amount of height to which it was raised. Gravitational potential energy depended upon object mass and objects height. An object with twice the mass would have twice the potential energy and an object with twice the height would have twice the potential energy. It is common to refer to high positions as high potential energy locations. A glance at the diagram at the right reveals the fallacy of such a statement. Observe that the 1 kg mass held at a height of 2 meters has the same potential energy as a 2 kg mass held at a height of 1 meter. Potential energy depends upon more than just location; it also depends upon mass. In this sense, gravitational potential energy depends upon at least two types of quantities:

1. Mass - a property of the object experiencing the gravitational field;
2. Height - the location within the gravitational field.

So it is improper to refer to high positions within Earth's gravitational field as high potential energy positions. But is there a quantity that could be used to rate such heights as having great potential of providing large quantities of potential energy to masses that are located there? Yes! While not discussed during the unit on gravitational potential energy, it would have been possible to introduce a quantity known as gravitational potential - the potential energy per kilogram. Gravitational potential would be a quantity that could be used to rate various locations about the surface of the Earth in terms of how much potential energy each kilogram of mass would possess when placed there. The quantity of gravitational potential is defined as the PE/mass. Since both the numerator and the denominator of PE/mass are proportional to the object's mass, the expression becomes mass independent. Gravitational potential is a location-dependent quantity that is independent of the mass of the object experiencing the field. Gravitational potential describes the effects of a gravitational field upon objects that are placed at various locations within it.

If gravitational potential is a means of rating various locations within a gravitational field in terms of the amount of potential energy per unit of mass, then the concept of electric potential must have a similar meaning. Consider the electric field created by a positively charged Van de Graaff generator. The direction of the electric field is in the direction that a positive test charge would be pushed; in this case, the direction is outward away from the Van de Graaff sphere. Work would be required to move a positive test charge towards the sphere against the electric field. The amount of force involved in doing the work is dependent upon the amount of charge being moved (according to Coulomb's law of electric force). The greater the charge on the test charge, the greater the repulsive force and the more work that would have to be done on it to move it the same distance. If two objects of different charge – with one being twice the charge of the other – are moved the same distance into the electric field, then the object with twice the charge would require twice the force and thus twice the amount of work. This work would change the potential energy by an amount that is equal to the amount of work done. Thus, the electric potential energy is dependent upon the amount of charge on the object experiencing the field and upon the location within the field. Just like gravitational potential energy, electric potential energy is dependent upon at least two types of quantities:

1. Electric charge – a property of the object experiencing the electrical field;
2. Distance from source – the location within the electric field.

While electric potential energy has a dependency upon the charge of the object experiencing the electric field, electric potential is purely location dependent. Electric potential is the potential energy per charge.

The concept of electric potential is used to express the effect of an electric field of a source in terms of the location within the electric field. A test charge with twice the quantity of charge would possess twice the potential energy at a given location; yet its electric potential at that location would be the same as any other test charge. A positive test charge would be at a high electric potential when held close to a positive source charge and at a lower electric potential when held further away. In this sense, electric potential becomes simply a property of the location within an electric field. Suppose that the electric potential at a given location is 12 Joules per coulomb, then that is the electric potential of a 1 coulomb or a 2 coulomb charged object. Stating that the electric potential at a given location is 12 Joules per coulomb, would mean that a 2 coulomb object would possess 24 Joules of potential energy at that location and a 0.5 coulomb object would experience 6 Joules of potential energy at the location.

Electric Potential in Circuits. As we begin to discuss electric circuits, we will notice that a battery powered electric circuit has locations of high and low potential. Charge moving through the wires of the circuit will encounter changes in electric potential as it traverses the circuit. Within the electrochemical cells of the battery, there is an electric field established between the two terminals, directed from the positive terminal towards the negative terminal. As such, the movement of a positive test charge through the cells from the negative terminal to the positive terminal would require work, thus increasing the potential energy of every Coulomb of charge that moves along this path. This corresponds to a movement of positive charge against the electric field. It is for this reason that the positive terminal is described as the high potential terminal. Similar reasoning would lead one to conclude that the movement of positive charge through the wires from the positive terminal to the negative terminal would occur naturally. Such a movement of a positive test charge would be in the direction of the electric field and would not require work. The charge would lose potential energy as moves through the external circuit from the positive terminal to the negative terminal. The negative terminal is described as the low potential terminal. This assignment of high and low potential to the terminals of an electrochemical cell presumes the traditional convention that electric fields are based on the direction of movement of positive test charges.

In a certain sense, an electric circuit is nothing more than an energy conversion system. In the electrochemical cells of a battery-powered electric circuit, the chemical energy is used to do work on a positive test charge to move it from the low potential terminal to the high potential terminal. Chemical energy is transformed into electric potential energy within the internal circuit (i.e., the battery). Once at the high potential terminal, a positive test charge will then move through the external circuit and do work upon the light bulb or the motor or the heater coils, transforming its electric potential energy into useful forms for which the circuit was designed. The positive test charge returns to the negative terminal at a low energy and low potential, ready to repeat the cycle (or should we say circuit*)* all over again.

Text 10: Electromagnet

An electromagnet is a type of magnet in which the magnetic field is produced by an electric current. The magnetic field disappears when the current is turned off. Electromagnets usually consist of a large number of closely spaced turns of wire that create the magnetic field. The wire turns are often wound around a magnetic core made from a ferromagnetic or ferrimagnetic material such as iron; the magnetic core concentrates the magnetic flux and makes a more powerful magnet.

The main advantage of an electromagnet over a permanent magnet is that the magnetic field can be quickly changed by controlling the amount of electric current in the winding. However, unlike a permanent magnet that needs no power, an electromagnet requires a continuous supply of current to maintain the magnetic field.

Electromagnets are widely used as components of other electrical devices, such as motors, generators, relays, loudspeakers, hard disks, MRI machines, scientific instruments, and magnetic separation equipment. Electromagnets are also employed in industry for picking up and moving heavy iron objects such as scrap iron and steel.

Danish scientist Hans Christian Ørsted discovered in 1820 that electric currents create magnetic fields. British scientist William Sturgeon invented the electromagnet in 1824. His first electromagnet was a horseshoe-shaped piece of iron that was wrapped with about 18 turns of bare copper wire (insulated wire didn't exist yet). The iron was varnished to insulate it from the windings. When a current was passed through the coil, the iron became magnetized and attracted other pieces of iron; when the current was stopped, it lost magnetization. Sturgeon displayed its power by showing that although it only weighed seven ounces (roughly 200 grams), it could lift nine pounds (roughly 4 kilos) when the current of a single-cell battery was applied. However, Sturgeon's magnets were weak because the uninsulated wire he used could only be wrapped in a single spaced out layer around the core, limiting the number of turns.

Beginning in 1827, US scientist Joseph Henry systematically improved and popularized the electromagnet. By using wire insulated by silk thread he was able to wind multiple layers of wire on cores, creating powerful magnets with thousands of turns of wire, including one that could support 2,063 lb (936 kg). The first major use for electromagnets was in telegraph sounders.

The magnetic domain theory of how ferromagnetic cores work was first proposed in 1906 by French physicist Pierre-Ernest Weiss, and the detailed modern quantum mechanical theory of ferromagnetism was worked out in the 1920s by Werner Heisenberg, Lev Landau, Felix Bloch and others.

Electromagnets are very widely used in electric and electromechanical devices, including: motors and generators; transformers; relays, including reed relays originally used in telephone exchanges; electric bells and buzzers; loudspeakers and earphones; actuators; magnetic recording and data storage equipment: tape recorders, VCRs, hard disks; MRI machines; scientific equipment such as mass spectrometers; particle accelerators; magnetic locks; magnetic separation equipment, used for separating magnetic from nonmagnetic material, for example separating ferrous metal from other material in scrap; industrial lifting magnets; magnetic levitation; induction heating for cooking, manufacturing, and hyperthermia therapy.

Physics. An electric current flowing in a wire creates a magnetic field around the wire, due to Ampere's law. To concentrate the magnetic field, in an electromagnet the wire is wound into a coil with many turns of wire lying side by side. The magnetic field of all the turns of wire passes through the center of the coil, creating a strong magnetic field there. A coil forming the shape of a straight tube (a helix) is called a solenoid.

The direction of the magnetic field through a coil of wire can be found from a form of the right-hand rule. If the fingers of the right hand are curled around the coil in the direction of current flow (conventional current, flow of positive charge) through the windings, the thumb points in the direction of the field inside the coil. The side of the magnet that the field lines emerge from is defined to be the north pole.

Much stronger magnetic fields can be produced if a «magnetic core» of a soft ferromagnetic (or ferrimagnetic) material, such as iron, is placed inside the coil. A core can increase the magnetic field to thousands of times the strength of the field of the coil alone, due to the high magnetic permeability μ of the material. This is called a ferromagnetic-core or iron-core electromagnet. However, not all electromagnets use cores, and the very strongest electromagnets, such as superconducting and the very high current electromagnets, cannot use them due to saturation.

Magnetic core. The material of a magnetic core (often made of iron or steel) is composed of small regions called magnetic domains that act like tiny magnets. Before the current in the electromagnet is turned on, the domains in the iron core point in random directions, so their tiny magnetic fields cancel each other out, and the iron has no large scale magnetic field. When a current is passed through the wire wrapped around the iron, its magnetic field penetrates the iron, and causes the domains to turn, aligning parallel to the magnetic field, so their tiny magnetic fields add to the wire's field, creating a large magnetic field that extends into the space around the magnet. The effect of the core is to concentrate the field, and the magnetic field passes through the core more easily than it would pass through air.

The larger the current passed through the wire coil, the more the domains align, and the stronger the magnetic field is. Finally all the domains are lined up, and further increases in current only cause slight increases in the magnetic field: this phenomenon is called saturation.

When the current in the coil is turned off, in the magnetically soft materials that are nearly always used as cores, most of the domains lose alignment and return to a random state and the field disappears. However some of the alignment persists, because the domains have difficulty turning their direction of magnetization, leaving the core a weak permanent magnet. This phenomenon is called hysteresis and the remaining magnetic field is called remanent magnetism. The residual magnetization of the core can be removed by degaussing. In alternating current electromagnets, such as are used in motors, the core's magnetization is constantly reversed, and the remanence contributes to the motor's losses.

In many practical applications of electromagnets, such as motors, generators, transformers, lifting magnets, and loudspeakers, the iron core is in the form of a loop or magnetic circuit, possibly broken by a few narrow air gaps. This is because the magnetic field lines are in the form of closed loops. Iron presents much less «resistance» (reluctance) to the magnetic field than air, so a stronger field can be obtained if most of the magnetic field's path is within the core.

Text 11: Electric Current and Theory of Electricity

Electric current is nothing but the rate of flow of electric charge through a conductor with respect to time. It is caused by drift of free electrons through a conductor to a particular direction. As we all know, the measuring unit of electric change is Coulomb and the unit of time is second, the measuring unit of current is Coulombs per second and this logical unit of current has a specific name Ampere after the famous French scientist André-Marie Ampere.

If total Q Coulomb charge passes through a conductor by time t, then current I = Q / t coulomb par second or Ampere.

For better understanding, let give an example, suppose total 100 coulombs of charge is transferred through a conductor in 50 seconds.

What is the current? As the current is nothing but the rate at which charge is transferred per unit of time, it would be ratio of total charge transferred to the required time for that. Hence, here

$$I = \frac{100\ coloumbs}{50\ second} = 2\ Amperes$$

'Ampere' is Sl unit of current.

Definition of Electric Current. While a potential difference is applied across a conductor, electrical charge flows through it and electrical current is the measure of the quantity of the electrical charge flowing through the conductor per unit time.

Theory of Electricity. There is an equal number of electrons and protons in an atom. Hence, atom is in general electrically neutral. As the protons in the central nucleus are positive in charge and electrons orbiting the nucleus, are negative in charge, there will be an attraction force acts between the electrons and protons. In an atom various electrons arrange themselves in different orbiting shells situated at different distances from the nucleus. The force is more active to the electrons nearer to the nucleus, than to the electrons situated at outer shell of the atom. One or more of these loosely bonded electrons may be detached from the atom. The atoms with lack of electrons are called ions. Due to lack of electrons, compared to number of protons, the said ion becomes positively charged. Hence, this ion is referred as positive ion and because of positive electrical charge; this ion can attract other electrons from outside. The electron, which was previously detached from any other atom, may occupy the outer most shell of this ion and hence this ion again becomes neutral atom. The electrons which move from atom to atom in random manner are called free elections. When a voltage is applied across a conductor, due to presence of electric field, the free electrons start drifting to a particular direction according the direction of voltage and electric field. This phenomenon causes current in the conductor. The movement of electrons, means movement of negative charge and rate of this charge transfer with respect to time is known as current. The amount of negative electric charge in an electron is $1.602 \text{ X } 10^{-19}$ Coulomb. Hence, one coulomb negative electric charge consists of $1/1.602 \text{ X } 10^{-19} = 6.24 \text{ X } 10^{18}$ number of electrons. Hence, during drift of electron to a particular direction, if $6.24 \text{ X } 10^{18}$ number of electrons cross a specific cross-section of the conductor, in one second, the current is said to be one ampere. Since, we have already seen the unit of current, ampere is coulomb/second.

Measurement of Current. The most common method of measuring current is to connect an ammeter in series with the circuit that's current to be measured. This is so because the entire current flowing through the circuit must also flow through the ammeter. The ideal internal resistance or impedance of an ammeter is zero. Hence, ideally there is no voltage drop across the ammeter connected in the circuit. A conventional analog ammeter consists of a current coil. Whenever current flows through this coil, it deflects from its position depending upon the amount of current flowing through it. A pointer is attached to the coil assembly; hence it points the current reading on the dial of the ammeter. For measuring alternating current, clip on meter or tong tester can also be used instead of conventional ammeter. In this ammeter a current transformer core is attached to the meter which can easily be clipped on the live current carrying conductor. Due to this arrangement, current in the circuit transforms to the secondary of the CT and this secondary current then measured on the dial of clip on meter without disturbing the continuity of the current unlike conventional ammeter.

Conventional Flow of Current Vs Electrons Flow. In the early days, it was thought that the current is flow of positive charge and hence current always comes out from the positive terminal of the battery, passing through the external circuit and enters in the negative terminal of the battery. This is called conventional flow of current. On the basis of this conception, all the theories of electricity, formulas and symbols were developed. After the development of atomic nature of matter, we have come to know that actual cause of current in a conductor is due to movement of free electrons and electrons have negative change. Due to negative charge, electrons move from the negative terminal to the positive terminal of the battery through the external circuit. So the conventional flow of current is always in the opposite direction of electrons flow. But it was impossible to change all the previously discovered subsequent rules, conventions, theories and formulas according to the direction of electrons flow in the conductor. Thus the concept of conventional current flow was adopted. The true electron flow is used only when it is necessary to explain certain effects (as in semiconductor devices such as diodes and transistors). Whenever we consider the basic electrical circuits and devices, we use conventional flow of current i.e. current flowing around the circuit from the positive terminal to the negative terminal.

Types of Current. There are only two types of electrical current, direct current and alternating current. We abbreviate them as DC and AC respectively. Concept of DC was developed before AC. But AC becomes most popular means of generating, transmitting and distributing of electric power. The direction of the flow of direct current is unidirectional, means this current does not alter its direction during flowing. Most common examples of DC in our daily life, are the current that we get from all kinds of battery system. But most popular form of electrical current is alternating current or AC. AC does have some advantages over DC for generating, transmitting and distributing and that is why the current we get from our electric supply companies, is normally alternating current.

Alternating Current. The current whose flow is not unidirectional moreover it alternates at a frequency, is called alternating current. In other words, the direction of the current continuously changes from forward to backward and then backward to forward in the circuit. The number of times, this direction changes from forward to backward or from backward to forward per second, is referred as frequency of the current. The current produced in an alternator is always an alternating current. The shape of the waveform of an alternating current is usually sinusoidal. But square, triangular and other types of waveform are also available for attending current.

Conventional Direction of Alternating Current. As direct current, alternating current is denoted with arrow. An AC has both forward and backward direction of flow. The arrow head always indicates the forward direction of the current. In different point of view, when the current has a positive valve, the direction of current is same as the reference arrow and when the current gets negative value; its direction is just opposite of the reference arrow.

Text 12: Voltage

Voltage is the electric energy charge difference of electric potential energy transported between two points. Voltage is equal to the work done per unit of charge against a static electric field to move the charge between two points. A voltage may represent either a source of energy (electromotive force), or lost, used, or stored energy (potential drop). A voltmeter can be used to measure the voltage (or potential difference) between two points in a system; often a common reference potential such as the ground of the system is used as one of the points. Voltage can be caused by static electric fields, by electric current through a magnetic field, by time-varying magnetic fields, or some combination of these three.

Given two points in the space, called A and B, voltage is the difference of electric potentials between those two points.

Voltage is electric potential energy per unit charge, measured in joules per coulomb (= volts). It is often referred to as «electric potential», which then must be distinguished from electric potential energy by noting that the «potential» is a «per-unit-charge» quantity. Like mechanical potential energy, the zero of potential can be chosen at any point, so the difference in voltage is the quantity which is physically meaningful. The difference in voltage measured when moving from point A to point B is equal to the work which would have to be done, per unit charge, against the electric field to move the charge from A to B. The voltage between the two ends of a path is the total energy required to move a small electric charge along that path, divided by the magnitude of the charge. Mathematically this is expressed as the line integral of the electric field and the time rate of change of magnetic field along that path. In the general case, both a static (unchanging) electric field and a dynamic (time-varying) electromagnetic field must be included in determining the voltage between two points.

Historically this quantity has also been called «tension» and «pressure». Pressure is now obsolete but tension is still used, for example within the phrase «high tension» (HT) which is commonly used in thermionic valve (vacuum tube) based electronics.

Voltage is defined so that negatively charged objects are pulled towards higher voltages, while positively charged objects are pulled towards lower voltages. Therefore, the conventional current in a wire or resistor always flows from higher voltage to lower voltage. Current can flow from lower voltage to higher voltage, but only when a source of energy is present to «push» it against the opposing electric field. For example, inside a battery, chemical reactions provide the energy needed for current to flow from the negative to the positive terminal.

The electric field is not the only factor determining charge flow in a material, and different materials naturally develop electric potential differences at equilibrium (Galvani potentials). The electric potential of a material is not even a well defined quantity, since it varies on the subatomic scale. A more convenient definition of «voltage» can be found instead in the concept of Fermi level. In this case the voltage between two bodies is the thermodynamic work required to move a unit of charge between them. This definition is practical since a real voltmeter actually measures this work, not differences in electric potential.

Hydraulic analogy. A simple analogy for an electric circuit is water flowing in a closed circuit of pipe work, driven by a mechanical pump. This can be called a "water circuit". Potential difference between two points corresponds to the pressure difference between two points. If the pump creates a pressure difference between two points, then water flowing from one point to the other will be able to do work, such as driving a turbine. Similarly, work can be done by an electric current driven by the potential difference provided by a battery. For example, the voltage provided by a sufficiently-charged automobile battery can «push» a large current through the windings of an automobile's starter motor. If the pump isn't working, it produces no pressure difference, and the turbine will not rotate. Likewise, if the automobile's battery is very weak or «dead» (or «flat»), then it will not turn the starter motor.

The hydraulic analogy is a useful way of understanding many electrical concepts. In such a system, the work done to move water is equal to the pressure multiplied by the volume of water moved. Similarly, in an electrical circuit, the work done to move electrons or other charge-carriers is equal to «electrical pressure» multiplied by the quantity of electrical charges moved. In relation to «flow», the larger the «pressure difference» between two points (potential difference or water pressure difference), the greater the flow between them (electric current or water flow).

Applications. Specifying a voltage measurement requires explicit or implicit specification of the points across which the voltage is measured. When using a voltmeter to measure potential difference, one electrical lead of the voltmeter must be connected to the first point, one to the second point.

A common use of the term «voltage» is in describing the voltage dropped across an electrical device (such as a resistor). The voltage drop across the device can be understood as the difference between measurements at each terminal of the device with respect to a common reference point (or ground). The voltage drop is the difference between the two readings. Two points in an electric circuit that are connected by an ideal conductor without resistance and not within a changing magnetic field have a voltage of zero. Any two points with the same potential may be connected by a conductor and no current will flow between them.

Addition of voltages. The voltage between A and C is the sum of the voltage between A and B and the voltage between B and C. The various voltages in a circuit can be computed using Kirchhoff's circuit laws.

When talking about alternating current (AC) there is a difference between instantaneous voltage and average voltage. Instantaneous voltages can be added for direct current (DC) and AC, but average voltages can be meaningfully added only when they apply to signals that all have the same frequency and phase.

Measuring instruments. Instruments for measuring voltages include the voltmeter, the potentiometer, and the oscilloscope. The voltmeter works by measuring the current through a fixed resistor, which, according to Ohm's Law, is proportional to the voltage across the resistor. The potentiometer works by balancing the unknown voltage against a known voltage in a bridge circuit. The cathode-ray oscilloscope works by amplifying the voltage and using it to deflect an electron beam from a straight path, so that the deflection of the beam is proportional to the voltage.

Typical voltages. A common voltage for flashlight batteries is 1.5 volts (DC). A common voltage for automobile batteries is 12 volts (DC).

Common voltages supplied by power companies to consumers are 110 to 120 volts (AC) and 220 to 240 volts (AC). The voltage in electric power transmission lines used to distribute electricity from power stations can be several hundred times greater than consumer voltages, typically 110 to 1200 kV (AC).

The voltage used in overhead lines to power railway locomotives is between 12 kV and 50 kV (AC).

Galvani potential vs. electrochemical potential. Inside a conductive material, the energy of an electron is affected not only by the average electric potential, but also by the specific thermal and atomic environment that it is in. When a voltmeter is connected between two different types of metal, it measures not the electrostatic potential difference, but instead something else that is affected by thermodynamics. The quantity measured by a voltmeter is the negative of difference of electrochemical potential of electrons (Fermi level) divided by electron charge, while the pure unadjusted electrostatic potential (not measurable with voltmeter) is sometimes called Galvani potential. The terms «voltage» and «electric potential» are a bit ambiguous in that, in practice, they can refer to either of these in different contexts.

Text 13: Electrical resistance and conductance

The electrical resistance of an electrical conductor is the opposition to the passage of an electric current through that conductor. The inverse quantity is electrical conductance, the ease with which an electric current passes. Electrical resistance shares some conceptual parallels with the notion of mechanical friction. The SI unit of electrical resistance is the ohm (Ω), while electrical conductance is measured in siemens (S).

An object of uniform cross section has a resistance proportional to its resistivity and length and inversely proportional to its cross-sectional area. All materials show some resistance, except for superconductors, which have a resistance of zero.

The resistance (R) of an object is defined as the ratio of voltage across it (*V*) to current through it (*I*), while the conductance (G) is the inverse:

$$R = \frac{V}{I}, \qquad G = \frac{I}{V} = \frac{1}{R}$$

For a wide variety of materials and conditions, *V* and *I* are directly proportional to each other, and therefore *R* and *G* are constant (although they can depend on other factors like temperature or strain). This proportionality is called Ohm's law, and materials that satisfy it are called «Ohmic» materials.

In other cases, such as a diode or battery, *V* and *I* are *not* directly proportional, or in other words the *I*–*V* curve is not a straight line through the origin, and Ohm's law does not hold. In this case, resistance and conductance are less useful concepts, and more difficult to define. The ratio V/I is sometimes still useful, and is referred to as a «chordal resistance» or «static resistance», as it corresponds to the inverse slope of a hord between the origin and an *I*–*V* curve. In other situations, the derivative $\frac{dV}{dI}$ may be most useful; this is called the «differential resistance».

In the hydraulic analogy, current flowing through a wire (or resistor) is like water flowing through a pipe, and the voltage drop across the wire is like the pressure drop that pushes water through the pipe. Conductance is proportional to how much flow occurs for a given pressure, and resistance is proportional to how much pressure is required to achieve a given flow. (Conductance and resistance are reciprocals.)

The voltage drop (i.e., difference between voltages on one side of the resistor and the other), not the voltage itself, provides the driving force pushing current through a resistor. In hydraulics, it is similar: The pressure difference between two sides of a pipe, not the pressure itself, determines the flow through it. For example, there may be a large water pressure above the pipe, which tries to push water down through the pipe. But there may be an equally large water pressure below the pipe, which tries to push water back up through the pipe. If these pressures are equal, no water flows. The resistance and conductance of a wire, resistor, or other element is mostly determined by two properties:

- geometry (shape);
- material.

Geometry is important because it is more difficult to push water through a long, narrow pipe than a wide, short pipe. In the same way, a long, thin copper wire has higher resistance (lower conductance) than a short, thick copper wire.

Materials are important as well. A pipe filled with hair restricts the flow of water more than a clean pipe of the same shape and size. Similarly, electrons can flow freely and easily through a copper wire, but cannot flow as easily through a steel wire of the same shape and size, and they essentially cannot flow at all through an insulator like rubber, regardless of its shape. The difference between, copper, steel, and rubber is related to their microscopic structure and electron configuration, and is quantified by a property called resistivity.

In addition to geometry and material, there are various other factors that influence resistance and conductance, such as temperature.

Conductors and resistors. Substances in which electricity can flow are called conductors. A piece of conducting material of a particular resistance meant for use in a circuit is called a resistor. Conductors are made of high-conductivity materials such as metals, in particular copper and aluminium.

Resistors, on the other hand, are made of a wide variety of materials depending on factors such as the desired resistance, amount of energy that it needs to dissipate, precision, and costs.

Ohm's law. The current-voltage characteristics of four devices: Two resistors, a diode, and a battery. The horizontal axis is voltage drop, the vertical axis is current. Ohm's law is satisfied when the graph is a straight line through the origin. Therefore, the two resistors are «ohmic», but the diode and battery are not.

Ohm's law is an empirical law relating the voltage V across an element to the current I through it: $V \propto I$

(V is directly proportional to I). This law is not always true: For example, it is false for diodes, batteries, etc. However, it is true to a very good approximation for wires and resistors (assuming that other conditions, including temperature, are held constant). Materials or objects where Ohm's law is true are called ohmic, whereas objects that do not obey Ohm's law are non-ohmic.

Relation to resistivity and conductivity. The resistance of a given object depends primarily on two factors: What material it is made of, and its shape. For a given material, the resistance is inversely proportional to the cross-sectional area; for example, a thick copper wire has lower resistance than an otherwise-identical thin copper wire. Also, for a given material, the resistance is proportional to the length; for example, a long copper wire has higher resistance than an otherwise-identical short copper wire. The resistance R and conductance G of a conductor of uniform cross section, therefore, can be computed as $R = \rho\frac{\ell}{A}, \qquad G = \sigma\frac{A}{\ell}.$

where ℓ is the length of the conductor, measured in meters [m], A is the cross-sectional area of the conductor measured in square meters [m²], σ (sigma) is the electrical conductivity measured in siemens per meter ($S \cdot m^{-1}$), and ρ (rho) is the electrical resistivity of the material, measured in ohm-meters (Ω·m). The resistivity and conductivity are proportionality constants, and therefore depend only on the material the wire is made of, not the geometry of the wire.

Resistivity and conductivity are reciprocals: $\rho = 1/\sigma$. Resistivity is a measure of the material's ability to oppose electric current.

This formula is not exact, as it assumes the current density is totally uniform in the conductor, which is not always true in practical situations. However, this formula still provides a good approximation for long thin conductors such as wires.

Another situation for which this formula is not exact is with alternating current (AC), because the skin effect inhibits current flow near the center of the conductor. For this reason, the geometrical cross-section is different from the effective cross-section in which current actually flows, so resistance is higher than expected. Similarly, if two conductors near each other carry AC current, their resistances increase due to the proximity effect. At commercial power frequency, these effects are significant for large conductors carrying large currents, such as bus bars in an electrical substation, or large power cables carrying more than a few hundred amperes.

What determines resistivity? The resistivity of different materials varies by an enormous amount: For example, the conductivity of teflon is about 10^{30} times lower than the conductivity of copper. Why is there such a difference? Loosely speaking, a metal has large numbers of "delocalized" electrons that are not stuck in any one place, but free to move across large distances, whereas in an insulator (like teflon), each electron is tightly bound to a single molecule, and a great force is required to pull it away. Semiconductors lie between these two extremes.

Resistivity varies with temperature. In semiconductors, resistivity also changes when exposed to light.

Measuring resistance. An instrument for measuring resistance is called an ohmmeter. Simple ohmmeters cannot measure low resistances accurately because the resistance of their measuring leads causes a voltage drop that interferes with the measurement, so more accurate devices use four-terminal sensing.

Static and differential resistance. Many electrical elements, such as diodes and batteries do not satisfy Ohm's law. These are called non-ohmic or nonlinear, and are characterized by an I–V curve, which is not a straight line through the origin.

Resistance and conductance can still be defined for non-ohmic elements. However, unlike ohmic resistance, nonlinear resistance is not constant but varies with the voltage or current through the device, i.e. its operating point. There are two types of resistance:

- Static resistance (also called chordal or DC resistance) – This corresponds to the usual definition of resistance; the voltage divided by the current $R_{\text{static}} = \frac{V}{I}$.

It is the slope of the line (chord) from the origin through the point on the curve. Static resistance determines the power dissipation in an electrical component. Points on the *IV* curve located in the 2nd or 4th quadrants, for which the slope of the chordal line is negative, have negative static resistance. Passive devices, which have no source of energy, cannot have negative static resistance. However active devices such as transistors or op-amps can synthesize negative static resistance with feedback, and it is used in some circuits such as gyrators.

- Differential resistance (also called dynamic, incremental or small signal resistance) – Differential resistance is the derivative of the voltage with respect to the current; the slope of the *IV* curve at a point

$$R_{\text{diff}} = \frac{dV}{dI}.$$

If the IV curve is nonmonotonic (with peaks and troughs), the curve has a negative slope in some regions – so in these regions the device has negative differential resistance. Devices with negative differential resistance can amplify a signal applied to them, and are used to make amplifiers and oscillators. These include tunnel diodes, Gunn diodes, IMPATT diodes, magnetron tubes, and unijunction transistors.

AC circuits: Impedance and admittance. When an alternating current flows through a circuit, the relation between current and voltage across a circuit element is characterized not only by the ratio of their magnitudes, but also the difference in their phases. For example, in an ideal resistor, the moment when the voltage reaches its maximum, the current also reaches its maximum (current and voltage are oscillating in phase).

Energy dissipation and Joule heating. Resistors (and other elements with resistance) oppose the flow of electric current; therefore, electrical energy is required to push current through the resistance. This electrical energy is dissipated, heating the resistor in the process. This is called Joule heating (after James Prescott Joule), also called ohmic heating or resistive heating.

The dissipation of electrical energy is often undesired, particularly in the case of transmission losses in power lines. High voltage transmission helps reduce the losses by reducing the current for a given power.

On the other hand, Joule heating is sometimes useful, for example in electric stoves and other electric heaters (also called resistive heaters). As another example, incandescent lamps rely on Joule heating: the filament is heated to such a high temperature that it glows «white hot» with thermal radiation (also called incandescence).

The formula for Joule heating is:

$$P = I^2 R$$

where P is the power (energy per unit time) converted from electrical energy to thermal energy, R is the resistance, and I is the current through the resistor.

Dependence of resistance on other conditions: Temperature dependence. Near room temperature, the resistivity of metals typically increases as temperature is increased, while the resistivity of semiconductors typically decreases as temperature is increased. The resistivity of insulators and electrolytes may increase or decrease depending on the system. As a consequence, the resistance of wires, resistors, and other components often change with temperature. This effect may be undesired, causing an electronic circuit to malfunction at extreme temperatures. In some cases, however, the effect is put to good use. When temperature-dependent resistance of a component is used purposefully, the component is called a resistance thermometer or thermistor. (A resistance thermometer is made of metal, usually platinum, while a thermistor is made of ceramic or polymer.)

Resistance thermometers and thermistors are generally used in two ways. First, they can be used as thermometers: By measuring the resistance, the temperature of the environment can be inferred. Second, they can be used in conjunction with Joule heating (also called self-heating): If a large current is running through the resistor, the resistor's temperature rises and therefore its resistance changes. Therefore, these components can be used in a circuit-protection role similar to fuses, or for feedback in circuits, or for many other purposes. In general, self-heating can turn a resistor into a nonlinear and hysteretic circuit element.

If the temperature T does not vary too much, a linear approximation is typically used:

$$R(T) = R_0[1 + \alpha(T - T_0)]$$

where $\alpha$is called the temperature coefficient of resistance, $T_0$is a fixed reference temperature (usually room temperature), and $R_0$is the resistance at temperature T_0. The parameter $\alpha$is an empirical parameter fitted from measurement data. Because the linear approximation is only an approximation, $\alpha$is different for different reference temperatures. For this reason it is usual to specify the temperature that $\alpha$was measured at with a suffix, such as α_{15}, and the relationship only holds in a range of temperatures around the reference.

The temperature coefficient $\alpha$is typically $+3\times10^{-3}$ K^{-1} to $+6\times10^{-3}$ K^{-1} for metals near room temperature. It is usually negative for semiconductors and insulators, with highly variable magnitude.

Strain dependence. Just as the resistance of a conductor depends upon temperature, the resistance of a conductor depends upon strain. By placing a conductor under tension (a form of stress that leads to strain in the form of stretching of the conductor), the length of the section of conductor under tension increases and its cross-sectional area decreases. Both these effects contribute to increasing the resistance of the strained section of conductor. Under compression (strain in the opposite direction), the resistance of the strained section of conductor decreases. See the discussion on strain gauges for details about devices constructed to take advantage of this effect.

Light illumination dependence. Some resistors, particularly those made from semiconductors, exhibit photoconductivity, meaning that their resistance changes when light is shining on them. Therefore they are called photoresistors (or light dependent resistors). These are a common type of light detector.

Superconductivity. Superconductors are materials that have exactly zero resistance and infinite conductance, because they can have $V=0$ and $I\neq 0$. This also means there is no joule heating, or in other words no dissipation of electrical energy. Therefore, if superconductive wire is made into a closed loop, current flows around the loop forever. Superconductors require cooling to temperatures near 4 K with liquid helium for most metallic superconductors like NbSn alloys, or cooling to temperatures near 77K with liquid nitrogen for the expensive, brittle and delicate ceramic high temperature superconductors. Nevertheless, there are many technological applications of superconductivity, including superconducting magnets.

Text 14: Electrical measurement

Electrical Measurements are measurements of electrical quantities, such as voltage, impedance, current, AC frequency and phase, power, electric energy, electric charge, inductance, and capacitance.

Electrical measurements are among the most widely performed types of measurement. Owing to the development of electrical equipment capable of converting nonelectrical quantities into electrical quantities, the techniques and instruments associated with electrical measurements are employed to measure virtually all physical quantities. Electrical measurements are used in physical, chemical, and biological research and in the energy, metallurgical, and chemical industries. They also find application in transportation, meteorology, oceanography, medical diagnostics, the exploration and mining of mineral deposits, and the manufacture and use of radio and television equipment, of aircraft, and of spacecraft.

The vast array of techniques and instruments for measuring electrical quantities owes its existence to the great diversity of such quantities, to the wide ranges of the quantities’ values, to requirements for high levels of accuracy, and to the multiplicity of the conditions and fields of application of electrical measurements. The measurement of «active» electrical quantities (such as current and voltage), which characterize the energy state of a measured circuit, makes use of the direct action of these quantities on the measuring instrument and generally draws some amount of power from the circuit. The measurement of «passive» electrical quantities (such as impedance and its complex components, inductance, and the tangent of the dielectric loss angle), which characterize the electrical properties of a measured circuit, requires excitation of the circuit by an outside source of electric energy and measurement of the circuit’s response.

The techniques and instruments used for electrical measurements in DC circuits differ substantially from those used in AC circuits. In AC circuits, the choice of technique and instrument depends on the frequency, on the nature of the quantities’ variations, and on which values – instantaneous, effective, maximum, or average – of the varying electrical quantities are being measured. Permanent-magnet instruments and digital measuring devices are the instruments most widely used for measuring DC circuits, whereas measurements in AC circuits are made with electromagnetic, electrodynamic, induction, electrostatic, rectifier, and digital instruments and with oscillographs. Some of these instruments are used for measurements in both AC and DC circuits.

The values of measured electrical quantities fall roughly within the following ranges: current, from 10^{-16} to 10^{5} amperes; voltage, from 10^{-9} to 10^{7} volts; resistance, from 10^{-8} to 10^{16} ohms; power, from 10^{-16} watt to tens of gigawatts; and AC frequency, from 10^{-3} to 10^{12} hertz. Such ranges are constantly expanding. Distinct areas of metrology, with specific measurement techniques and instruments, have been developed to deal with measurements at high and superhigh frequencies, measurements of small currents and large resistances, and measurements of high voltages and of electrical quantities in high-power installations.

The expansion of the measurement ranges is a result of development of the technology of electrical measuring transducers, especially the technology associated with the amplification and attenuation of currents and voltages. The elimination of the distortions that accompany the amplification and attenuation of electric signals and the development of techniques to extract a useful signal from a noise background are specific problems associated with electrical measurements of either very small or very large electrical quantities.

The maximum allowable error for electrical measurements may be as large as a few percent or as small as 10^{-4} percent. Direct-reading instruments are used for relatively rough measurements, and techniques that involve bridge and balanced circuits are used for measurements that require greater accuracy. The use of electrical-measurement techniques to measure nonelectrical quantities is based on either a known relationship between the nonelectrical and electrical quantities or on the use of measuring transducers. Various intermediate transducers are employed to ensure the compatible operation of a measuring transducer and the secondary measuring instruments, to transmit the output signals of the measuring transducer over a distance, and to improve the noise immunity of the transmitted signals. Generally such intermediate transducers perform simultaneously amplification or, sometimes, attenuation of the electric signals and, in order to compensate for the nonlinearity of a measuring transducer, carry out nonlinear conversion. Any electric signal may be fed to the input of an intermediate transducer, with standardized signals of direct, sinusoidal, or pulse currents or voltages serving most frequently as the output signals. Amplitude, frequency, and phase modulations are used with AC output signals. Digital transducers are coming into increasing use as intermediate transducers.

The integrated automation of scientific experimentation and industrial processes has led to the creation of complex electrical-measurement equipment that includes measuring apparatus and measurement and information systems and to the development of the technology associated with telemetry and radio remote control.

Recent advances in electrical measurements are based on such new physical effects as the Josephson Effect and the Hall Effect, which have made possible the development of equipment of greater sensitivity and accuracy. Innovations in electronics have been incorporated into electrical-measurement technology, and microcircuitry has come into use. In addition, the technology of electrical measurements has been combined with computer technology, measurement techniques have been automated, and metrological requirements have been standardized. An integrated electrical-measurement equipment ensemble known as ASET has been developed in the USSR.

The All-Union State Standard (GOST) 22261–76, Equipment for the Measurement of Electrical Quantities: General Technical Specifications, has established standard technical, especially metrological, requirements for electrical-measurement equipment, it has been in effect since July 1, 1978.

Text 15: Electrical Units of Measure

The standard SI units used for the measurement of voltage, current and resistance are the Volt $[V]$, Ampere $[A]$ and Ohm $[\Omega]$ respectively. Sometimes in electrical or electronic circuits and systems it is necessary to use multiples or sub-multiples (fractions) of these standard units when the quantities being measured are very large or very small.

The following table gives a list of some of the standard electrical units of measure used in electrical formulas and component values.

Standard Electrical Units

Electrical Parameter	Measuring Unit	Symbol	Description
Voltage	Volt	V or E	Unit of Electrical Potential $V = I \times R$
Current	Ampere	I or i	Unit of Electrical Current $I = V \div R$
Resistance	Ohm	R or Ω	Unit of DC Resistance $R = V \div I$
Conductance	Siemen	G or Ʊ	Reciprocal of Resistance $G = 1 \div R$
Capacitance	Farad	C	Unit of Capacitance $C = Q \div V$
Charge	Coulomb	Q	Unit of Electrical Charge $Q = C \times V$
Inductance	Henry	L or H	Unit of Inductance $V_L = -L(di/dt)$
Power	Watts	W	Unit of Power $P = V \times I$ or $I^2 \times R$
Impedance	Ohm	Z	Unit of AC Resistance $Z^2 = R^2 + X^2$
Frequency	Hertz	Hz	Unit of Frequency $f = 1 \div T$

Multiples and Sub-multiples

There is a huge range of values encountered in electrical and electronic engineering between a maximum value and a minimum value of a standard electrical unit. For example, resistance can be lower than 0.01Ω's or higher than 1,000,000Ω's. By using multiples and submultiples of the standard unit we can avoid having to write too many zero's to define the position of the decimal point. The table below gives their names and abbreviations.

Prefix	**Symbol**	**Multiplier**	**Power of Ten**
Terra	T	1,000,000,000,000	10^{12}
Giga	G	1,000,000,000	10^{9}
Mega	M	1,000,000	10^{6}
kilo	k	1,000	10^{3}
none	none	1	10^{0}
centi	c	1/100	10^{-2}
milli	m	1/1,000	10^{-3}
micro	μ	1/1,000,000	10^{-6}
nano	n	1/1,000,000,000	10^{-9}
pico	p	1/1,000,000,000,000	10^{-12}

So to display the units or multiples of units for Resistance, Current or Voltage we would use as an example:

- 1kV = 1 kilo-volt – which is equal to 1,000 Volts.
- 1mA = 1 milli-amp – which is equal to one thousandths (1/1000) of an Ampere.
- 47kΩ = 47 kilo-ohms – which is equal to 47 thousand Ohms.
- 100uF = 100 micro-farads – which is equal to 100 millionths (1/1,000,000) of a Farad.
- 1kW = 1 kilo-watt – which is equal to 1,000 Watts.
- 1MHz = 1 mega-hertz – which is equal to one million Hertz.

To convert from one prefix to another it is necessary to either multiply or divide by the difference between the two values. For example, convert 1MHz into kHz.

Well we know from above that 1MHz is equal to one million (1,000,000) hertz and that 1kHz is equal to one thousand (1,000) hertz, so one 1MHz is one thousand times bigger than 1kHz. Then to convert Mega-hertz into Kilo-hertz we need to multiply mega-hertz by one thousand, as 1MHz is equal to 1000 kHz.

Likewise, if we needed to convert kilo-hertz into mega-hertz we would need to divide by one thousand. A much simpler and quicker method would be to move the decimal point either left or right depending upon whether you need to multiply or divide.

As well as the «Standard» electrical units of measure shown above, other units are also used in electrical engineering to denote other values and quantities such as:

- **Wh – The Watt-Hour**, The amount of electrical energy consumed by a circuit over a period of time. Eg, a light bulb consumes one hundred watts of electrical power for one hour. It is commonly used in the form of: Wh (watt-hours), kWh (Kilowatt-hour) which is 1,000 watt-hours or MWh (Megawatt-hour) which is 1,000,000 watt-hours.
- **dB – The Decibel**, The decibel is a one tenth unit of the Bel (symbol B) and is used to represent gain either in voltage, current or power. It is a logarithmic unit expressed in dB and is commonly used to represent the ratio of input to output in amplifier, audio circuits or loudspeaker systems.
- For example, the dB ratio of an input voltage (Vin) to an output voltage (Vout) is expressed as $20\log_{10}$ (Vout/Vin). The value in dB can be either positive (20dB) representing gain or negative (-20dB) representing loss with unity, ie input = output expressed as 0dB.
- **θ – Phase Angle**, The Phase Angle is the difference in degrees between the voltage waveform and the current waveform having the same periodic time. It is a time difference or time shift and depending upon the circuit element can

have a «leading» or «lagging» value. The phase angle of a waveform is measured in degrees or radians.

- **ω – Angular Frequency**, Another unit which is mainly used in a.c. circuits to represent the Phasor Relationship between two or more waveforms is called Angular Frequency, symbol ω. This is a rotational unit of angular frequency $2\pi f$ with units in radians per second, rads/s. The complete revolution of one cycle is 360 degrees or 2π, therefore, half a revolution is given as 180 degrees or π rad.
- ***τ* – Time Constant**, The Time Constant of an impedance circuit or linear first-order system is the time it takes for the output to reach 63.7% of its maximum or minimum output value when subjected to a Step Response input. It is a measure of reaction time.

Text 16: Alternative energy sources and ecology

World energy today stands on the threshold of tremendous change. Rapid population growth and the extent of social and economic development led to significant growth of energy consumption.

At present energy consumption is extremely high, and the use of traditional resources such as oil, coal and gas are not unlimited. In most instances their usage is very harmful to the ecology and nature because of numerous emissions into the atmosphere that leads to increased levels of dangerous and hazardous substances and gases that, in their turn, cause a great deal of global environmental problems which affect our entire world. As globalization continues and the earth's natural processes transform local problems into international issues, few societies are being left untouched by major environmental problems.

Some of the largest problems now affecting the world are acid rains, air pollution, global warming, hazardous waste, ozone depletion, smog, water pollution, overpopulation, rain forest destruction and so on. So scientists are developing other ways to produce energy and resources that are more environmentally friendly, cost effective and renewable. In most technologically developed countries distinguished scientists and government solve the energy problem by speedy transition to the so-called «alternative» energy sources. The use of alternative energy sources will help people avoid many of the problems and consequences, as well as benefit without detriment to the nature.

Alternative energy is an umbrella term that refers to any source of usable energy intended to replace fuel sources without the undesired consequences of the replaced fuels.

There are some more definitions of this term. According to Oxford Dictionary, alternative energy is energy fuelled in ways that do not use up natural resources or harm the environment. Natural Resources Defense Council reports that alternative energy is energy that is not popularly used and is usually environmentally sound, such as solar or wind energy (as opposed to fossil fuels).

Alternative energy refers to energy sources that have no undesired consequences such for example fossil fuels or nuclear energy. Alternative energy sources are renewable and are thought to be «free» energy sources. It is necessary to point out that renewable energy is energy which comes from natural resources such as sunlight, wind, rain, tides, and geothermal heat, which are renewable (naturally replenished). About 16% of global final energy consumption comes from renewables, with 10% coming from traditional biomass, which is mainly used for heating, and 3.4% from hydroelectricity. New renewables (small hydro, modern biomass, wind, solar, geothermal, and biofuels) accounted for another 3% and are growing very rapidly. The share of renewables in electricity generation is around 19%, with 16% of global electricity coming from hydroelectricity and 3% from new renewables. They all have lower carbon emissions compared to conventional energy sources.

Speaking about alternative energy sources, it should be pointed out that it may be a device, installation or just a way that give the opportunity to get some kind of energy and replace current sources.

To understand how alternative energy use can help preserve the delicate ecological balance of the planet, and help us conserve the non-renewable energy sources like fossil fuels, it is important to know what types of alternative energy are there in the world.

There is a great amount of alternative energy sources nowadays such as solar energy, wind energy, geothermal energy, biomass energy, hydrogen, hydropower, etc. All of these energy sources are very important and unavoidable part of everyday life but we pay our great and scrupulous attention to solar/wind and geothermal energy because these kinds of alternative energy really have an opportunity to replace harmful fuel energy sources which have a negative influence on the environment.

Solar Power. Solar energy has been harnessed by humans since ancient times using a range of ever-evolving technologies. Solar energy technologies include solar heating, solar photovoltaics, solar thermal electricity and solar architecture, which can make considerable contributions to solving some of the most urgent problems the world now faces. Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute solar energy.

Active solar techniques include the use of photovoltaic panels and solar thermal collectors to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air.

Solar power works by trapping the sun's rays into solar cells where this sunlight is then converted into electricity. Additionally, solar power uses sunlight that hits solar thermal panels to convert sunlight to heat water or air. Other methods include using sunlight that hits parabolic mirrors to heat water (producing steam), or simply opening a rooms blinds or window shades to allow entering sunlight to passively heat a room. But, solar power does not produce energy if the sun is not shining. Nighttime and cloudy days seriously limit the amount of energy produced. Solar power stations can be very expensive to build.

From an environmental perspective, solar power is the best thing going. A 1.5 kilowatt PV system will keep more than 110,000 pounds of carbon dioxide, the chief greenhouse gas, out of the atmosphere over the next 25 years. The same solar system will also prevent the need to burn 60,000 pounds of coal. With solar systems, there's no acid rain, no urban smog, no pollution of any kind.

Wind Power. Wind power is another alternative energy source and could be used without producing byproducts that are harmful to nature. Electricity generated by wind turbines is absolutely free of emissions, although research is still needed on reducing the noise levels of the turbines. Wind power is the conversion of wind energy into a useful form of energy, such as using wind turbines to make electricity, windmills for mechanical power, windpumps for water pumping or drainage, or sails to propel ships.

Now, electrical currents are harnessed by large scale wind farms that are used by national electrical grids as well as small individual turbines used for providing electricity to isolated locations or individual homes. In 2005, worldwide capacity of wind-powered generators was 58,982 megawatts, their production making up less than 1 of world-wide electricity use. Wind power produces no pollution that can contaminate the environment, since no chemical processes take place, like in the burning of fossil fuels, in wind power generation, there are no harmful by-products left over.

Since wind generation is a renewable source of energy, we will never run out of it. Farming and grazing can still take place on land occupied by wind turbines which can help in the production of bio fuels. But we must note that wind power is intermittent. If the wind speed decreases, the turbine is stored and less energy is produced. Besides, large wind farms can have a negative impact on the scenery.

Geothermal Energy. The adjective geothermal originates from the Greek roots meaning earth, and hot. Geothermal energy is thermal energy generated and stored in the Earth. Thermal energy is the energy that determines the temperature of matter. Earth's geothermal energy originates from the original formation of the planet (20%) and from radioactive decay of minerals (80%). The geothermal gradient, which is the difference in temperature between the core of the planet and its surface, drives a continuous conduction of thermal energy in the form of heat from the core to the surface.

If done correctly, geothermal energy produces no harmful by-products. Geothermal power plants are generally small and have little effect on the natural landscape. However, if done properly, geothermal energy can lead to pollutants. Improper drilling in the ground may produce hazardous gases and minerals. Also, geothermal sites are prone to running out of steam.

One of the most crucial features of alternative energy is that many alternative energy sources are renewable so the supply never diminishes. The relationship between mankind and the earth is a fragile one. With the worldwide concerns of pollution, ozone layer depletion and global warming, we need to reconsider our use of conventional fuels such as gasoline, diesel and coal. Harnessing the power of clean, alternative energy sources has become a necessity. Moreover, we have a heavy dependence on petroleum products imported from around the world. Increasingly, the political stability of many of these sources is doubtful. This tends to reduce the reliability of supply and increase the volatility of the price. Alternative energy means energy security.

Text 17: Solar Energy

Solar energy, power from the sun, is a vast and inexhaustible resource. Once a system is in place to convert it into useful energy, the fuel is free and will never be subject to the ups and downs of energy markets. Furthermore, it represents a clean alternative to the fossil fuels that currently pollute our air and water, threaten our public health, and contribute to global warming. Given the abundance and the appeal of solar energy, this resource is poised to play a prominent role in our energy future.

In the broadest sense, solar energy supports all life on Earth and is the basis for almost every form of energy we use. The sun makes plants grow, which can be burned as «biomass» fuel or, if left to rot in swamps and compressed underground for millions of years, in the form of coal and oil. Heat from the sun causes temperature differences between areas, producing wind that can power turbines. Water evaporates because of the sun, falls on high elevations, and rushes down to the sea, spinning hydroelectric turbines as it passes. But solar energy usually refers to ways the sun's energy can be used to directly generate heat, lighting, and electricity.

The Solar Resource. The amount of energy from the sun that falls on Earth's surface is enormous. All the energy stored in Earth's reserves of coal, oil, and natural gas is matched by the energy from just 20 days of sunshine. Outside Earth's atmosphere, the sun's energy contains about 1,300 watts per square meter. About one-third of this light is reflected back into space, and some is absorbed by the atmosphere (in part causing winds to blow).

By the time it reaches Earth's surface, the energy in sunlight has fallen to about 1,000 watts per square meter at noon on a cloudless day. Averaged over the entire surface of the planet, 24 hours per day for a year, each square meter collects the approximate energy equivalent of almost a barrel of oil each year, or 4.2 kilowatt-hours of energy every day. Deserts, with very dry air and little cloud cover, receive the most sun – more than six kilowatt-hours per day per square meter. Northern climates, such as Boston, get closer to 3.6 kilowatt-hours. Sunlight varies by season as well, with some areas receiving very little sunshine in the winter. Seattle in December, for example, gets only about 0.7 kilowatt-hours per day. It should also be noted that these figures represent the maximum available solar energy that can be captured and used, but solar collectors capture only a portion of this, depending on their efficiency. For example, a one square meter solar electric panel with an efficiency of 15 percent would produce about one kilowatt-hour of electricity per day in Arizona.

Passive Solar Design for Buildings. One simple, obvious use of the sun is to light and heat our buildings. Residential and commercial buildings account for more than one-third of U.S. energy use. If properly designed, buildings can capture the sun's heat in the winter and minimize it in the summer, while using daylight year-round. Buildings designed in such a way utilize passive solar energy – a resource that can be tapped without mechanical means to help heat, cool, or light a building. Simple design features such as properly orienting a house toward the south, putting most windows on the south side of the building, skylights, awnings, and shade trees are all techniques for exploiting passive solar energy. Buildings constructed with the sun in mind can be comfortable and beautiful places to live and work.

Solar Heat Collectors. Besides using design features to maximize their use of the sun, some buildings have systems that actively gather and store solar energy. Solar collectors, for example, sit on the rooftops of buildings to collect solar energy for space heating, water heating, and space cooling. Most are large, flat boxes painted black on the inside and covered with glass. In the most common design, pipes in the box carry liquids that transfer the heat from the box into the building. This heated liquid usually a water-alcohol mixture to prevent freezing is used to heat water in a tank or is passed through radiators that heat the air.

Oddly enough, solar heat can also power a cooling system. In desiccant evaporators, heat from a solar collector is used to pull moisture out of the air. When the air becomes drier, it also becomes cooler. The hot moist air is separated from the cooler air and vented to the outside. Another approach is an absorption chiller. Solar energy is used to heat a refrigerant under pressure;

when the pressure is released, it expands, cooling the air around it. This is how conventional refrigerators and air conditioners work, and it's a particularly efficient approach for home or office cooling since buildings need cooling during the hottest part of the day. These systems are currently at work in humid southeastern climates such as Florida.

Solar collectors were quite popular in the early 1980s, in the aftermath of the energy crisis. Federal tax credits for residential solar collectors also helped. In 1984, for example, 16 million square feet of collectors were sold in the United States, but when fossil fuel prices dropped and tax credits expired in the mid-1980s, demand for solar collectors plummeted. By 1987, sales were down to only four million square feet. Most of the more than one million solar collectors sold in the 1980s were used for heating hot tubs and swimming pools.

Today, a small number of U.S. homes and businesses use solar water heaters. In other countries, solar collectors are much more common; Israel requires all new homes and apartments to use solar water heating, and 92 percent of the existing homes in Cyprus already have solar water heaters. But the number of Americans choosing solar hot water could rise dramatically in the next few years as a result of federal tax incentives that can reduce their cost by as much as 30 percent.

According to the U.S. Department of Energy, water heating accounts for about 15 percent of the average household's energy use. As natural gas and electricity prices rise, the costs of maintaining a constant hot water supply will increase as well. Homes and businesses that heat their water through solar collectors could end up saving as much as $250 to $500 per year depending on the type of system being replaced.

Solar Thermal Concentrating Systems. By using mirrors and lenses to concentrate the rays of the sun, solar thermal systems can produce very high temperatures as high as 3,000 degrees Celsius. This intense heat can be used in industrial applications or to produce electricity. One of the greatest benefits of large scale solar thermal systems is the possibility of storing the sun’s heat energy for later use, which allows the production of electricity even when the sun is no longer shining. Properly sized storage systems, commonly consisting of molten salts, can transform a solar plant into a supplier of continuous baseload electricity. Solar thermal systems now in development will be able to compete in output and reliability with large coal and nuclear plants.

Solar concentrators come in three main designs: parabolic troughs, parabolic dishes, and central receivers. The most common is parabolic troughs – long, curved mirrors that concentrate sunlight on a liquid inside a tube that runs parallel to the mirror. The liquid, at about 300 degrees Celsius, runs to a central collector, where it produces steam that drives an electric turbine.

Parabolic dish concentrators are similar to trough concentrators, but focus the sunlight on a single point. Dishes can produce much higher temperatures, and so, in principle, should produce electricity more efficiently.

A promising variation on dish concentrating technology uses a stirling engine to produce power. Unlike a car's internal combustion engine, in which gasoline exploding inside the engine produces heat that causes the air inside the engine to expand and push out on the pistons, a stirling engine produces heat by way of mirrors that reflect sunlight on the outside of the engine. These dish-stirling generators produce about 30 kilowatts of power, and can be used to replace diesel generators in remote locations.

The third type of concentrator system is a central receiver. One such plant in California features a «power tower» design in which a 17-acre field of mirrors concentrates sunlight on the top of an 80-meter tower. The intense heat boils water, producing steam that drives a 10-megawatt generator at the base of the tower. The first version of this facility, Solar One, operated from 1982 to 1988 but had a number of problems. Reconfigured as Solar Two during the early to mid-1990s, the facility is successfully demonstrating the ability to collect and store solar energy efficiently. Solar Two's success has opened the door for further development of this technology.

To date, the parabolic trough has had the greatest commercial success of the three solar concentrator designs, in large part due to the nine Solar Electric Generating Stations (SEGS) built in California's Mojave Desert from 1985 to 1991. Ranging from 14 to 80 megawatts and with a total capacity of 354 megawatts, each of these plants is still operating effectively. Nevada Solar One, a 75 MW parabolic trough plant that was built near Boulder City, Nevada in 2007, offers another example of recent success in the burgeoning U.S. solar thermal industry.

More commercial-scale solar concentrator projects are under development in the United States, thanks mostly to various state policies and incentives. To help meet California's 20 percent renewable electricity standard, for example, almost 5,000 MW of solar thermal capacity are under review by the state's Energy Commission and Bureau of Land Management. Additionally, more than 3,500 MW of capacity have been announced or agreed to under power purchase agreements between major utilities and power-producing companies. As of 2009, the largest project awaiting approval is a 1,000 MW plant to be owned by Solar Millenium, LLC. Concentrating solar thermal is on its way to becoming a strong competitor in utility-scale energy production.

Text 18: Hydropower

Hydropower or water power is power derived from the energy of falling water, which may be harnessed for useful purposes. Since ancient times, hydropower has been used for irrigation and the operation of various mechanical devices, such as watermills, sawmills, textile mills, dock cranes, domestic lifts and paint making. Since the early 20th century, the term is used almost exclusively in conjunction with the modern development of hydro-electric power, which allowed use of distant energy sources.

Hydro comes from the Greek word for water. Hydro-electricity, or hydro-power, is usually generated by turbines in a dam in a river. The dam means that a great body of water builds up in the river valley behind the dam. This is released through the turbines when electricity is needed. Smaller than dams are barrages across the mouths of rivers which capture water from high tides and release it to generate electricity. Smaller still are turbines in river and tidal streams which do the same thing.

Hydro power is one of the largest sources of energy accounting for roughly 20% of the worldwide demand of electricity and for well resourced countries it accounts for majority of the energy. Compared to other sources of energy, hydroelectric power is one of the cheapest, non-carbon emitting, non polluting sources. Hydro power plants have been developed to almost full potential in developed countries because of their superior characteristics and many more are being constructed by developing countries like China and India. However hydro power like all other things in life suffers from disadvantages as well. The failure of a hydro dam can result in massive losses of human life and cause widespread devastation. Large dams have always been controversial leading to displacement of people and ecology. They have also been cited as the reason for earthquakes due to large land changes.

There are three types of hydropower facilities: impoundment, diversion, and pumped storage. The most common type of hydroelectric power plant is an impoundment facility, typically a large hydropower system, uses a dam to store river water in a reservoir. Water released from the reservoir flows through a turbine, spinning it, which in turn activates a generator to produce electricity. The water may be released either to meet changing electricity needs or to maintain a constant reservoir level. A diversion, sometimes called run-of-river, facility channels a portion of a river through a canal or penstock. It may not require the use of a dam. When the demand for electricity is low, pumped storage facility stores energy by pumping water from a lower reservoir to an upper reservoir. During periods of high electrical demand, the water is released back to the lower reservoir to generate electricity.

Things you don't know about hydropower

1. Hydropower is one of the oldest power sources on the planet, generating power when flowing water spins a wheel or turbine. It was used by farmers as far back as ancient Greece for mechanical tasks like grinding grain. Hydropower is also a renewable energy source and produces no air pollution or toxic byproducts. Learn more about the history of hydropower.

2. When most people think of hydropower, they imagine the Hoover Dam – a huge facility storing the power of an entire river behind its walls – but hydropower facilities can be tiny too, taking advantage of water flows in municipal water facilities or irrigation ditches. They can even be «dam-less», with diversions or run-of-river facilities channeling part of a stream through a powerhouse before the water rejoins the main river.

3. Niagara Falls was the site of the country's first hydroelectric generating facility built in 1881 when Charles Brush connected a generator to turbines powered by the falls and used the electricity to power nighttime lighting for visiting tourists. America's first commercial hydropower facility was built in 1882 in Appleton, Wisconsin – powering lighting for a paper mill and multiple homes.

4. Every state uses hydropower for electricity, and some states use a lot of it. Over 70 percent of Washington State's electricity comes from hydropower, and 11 states get more than 10 percent of their electricity from hydropower.

5. Hydropower costs less than most energy sources. States that get the majority of their electricity from hydropower, like Idaho, Washington, and Oregon, have energy bills that are lower than the rest of the country.

6. Hydroelectricity provides about seven percent of the electricity generated in the United States and about half of the electricity from all renewable sources, finds the Energy Information Administration.

7. Some hydropower facilities can quickly go from zero power to maximum output, making them ideal for meeting sudden changes in demand for electricity. Because hydropower plants can dispatch power to the grid immediately, they provide essential back-up power during major electricity disruptions such as the 2003 blackout that affected the northeastern states and southern Canada. Read a report about other services hydropower can provide to the electric grid.

8. Another type of hydropower called pumped storage works like a battery, storing the electricity generated by other power sources like solar, wind, and nuclear for later use. It stores energy by pumping water uphill to a reservoir at higher elevation from a second reservoir at a lower elevation. When the power is needed, the water is released and turns a turbine, generating electricity.

9. Devices at dams can help fish and other wildlife move freely around dams and between sections of rivers. Fish ladders and fish elevators are just some of the techniques used to help fish migrate.

10. Dams are built for a number of uses in addition to producing electricity, such as irrigation, shipping and navigation, flood control or to create reservoirs for recreational activities. In fact, only 3 percent of the nation’s 80,000 dams currently generate power.

РАЗДЕЛ III: СЛОВАРЬ-МИНИМУМ

A

abnormal – отклоняющийся от нормы; необычный

to absorb – поглощать

accuracy – точность

acquisition – приобретение, овладение

actuarial science – актуарная наука

AD – сокр. от *Anno Domini*; н.э., нашей эры

admittance – проводимость

advancement – прогресс, достижение

ailment – недуг

aka – сокр. от *also known as* также известный под именем

alchemy – алхимия

allied soldier – союзник

alternate – попеременный, поочередный

alternating current (AC) – переменный ток

amber – янтарь

ammeter – амперметр

amperage – сила тока (в амперах)

ample – обширный, богатый

Analytical Engine – Аналитическая машина

Ansafone – "Ансафон" *(фирменное название автоматического телефонного аппарата компании National Telephones (UK) Ltd; принимает вызов и даёт на него заранее записанный на магнитофонную плёнку ответ)*

answering machine – автоответчик

antiquity – античность

appearance – появление

appliance – аппарат, прибор

Artificial Intelligence – искусственный интеллект

assassination attempt – покушение на убийство по политическим мотивам

assembly line – сборочный конвейер

asset – ценное свойство

assumption – предположение, допущение

asymptotic freedom – асимптотическая свобода

at an accelerated rate – ускоренными темпами

at the ripe age – в зрелом возрасте

atomic structure – строение атома, атомарная структура

audible – слышный, внятный; слышимый

average – средний

avid swimmer – заядлый пловец

B

backbone – основной, базовый, суть

ballistic galvanometer – баллистический гальванометр

to bestow (on) – давать, присуждать, присваивать

bimetallic – биметаллический

bizarre – неестественный, ненормальный, причудливый, странный, эксцентричный, аномальный, неправильный

blue box – «голубой ящик» *(электронное приспособление, использовавшееся для незаконного подключения к междугородним телефонным линиям)*

blueprint – (детальный) план, программа, проект

bolts of lightning – удар молнии

bombardment – бомбардировка; артиллерийский, миномётный обстрел

bone marrow – костный мозг

boxcar – товарный вагон

brain tumor – опухоль головного мозга

to breed – выводить, разводить

bridge circuit – мостовая схема

building blocks – строительные блоки/детские кубики/конструктор

burden of labour – бремя труда

C

cadmium – кадмий

calibration – маркировка; калибровка

capacitor – конденсатор

capacity – мощность; вместимость, ёмкост

cargo – груз

carpentry – плотничные работы

cathode ray tube – электронно-лучевая трубка

central processing unit – центральный процессор

chassis – ходовая часть

circa – приблизительно, примерно

circuit breaker – автоматический выключатель; прерыватель

to cling (to) – оставаться верным (чему-либо)

clockwise – по часовой стрелке

closed circuit – замкнутая цепь

to coin – выдумывать, придумывать

to compose of – состоять из

to conduct experiments – проводить эксперименты

to contribute – вносить вклад, обогатить ценным достижением

co-founder – соучредитель

common descent – общий предок

commutator – коммутатор

compound – строение, структура, целостное образование; смесь

computer geek – компьютерный фанатик

computer science – вычислительная техника *(область знаний)*; информатика

condenser – конденсатор

to confine – ограничивать

consumer goods – потребительские товары

coolant fluid – смазочно-охлаждающая жидкость

copper – медь

corresponding – надлежащий, соответственный, соответствующий

coulomb – кулон

counterpart – аналог; коллега

credible – заслуживающий доверия, правдоподобный надёжный, прочный; настоящий, соответствующий своим функциям

credit (with) – приписывать, считать

crossbow – самострел; арбалет

cumbersome – громоздкий

curiosity – любознательность

D

to dabble – заниматься (чем-л.) непрофессионально, время от времени; проявлять поверхностный интерес (к чему-л.)

day-to-day – обыденный, повседневный

to dazzle – поражать, изумлять

DDT – сокр. от *dichlorodiphenyltrichloroethane* ДДТ (инсектицид)

decaffeination – декофеинирование, удаление кофеина

dehydration – дегидратация, обезвоживание

destitute – покинутый, брошенный; очень бедный

Difference Engine – Разностная машина

to dip – падать, понижаться

direct current (DC) – постоянный ток

distribution – распределение; раздача

doable - выполнимый

driving force – движущая сила

to drop out – бросать (работу, учебу)

dryness – сухость

duration – длина, длительность, продолжительность

E

eddy current – вихревой ток

electric current – электрический ток

electric potential – электрический потенциал

electric shock – электрошок
electrical circuit – электрическая схема
electrical engineer – инженер-электрик
electrical engineering – электротехника
electromagnetic field – электромагнитное поле
electromagnetic induction – электромагнитная индукция
electromotive force – электродвижущая сила
electron shell – электронная оболочка
Electronic Frontier Foundation – Фонд борьбы с нарушением конфиденциальности и гражданских свобод с помощью электронных технологий
endanger – подвергать опасности, создавать угрозу
energy conservation – энергосбережение
enormous – громадный; гигантский, обширный, огромный
environmental protection – охрана окружающей среды
to evolve – эволюционировать, развиваться
expansion – расширение
explicit – подробно разработанный, явный, ясный
to explode – взрывать, взрываться

F
facility – возможность, способность; функция
fairground – ярмарочная площадь
far-out – необычный, экстравагантный, авангардистский
to fatigue – изматывать, изнурять
fatigue – усталость, утомление
to feature – содержать в себе как отличительный, особенный элемент, свойство
ferrite core – ферритовый сердечник
ferromagnetic – ферромагнитный
fire-fighting – пожаротушение
to fission – разбиваться, раскалываться

flashlight batterie – гальванический элемент / батарейка для карманного фонарика
to flee from – убегать от(проблем), сбегать
floppy disk – дискета, гибкий магнитный диск
floppy disk drive – дисковод для гибких дисков
fluid – жидкий, текучий
fluorescent lighting – люминесцентное освещение
flyback diode – диод обратного хода
free charge – свободный заряд
frequency – частота
friction – трение
fuel – топливо
fuse – плавка, процесс плавления
fusion – расплавленная масса, сплав

G
gain in productivity – повышение производительности
galvanic cell – гальванический элемент
gaseous substance – газообразное вещество
GDP – сокр. от *gross domestic product* валовой внутренний продукт
generation – образование, производство, выработка
to get out of hand – выходить из-под контроля
gold foil experiment – эксперимент с золотой фольгой
government funding – правительственные субсидии
greenhouse gas – парниковый газ
gunpowder – порох
gyrator – гиратор

H
hence – поэтому, следовательно
to herald – возвещать, объявлять

HID (High-Intensity Discharge lamp) – разрядная лампа высокой интенсивности

high-pressure engine – двигатель высокого давления

high-voltage transmission line – высоковольтная линия электропередачи

highway system – сеть автомобильных дорог

HMS – сокр. от *Her Majesty's Ship, His Majesty's Ship (ставится перед названием корабля военно-морских сил Великобритании)*

holy grail – 1) Священный Грааль *(чаша, из которой Иисус Христос пил на Тайной Вечере; предмет розысков рыцарей короля Артура);* 2) цель поисков, которой добиваются, к которой стремятся

horsepower – лошадиная сила

hydrogen – водород

hypersonic – сверхзвуковой

hysteresis – гистерезис, запаздывание, отставание фаз

hysteresis curve – кривая гистерезиса

I

impact – влияние

impedance – полное сопротивление

implementation – выполнение

implicit – подразумеваемый, не выраженный явно, скрытый; имплицитный

implosion – внутренний взрыв; имплозия

to improve on – превосходить по качеству

in charge of – ответственный за

in favor of – в пользу, в поддержку (кого-либо)

incandescent light bulb – лампа накаливания

inception – начало

indefinitely – неопределённо, неясно, бесконечно

indentation – выемка, метка

indivisible – неделимый

to induct (into) – принимать в члены

induction motor – асинхронный двигатель
infancy – ранняя стадия развития, период становления
inquisitive – любознательный
instantaneous – мгновенный; немедленный
intact – незатронутый
integrated circuit – интегральная схема
interchangeable – взаимозаменяемый
internal combustion engine – двигатель внутреннего сгорания
intimate – близкий друг
intrusion – внедрение
invention – изобретение
inventor **–** изобретатель
ionic compound – ионное соединение
irrevocably – безвозвратно
issue – спорный вопрос, проблема

K
keyboard – клавиатура

L
lamination – расслоение
leakage flux – поток рассеяния
LED (light-emitting diode) – светодиод
Leyden jar – лейденская банка
life annuity – пожизненная рента
life table - таблица продолжительности жизни
lifespan – продолжительность жизни
light bulb – электрическая лампочка
linear distance – линейное расстояние
liquid – жидкость, жидкий
load – нагрузка
load center – центр нагрузки

long-lasting – долговечный
loosely – свободно; неточно
low resistance – низкая сопротивляемость

M
magnetic flux – магнитный поток
magnitude – величина, размер
Mandarin – китайский язык *(современный литературный китайский язык)*
man-made – искусственный
meaningful – значительный, значимый, важный,
means – способ, средство
measurable – измеримый
measurement – измерение
measuring instrument – измерительный прибор
mechanical computer – механическое вычислительное устройство
metrology – метрология
Middle Ages – Средние века, Средневековье *(исторический период в Европе: вторая половина 5-го в. н.э. - конец 15-го в. н.э.)*
mining engineer – горный инженер
misleading – вводящий в заблуждение, обманчивый
mollify – ослаблять, смягчать, успокаивать
monatomic – одноатомный
monopole – монополь
motion picture camera – кинокамера
motionless – неподвижный, без движения; в состоянии покоя
motive – движущий, стимулирующий
mouse-driven – с управлением от мыши
to multiply – умножать

N
natural selection – естественный отбор

negatively charged – отрицательно заряженный
to neglect – пренебрегать, игнорировать
nerve cell – нервная клетка
non-conductive – непроводящий
nonlinear equation – нелинейное уравнение
notepad – блокнот
nuclear power – ядерная энергия
nucleus – ядро
numerical method – численный метод

O
observation – наблюдение
offspring – отпрыск, потомок
oil embargo – эмбарго на ввоз нефти
on a par with – наравне с
on the threshold (of) – в преддверии, накануне
open circuit – разомкнутая цепь
Orthodox clergyman – православный священник
oscilloscope – осциллограф
oversimplification – чрезмерное упрощение

P
parallel circuit – параллельная схема
particle accelerator – ускоритель частиц
to pass an act – принять закон
to pave the way – прокладывать путь, подготавливать почву
peaceful purposes – мирные цели
permittivity – диэлектрическая постоянная
philosophical inquiry – философский вопрос
photocell – фотоэлемент
physical property – физическое свойство
polyatomic – многоатомный

polyphase induction motor – многофазный асинхронный двигатель
positevely charged – положительно заряженный
potential drop – падение напряжения
potentiometer – потенциометр
power dissipation – рассеяние мощности
power engineering – энергетика
power generation – производство электроэнергии
power plant – электростанция
precision – точность
prime mover – первичный двигатель
printing press – печатная машина; печатный станок
prominent – известный, выдающийся
proof – доказательство
punched card – перфокарта
pursue the research – проводить исследование

R
rate – темп, скорость
ratio – отношение
raw material – сырье
reactance – реактивное сопротивление
reciprocal – взаимный, обоюдный; обратный
rectifier – выпрямитель (преобразователь переменного электрического тока в постоянный)
reluctant – делающий что-л. с большой неохотой, по принуждению
remanent magnetism – остаточный магнетизм
remedy – лекарство; способ устранения неисправности
renowned – знаменитый
to repell – отталкивать
replica – модель
repulsive – отталкивающий
residential use – бытовое использование

to resign – отказываться от должности, уйти в отставку
resistance – сопротивление
respectively – соответственно
reversed copy – перевернутая копия
Revolutionary War – Война за независимость (Американская революция)
to revolve around – вращаться вокруг
rival – соперник, конкурент
roundabout way – окольный путь
Royal Institution – Королевская ассоциация *(научная организация; проводит исследования и распространяет знания в области физики, астрономии, химии, электроники, физиологии; находится в Лондоне. Основана в 1799 году)*
rubber – резина, каучук
to run out of – израсходовать

S

scarlet fever – скарлатина
science fair – ярмарка научных проектов учащихся
self-replicating – самовоспроизводящийся
semiconductor – полупроводник
series circuit – последовательная цепь
short circuit – короткое замыкание
skin effect – скин-эффект, поверхностный эффект
solar system – солнечная система
solid – твердое вещество, твердый
solid-state device – твердотельный прибор
solution – решение; раствор
to speed up – ускорять
sprinkler system – оросительная система
starvation – голод
static electricity – статическое электричество
stealth – невидимый

stem cell – стволовая клетка
stock ticker – тикер *(телеграфный или электронный аппарат, оперативно выдающий текущую финансовую информацию на бумажную ленту или на экран; впервые был использован на биржах США в 1867 году)*
subatomic particle – субатомная частица
subdivision of labor – разделение труда
submersible – подводный, погружаемый
subsequently – впоследствии
substance – вещество
subtract – вычитать
suburbia – пригородные зоны
Supreme Court – Верховный суд
susceptance – реактивная проводимость
swim fins – ласты

T

to take for granted – считать само собой разумеющимся
to take into account – принимать во внимание
to team up – объединиться
The Age of Enlightenment – эпоха Просвещения
the multitude – массы, простонародье
the well-to-do – состоятельные слои общества
three-shift workday – трёхсменный рабочий день
thunderstorm – гроза
to tinker – чинить кое-как, на скорую руку
to trace the history – восходить, брать начало
traceability – 1) единство измерений 2) прослеживаемость
traffic grid – транспортная сеть
transmission – передача
turmoil – беспорядок, смятение
to turn out – выпускать, производить
typewriter – пишущая машинка

U

ubiquitous – вездесущий; повсеместный

unstable – нетвёрдый; нестабильный

V

variety of – разнообразие

versatility – непостоянство, изменчивость

vessel – сосуд

vice versa – наоборот

vicinity – близость, соседство

virtually – фактически

visible – видимый

voltage – напряжение

voltage drop – падение напряжения

voltaic pile – гальваническая батарея

voltmeter – вольтметр

waste disposal – удаление отходов или сточных вод

winding – обмотка

witchcraft – колдовство

with respect to – что касается

Y

yet – зд. однако, но

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Приложение 1

Фразы-клише для реферирования текста

I. Title

The title of the text (article) is…

II. Author

The text (article) is written by…

The author of the text (article) is…

It was published in ...

III. Main Idea

The main idea of the text (article) is…

The text (article) is about...

The text (article) is devoted to ...

The text (article) deals with ...

The article touches upon ...

The purpose of the article is to give the reader some information on ...

IV. Main Part

The author starts by telling the readers (about, that) ...

The author writes (states, stresses, thinks, points out) that...

The article describes ...
explains…
points out…

The text (article) starts with the explanation of…
with the description of…
with the enumeration of…

According to the article (text) ...

The article is (can be) divided into 4(5-7) parts.

The first part deals with (is about, touches upon) ...

As for…, ….

Speaking about…, …

On the one hand, on the other hand…

It should be pointed out that …

It is necessary to say
to note
to add that…

V. Conclusion

In conclusion it is necessary to say…

Finally I would like to add…

The author comes to the conclusion that...

VI. Opinion

I think that…, consider that…, suppose that…, guess that…

In my opinion, …

To my mind …

From my point of view…

My opinion is…

I found the article interesting (important, dull, of no value, easy, too hard to understand).

Приложение 2

Основные арифметические выражения, формулы, уравнения и правила их чтения на английском языке

9	**nine**
32	**thirty-two**
73	**seventy-three**
539	**five hundred and thirty-nine**
1,930	**one thousand, nine hundred and thirty**
12,406	**twelve thousand, four hundred and six**
129,862	**one hundred and twenty-nine thousand, eight hundred and sixty-two**
583,950,487	**five hundred and eighty-three million, nine hundred and fifty thousand, four hundred and eighty-seven**
8,004,090,871	**eight billion, four million, ninety thousand, eight hundred and seventy-one**
198,980,062,333	**one hundred and ninety-eight billion, nine hundred and eighty million, sixty-two thousand, three hundred and thirty-three**
1,123,980,191,425	**one trillion, one hundred and twenty-three billion, nine hundred and eighty million, one hundred and ninety-one thousand, four hundred and twenty-five**
1 / 2	**one half, a half**
1 / 3	**a (one) third**
2 / 3	**two-thirds**
5 / 9	**five-ninths**
7 / 100	**seven hundredths**
1/1000	**one thousandth**
4 ½	**four and a half**
0.6 or .6	**point six**
5.34	**five point thirty-four; or five point three four**

2.01	two point nought one; or two point o [ou] one
0.007	point nought nought seven; or, point two oes [ouz] seven
19.021	nineteen point oh (zero) two one
.0001	point oh oh oh one; one ten-thousandth
3^2	the square of three; or three to the second power
6^3	six cubed; or six to the third power
31^{61} c^{18}	thirty-one to the sixty-first power c [si:] to the eighteenth (power)
a^{-10}	a [ei] to the minus tenth (power)
$7^4 = 2,401$	seven to the power of four equals two thousand four hundred and one
4 + 6 = 10	four plus six equals (is equal to) ten; or six added to four makes ten
21 – 6 = 15	twenty-one minus six equals fifteen; or twenty-one minus six leaves fifteen
1 x 1 = 1	once one is (equals) one
2 x 2 = 4	twice two is (equals) four
6 x 10 = 60	six multiplied by ten equals sixty; or six times ten is sixty
12 : 3 = 4	twelve divided by three equals (is) four
(3.6 + 4.4) / 7.7 = 1.093	the sum of three point six and four point four divided by seven point seven equals one point oh nine three; or three point six plus four point four divided by seven point seven equals one and ninety-three thousandths
$\sqrt{16} = 4$	the square root of sixteen is four
$\sqrt{144} = 12$	the square root of one hundred and forty-four is twelve
$\sqrt[5]{a^2}$	the fifth root of a square

$\sqrt[3]{a}$	the cube root of a
$\sqrt[10]{a^2 + b^2}$	the tenth root (out) of a square plus b square
$(a+b)^2$	a plus b all squared
$\sqrt{X} * 63 = 89Y$	the square root of X times sixty-three equals eighty-nine times Y
$\frac{dz}{dx}$	dz over dx
$y = f(x)$	y is a function of x
$f(x) = 4x^2$	The function of x equals four x squared
$\text{Log } 2 = 0.301$	the logarithm of two equals zero point three o[ou] one
$a = \log_c d$	a is equal to the logarithm of d to the base c
$\int_0^{\mu}$	integral from zero to µ (mu)
$\int \frac{dx}{\sqrt{a^2 - x^2}}$	indefinite integral of dx (divided) by the square root out of a2 minus x2
$V = u\sqrt{\sin^2 i - \cos^2 i} = u$	V equals *u* square root of sine square *i* minus cosine square *i* equals *u*
$\tan r = \frac{\tan i}{l}$	tangent *r* equals tangent *i* divided by *l*
20°	twenty degrees
$6'$	six minutes; also, six feet
$10''$	ten seconds; also, ten inches
a'	*a* prime
a''	*a* second prime; or *a* double prime; or *a* twice dashed
a'''	*a* triple prime
( )	round brackets; parentheses
{ }	curly brackets; braces
[ ]	square brackets; brackets

a = b	**a equals b; or a is equal to b**
a ≠ b	**a is not equal to b**
a > b	**a is greater than b**
a2 > ad	***a* second is greater than *a* dth**
b < a	***b* is less than *a***
a >> b	***a* is substantially greater than *b***
a ≥ b	***a* is greater than or equal to *b***
$x \to \infty$	**x trends to infinity**
$\bar{a}$	***a* vector ; the mean volume of *a***
$\dot{a}$	**the first derivative**
$\ddot{a}$	**the second derivative**

Таблица мер и весов

1 inch	2.54 centimeters (cm)
1 foot (12 inches)	30.48 cm
3.28 feet	1 meter, or metre (m)
1 yard (3 feet)	91.439 cm
1 ounce (oz)	28.3495 grams
1 pound (lb)	453.5926 gr
1 mile (statute mile)	1,609.31 m (1.609 km)

Приложение 3

Полезные ссылки

1. http://www.infoniac.com

InfoNIAC – Latest Inventions. The main goal of the site is to inform on various technical innovations, latest inventions and talented people around the world.

2. http://www.brighthub.com

Science and technology articles, education lesson plans, tech tips, computer hardware and software reviews, news and more.

3. http://beforeitsnews.com

Before It's News® is a community of individuals who report on what's going on around them, from all around the world.

4. http://www.inventions-handbook.com

Inventions help and inspiration for the first-time inventors.

5. http://www.scientificamerican.com

Science news, articles, and information – Scientific American.

6. http://www.telegraph.co.uk/technology/

The latest technology news, reviews, advice, picture galleries and video.

7. http://www.independent.co.uk/life-style/gadgets-and-tech

Tech – The Independent.

8. http://listverse.com

Listverse — the original Top 10 site — publishes lists that intrigue and educate, specializing in the bizarre or lesser-known trivia. Every day they present three or more new, unique lists.

9. http://www.toptenz.net/lists/science

Science archives – Top 10 Lists.

10. http://www.famousscientists.org/

Famous Scientists - Contains biographies of the most famous scientists and inventors in history.

11. http://www.infoplease.com/biography/science-technology-bios.html

Science and Technology: Biographies – Information about outstanding scientists, inventors and explorers.

12. http://scienceworld.wolfram.com/biography/

Eric Weisstein's World of Scientific Biography - A database of very brief biographies for over 1,000 figures in science.

13. http://www-history.mcs.st-and.ac.uk/

The MacTutor History of Mathematics archive - Comprehensive collection of biographies and history of mathematics articles.

14. http://www.achievement.org/autodoc/halls/sci

Academy of US Achievement: Science and Exploration - Collection of Biographies of US explorers, profiles and interviews with them.

15. http://nobelprize.org/nobel_prizes/

Nobel prize.org - All related information on all Nobel Prize Laureates, biographies, autobiographies, interviews and lectures.

16. http://inventors.about.com/

About: Inventors - A collection of biographies of famous inventors indexed in alphabetical order.

17. http://www.thefamouspeople.com/profiles/

World Famous Personalities: The Famous People – Society for recognition of famous people.

18. http://www.animatedengines.com/

Animated illustrations that explain the inner workings of a variety of steam, Stirling, and internal combustion engines.

19. http://www.science20.com/

Science and technology articles classified by the field of knowledge.

20. http://www.realclearscience.com

Real Clear Science – Science News and Opinion.

21. https://www.sciencenews.org/

Daily news articles, blogs and biweekly magazine covering all areas of science.

22. http://www.bbc.com/news/technology/

Technology – BBC News.

23. http://www.sciencedaily.com/

One of the Internet’s most popular science news web sites.

24. http://www.abc.net.au/science/news/

The Australian Broadcasting Corporation's online gateway to science.

25. http://www.huffingtonpost.com/science/

HuffPost Science - Science news, discoveries and breakthrough scientific research.

26. http://phys.org/

Phys.org is a leading web-based science, research and technology news service which covers a full range of topics. These include physics, earth science, medicine, nanotechnology, electronics, space, biology, chemistry, computer sciences, engineering, mathematics and other sciences and technologies.

27. http://www.eurekalert.org/

EurekAlert! is an online, global news service operated by AAAS, the science society. EurekAlert! features news and resources focused on all areas of science, medicine and technology.

28. http://www.newscientist.com/section/science-news

New Scientist – Science and technology news.

29. http://www.lingvo-online.ru/ru

Онлайн-словарь *ABBYY Lingvo-Online*

30. http://www.multitran.ru/c/m.exe?a=1

Электронный словарь Мультитран

31. http://dictionary.cambridge.org/ru

Бесплатный кембриджский словарь и тезаурус по английскому языку

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