UNIT LEARNING PACKS

FOCUS IN ACTION

Grade 9 Science In Action

Unit D - Electrical Principles and Technologies

EDQUEST
MIDDLE SCHOOL SCIENCE RESOURCES

http://www.edquest.ca

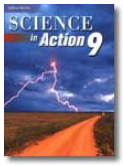
'Focus in Action' UNIT LEARNING PACKS

These booklets are designed to provide Grade 9 students with all the resources needed to review or reinforce concepts, covered in the Alberta Science Curriculum, and included in the Grade 9 Science Final Exam in June. There are circumstances in which **an entire unit** may be missed and covering the concepts from that unit (for the final exam) can be difficult. This can happen for a number of reasons:

- Students – new to the school – register throughout the year (from other provinces, school jurisdictions or countries)
- Students may be ill or have surgery and often can miss one or more units
- Students have extended holidays throughout the year
- Transfers from another school, who have completed the units in a different order

For additional support, students are directed to the **Edquest Middle School Science Website** or, Scienceman Resource (www.scienceman.com/scienceinaction/pgs/hot_9u4.html)

Unit 4 – Electrical Principles and Technologies



- **Section 1 Notes & Quiz**
- **Section 2 Notes & Quiz**
- **Section 3 Notes & Quiz**
- **Section 4 Notes & Quiz**
- **Unit Summary and Review Booklet**
  (Covered in class, prior to the Final Achievement Exam)
- **Unit Test**
- **Answer Key for Section Quizzes and Unit Test**

Additional support will be provided, in the form of practice Achievement Test Questions, during the course review in June. Multiple Choice Questions and Numerical Response Questions will be reviewed, as these are the types that will make up the Science 9 Final Exam

Handouts and other activities, to reinforce the concepts covered in this Unit, will be made available based on need. If you require further information or resources, email Edquest directly: edquest@gmail.com.

Finding Solutions to Problems, instead of Making Excuses

Student Instructions for use of this Learning Pack

The purpose of this Learning Unit Pack is to provide you with the resources that will help you cover the material from the curriculum that will be tested on the Final Exam in June.
Follow these steps to successfully complete this Unit Learning Pack:

Step 1 – Read the **Topic Notes**

Step 2 – Use a **highlighter** to identify the key words or phrases in the Topic Notes and reread the material again paying close attention to those words that you highlighted. If necessary, modify your highlights to make sure you understand the material in the notes.

Step 3 – Complete the **Topic Quiz**

Step 4 – Correct the Topic Quiz by **checking the answers** in the back of this Learning Pack.

Step 5 – Using your **textbook** and the **completed quiz**, find the page where the question and correct answer can be found and write it next to the question number in your Learning Pack.

Step 6 – **Repeat Steps 1-5** for each of the other Topics in this Unit.

Step 7 – Look over the **Unit Outline** to review the **Key Concepts** once you have completed all of the Topics.

Step 8 – Complete the **Unit Review**, using your **Learning Pack** and **Textbook**.

Step 9 – **Highlight** those sections of the Review that you had difficulty with and review those sections with your teacher prior to taking the Unit Test.

Step 10 – Take the **Unit Test** and correct it using the answer key provided in the back of the Learning Pack.

Step 11 – You should now be ready to answer any questions on the **Final Exam** related to this Unit.

Anything you still do not understand should be discussed with your teacher. Congratulations on your **Independent Study**, and Good Luck on the Final Exam. I hope you have made good use of this resource. Please provide feedback to your teacher, so that this resource can be improved.

Additional support is available in the form of practice Achievement Test Questions. **Multiple Choice Questions** and **Numerical Response Questions** will be made available on request, as these are the types that will make up the **Alberta Science 9 Achievement Exam**.

Handouts and other activities, to reinforce the concepts covered in this Unit may be acquired by visiting the Edquest Middle School Science Resource Website

http://www.edquest.ca

'The Atoms Family' (A Great Electrical Resource Site)
'Just for Kids' (Fun and Games - About Electricity)
'Theatre of Electricity'

Science in Action Textbook (pgs. 296-315)

Unit 4 Electrical Principles and Technologies

1.0 Electrical energy can be transferred and stored

1.1Static Electricity

When you get a 'shock', feel a 'jolt' or a 'spark', you are experiencing the same type of electrical effect that makes lightning. Static electricity happens when there is an imbalance of electrons (which have negative charges).

Electrical Charge

Most objects have the same number of positive (**proton**) and negative (**electron**) charges. This makes them **neutral** (no charge).

When there is a difference in the electrical charge, certain actions are predictable, because of **The Laws of Electrical Charges**.

Charge separation occurs, when a charged object is brought close to a neutral object. The charged electrons repel the electrons in the neutral object and the charged object is then attracted to the protons of the neutral object (balloon on a wall)

Lightning

Spark

Electrical Discharge is the movement of charges whenever an imbalance of charges occurs. The action results in neutralizing the objects. The over-charged electrons repel the electrons in the object and the positive protons attract the charged electrons causing a discharge or 'miniature lightning bolt'.

Van de Graaff (VDG) Generators

These generators build up an excess of static charge using friction. A rubber belt rubs a piece of metal and transfers the charge to a sphere. When you touch the sphere the charge builds up on you. (Remember! - like charges repel - that is why your hair strands separate as you touch the sphere as the charge builds up on your body.)

VandeGraaff Generator

1.2 Current Electricity

Certain animals, namely, the , can produce electric shock, to kill or stun prey. They have a special organ that contains specialized muscle cells called electroplaques. Each cell produces a small amount of electricity. When all the cells work together, a large amount of electricity is produce and used to help the eel survive. This type of electricity is like static electricity, which builds up and then discharges. It does not flow continuously. Electrical devices need a steady flow of electricity. The steady flow of charged particles is called electrical current. The flow continues until the energy source is used up, or disconnected.

Amperes

The rate at which an electrical current flows is measured in amperes (A). This flow varies from a fraction of an ampere to many thousands of amperes, depending on the device. Conductors are used to allow the flow of electrical charges from where they are produced to where they are needed. These conductors are materials (often wires), which allow the flow of electrical charges easily.

Circuits

A circuit is a pathway that allows the flow of electricity. Most electrical circuits use wires (as conductors), although others may use gases, other fluids or materials. A circuit consists of a conductor, an energy source, a load and often a switch (to control the flow).

Electrical Energy and Voltage

Electrical energy is the energy carried by charged particles. Voltage is a measure of how much electrical energy each charged particle carries. The higher the energy of each charged particle, the greater the potential energy. Also called **'potential difference',** the energy delivered by a flow of charged particles is equal to the voltage times the number of particles. Voltage units are volts (V), and for safety purposes, the voltage of most everyday devices we commonly use is relatively low, while industries and transmission lines is relatively high.

Voltmeter

Measuring Voltage

The simplest way to measure voltage is with a voltmeter.
[red to positive (+) and black to negative (-)]
Some voltmeters can measure a wide range of voltages. These multi-meters should be used with caution, so that the sensitive needle is not damaged (by testing a low range with high voltage).

Multimeter

Measuring Voltage with Computers

A voltmeter can be hooked up to a computer. Hook-up the red and black lead in the same way as you would for a voltmeter.

1.3 Electrical Safety

Coming in contact with a power transmission line can prove to be deadly. By touching it, a short circuit can occur, because the electricity is trying to find a path to the ground - you can complete the circuit, but it may be fatal.

The Dangers of Electrical Shock

High voltage power lines carry 50,000V of electricity. However, amperage is more important to consider. 0.001A will likely not be felt at all, 0.015A to 0.020A will cause a painful shock and loss of muscle control (which means you will not be able to let go of the line). ***Current as low as 0.1A can be fatal.*** Electrical Dangers vary, depending on the situation. When the current can flow easily, it is more dangerous. Insulators (such as wood, rubber and air) hamper the flow of electricity. Moisture is a good conductor of electricity, so avoid water when working with electricity.

Protecting Yourself From Electrical Shock

The **Canadian Standards Council** issues labels to identify the amount of voltage required

to operate electrical devices and the maximum current they use.
Electrical Safety Pointers ...

- Never handle electrical devices if you are wet or near water
- Don't use devices that have a frayed or exposed power cord
- Always unplug an electrical device before disassembling it
- Don't put anything into an electrical outlet - except a proper plug for an electrical device
- Don't overload an electrical circuit, by trying to operate too many devices at once
- Avoid power lines
- Don't bypass safety precautions when you are in a hurry
- Pull on the plug, not the wire
- Never remove the third prong from a 3 prong plug

Plugs, Fuses and Breakers

The third prong of a **3 prong plug** () is a ground wire, connected to the ground wire of the building, in case of a short circuit.

Fuses () and **circuit breakers** () interrupt a circuit when there is too much current flowing through it.
Fuses contain a thin piece of metal designed to melt if the current is too high. **Circuit breakers**, on the other hand, trip a spring mechanism, which shuts off the flow of electricity through the circuit, when there is too much current. It can be resused over and over (provided the cause of the increased flow is corrected).

The Danger of Lightning

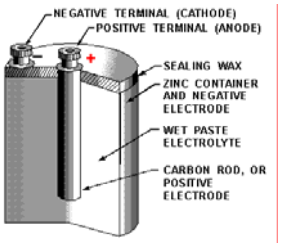
A lightning strike can have 30,000A - more than enough to kill you. Avoid being the target of a lightning strike, by staying low to the ground (horizon) and away from trees. Lightning can also do a lot of damage to a building. Metal lightning rods, that are connected to the ground with a grounding wire are fixed on the roof of many buildings to prevent damage to the building during an electrical storm.

1.4 Cells and Batteries

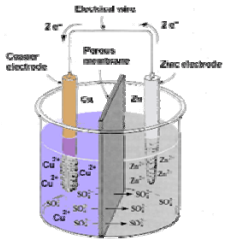
An electrochemical cell supplies a steady current. It is a collection of chemicals designed to produce small amounts of electricity. The electricity comes from chemical reactions within the cell. The tiny cells in a pacemaker can last from 5-12 years

Dry Cells

The electricity-producing cells, that are referred to as 'batteries', are called **dry cells**. They are 'dry' because the chemicals used are in a paste. The chemical reaction in a cell releases free electrons, which travel from the negative terminal of the cell, through the device, which uses the electricity, and back to the positive terminal of the cell. The dry cell is made up of two different metals, called electrodes in an electrolyte. An electrolyte is a paste or liquid that conducts electricity because it contains chemicals that form ions. An ion is an atom or group of atoms that has become electrically charged through the loss or gain of electrons from one atom to another. The electrolyte reacts with the electrodes, making one electrode positive and the other negative. These electrodes are connected to the terminals.



Wet Cells



Wet cells are 'wet' because the electrolyte is a liquid (usually an acid). Each electrode (zinc and copper) reacts differently in the electrolyte. The acidic electrolyte eats away the zinc electrode, leaving behind electrons that give it a negative charge. The copper electrode is positive, but it is not eaten away. Electrons travel from the negative terminal (attached to the zinc electrode) through the device and on to the positive terminal (attached to the copper electrode).

A car battery is made up of wet cells. Each battery has 6 lead-acid wet cells containing alternating positive and negative metal plated (electrodes) in a sulfuric acid electrolyte.

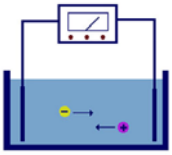
Rechargable Cells

The dry cells and wet cells are called primary cells. The chemical reactions, which produced the electricity, cannot be reversed. Using an external electrical source to rejuvenate the cell however can reverse the chemical reactions in a rechargeable battery. The reversed flow of electrons restores the reactants in the cell. Rechargeable cells are secondary cells, because they store electricity that is supplied by an external source. The most common reactions that are efficient enough to be used for these types of cells are Nickel Oxide and Cadmium (Ni-Cad). The reactants are restored, but the electrodes wear out over time.

Batteries

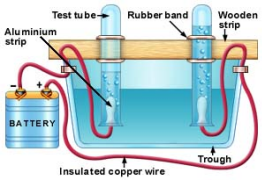
Connecting 2 or more cells together creates a **battery**, which is a sealed case with only two terminals.

Electrochemistry



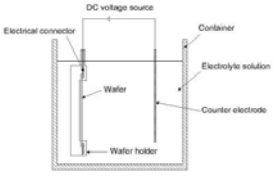
Allesandro Volta made the first practical battery around 1800, by piling zinc and copper plates on top of each other, separating them with electrolyte-soaked paper discs. Humphrey Davy filled an entire room with 2000 cells to make one massive battery. His work led to a whole new field of science called **electrochemistry**, the study of chemical reactions involving electricity.

Electrolysis



Smaller batteries were used to split molecules into their elements, a process called electrolysis. Many industries use electrolysis to separate useful elements from solutions. Chlorine to make drinking water safe. Fuel for the Space Shuttle (to get pure oxygen and hydrogen

Electroplating



Silver and Gold plating can make jewelry and other attractive items look very expensive. The thin coating (which is usually stronger than the original element) is produced through a process called electroplating. This process is often used to protect the metal from corrosion.

Other Electrochemical Applications

Anodizing and **Electro refining** are other examples of electrochemical process used in Canada. Anodizing is a process that coats aluminum parts with a layer of aluminum oxide, which is much harder than aluminum. It is used in products such as screen doors, airplanes, car parts, kitchenware and jewelry. Electro refining is used to remove impurities from metal. Another process used by automobile companies bonds special paints onto car parts.

ELECTRICAL PRINCIPLES AND TECHNOLOGIES

TOPIC 1.0 - Electrical Energy can be transferred and stored - Topic Quiz

1. These **forces** are responsible for lightning, nature's most spectacular show of electricity …
   - **A. magnetic forces**
   - **B. electric forces**
   - **C. attractive forces**
   - **D. repelling forces**

2. Some particles in an atom are charged. Those that are **charged positively** are called …
   - **A. neutrons**
   - **B. electrons**
   - **C. positrons**
   - **D. protons**

3. When **charged objects** are brought close to uncharged objects, this occurs …
   - **A. charge separation**
   - **B. charge attraction**
   - **C. neutralization**
   - **D. atomization**

4. The **laws of electric charges** include all of the following, EXCEPT…
   - **A. opposite charges attract each other**
   - **B. opposite charges repell each other**
   - **C. similar (like) charges repel each other**
   - **D. charged objects attract neutral objects**

5. A **Van de Graaff generator** uses this to build up a static charge on its surface …
   - **A. moisture**
   - **B. friction**
   - **C. heat**
   - **D. light**

6. An **electrical current** can only be produced if there is a …
   - **A. large quantity of particles**
   - **B. a steady flow of charged particles**
   - **C. a safe supply of energy**
   - **D. discharge of electricity**

7. The units used to measure the **flow** of an electric current are …
   - **A. amperes**
   - **B. potential energy**
   - **C. potential difference**
   - **D. volts**

8. 'Voltage' or '**potential difference**' is the energy carried by charged particles equal to the voltage times the …
   - **A. amperes**
   - **B. size of the particles**
   - **C. number of particles**
   - **D. conduction**

9. Very small amounts of electrical energy are measured by a voltmeter in millivolts. A **millivolt** is equal to …

A. 100 volts
B. 1000 volts
C. 1 one hundredth of a volt
D. 1 one thousandth of a volt

10. When lightning hits an area where there is sand and rock, these **glass-lined tubes** can be created. They are called …

A. stalagmites
B. stalactites
C. fulgurites
D. fusinites

11. Which of the following is **most likely** enough electricity to kill you…

A. .01A
B. .01V
C. 10A
D. 10V

12. This **agency** is responsible for ensuring all electrical devices are safe to use…

A. WHMIS Council
B. Canadian Safety Agency
C. Canadian Standards Association
D. Canadian Electrical Device Safety Council

13. Tammy Palmer was inspecting the wiring in a new house and found that the green wire had not been connected properly in the electrical panel. The wiring did not pass safety inspection because the …

A. electrical circuits were overloaded
B. panel had a short circuit
C. electrical outlets were not grounded
D. green wire was the hot wire

14. A fuse and a circuit breaker interrupt a circuit when there is too much current flowing. The disadvantage of the fuse is that it …

A. can be easily repaired
B. has to be replaced when it works
C. doesn't work on really small overloaded circuits
D. can be used over and over – taking a long time to wear out

15. Some foods can generate enough electricity to run a clock. The most effective source for this type of energy is …

a. dry foods
B. dairy products
C. deserts and beverages
D. fruit and vegetables

16. The electrolyte paste, which enables a dry cell to conduct electricity, does so because, it contains …

A. static electrical charges
B. metal plates that release electrons
C. chemicals that form ions
D. an insulator

17. Lead and zinc are usually used as the metal electrodes in a wet cell, such as a car battery. The sulfuric acid electrolyte reacts with the metal electrodes to make the battery produce electrical energy. Identify the statement that explains this correctly

A. The electrolyte gradually eats the lead electrode giving it a negative charge
B. The electrolyte gradually eats the zinc electrode giving it a negative charge
C. The electrolyte gradually eats the lead electrode giving it a positive charge
D. The electrolyte gradually eats the zinc electrode giving it a positive charge

18. A rechargeable battery can be recharged because the …

A. chemical reactions can be reversed
B. electrodes can be reversed
C. electrolyte is being replaced
D. wet cells are drying out

19. The process used to split molecules into their individual elements is called …

A. electricity
B. electroplating
C. electrolysis
D. anodizing

20. When bars of impure gold and strips of pure gold are placed in a strong acid solution and electricity is added, bars of very pure gold can be produced. This process is called…

A. electricity
B. electroplating
C. electrolysis
D. electro refining

Science in Action Textbook (pgs. 296-315)

2.0 Devices and Systems Convert Energy with Varying Efficiencies

Energy is found in many forms. The four most common forms are chemical, electrical, mechanical and thermal. Measuring energy inputs and energy outputs allows you to calculate the efficiency of devices and systems.

2.1 Energy Forms and Transformations

Neon signs have applications of electrical technology.

- First, electricity must travel all the way through the tube in order for the gas to glow.
- Second, The sign has to have a control to turn it off and on.
- Third, the sign must be safe

A Unique Circuit

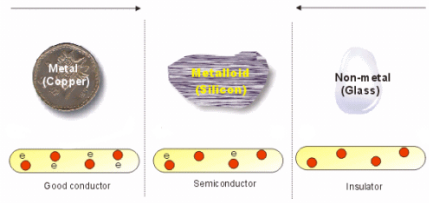
Neon gas acts in the same way as a wire. It conducts the flow of charged electrons from the negative terminal to the positive terminal. There are other gases which act as conductors, including:

- Neon - gives a orange-pink light
- Neon and argon - give a purple light
- Helium - gives a yellowish-white light

Neon is usually an insulator, but electricity 'excites the neon atoms, electrons themselves from the atoms, giving a mixture of charged particles inside the tube (which are good conductors).

Conductors and Insulators

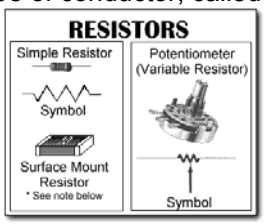
In **insulators** electrons are bonded closely to the nuclei (allowing little movement), while in **conductors**, the electrons are free. When electricity is added, the electrons move toward the positive terminal.



Semiconductors are almost perfect conductors - they have almost no resistance to electron flow. The largest obstacle is to get the semiconductor to work at reasonable temperatures for practical applications.

Using Conductors, Resistors and Insulators

A special type of conductor, called a **resistor** allows electrons to flow, but provides some resistance.



Resistance is a measure of how difficult it is for the electrons to flow through a conductor. It is measured in **ohms**. The more resistance a substance has, the greater the energy gain it receives from the electrons that pass through it. The energy gain is evident in heat and light energy (light bulb filament, wire in a toaster). Solutions can also be resistors. 'Lie detectors' are also special applications of resistance within the body (skin resistance, blood pressure and respiration). An increase in stress (usually associated with a lie) will improve conductivity and show a 'peak' in the recording device.

Switches and Variable Resistors

A **switch** is a device that allows the flow of electrons or stops the flow. When the switch is **open**, the is no flow, because there is a gap in the conductor. When the switch is **closed**, the switch becomes the 'gap replacement' and allows the flow of electrons to continue. To change the electron flow gradually, a **variable resistor**, or **rheostat** is used (a dimmer switch, volume control knob).

2.2 Modeling and Measuring Electricity

Modeling Voltage

A waterfall is used, as a model, to demonstrate voltage. Water flows when there is a change in the **gravitational potential energy** (elevation). Electricity will not flow unless there is a change in **electrical potential** (voltage).

Modeling Resistance and Current

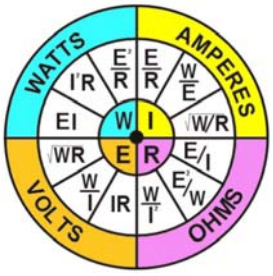
Flow of water in pipes is used, as a model, to demonstrate resistance. The size of pipe determines the volume of water allowed through it. The amount of resistance, in a circuit, determines the size of the current.

Ohm's Law

Georg Simon Ohm, a mathematician, proved a link between voltage (V), current (I) and resistance (R). The unit of resistance was named after him, the **ohm**.

Ohm's Law *states that as long as temperature stays the same:*
the resistance of a conductor stays constant, and the current is directly proportional to the voltage applied

Applying Ohm's Law



Sample textbook problems p. 306 and 307 (use R=V/I)
If the temperature of a resistor changes, the resistance changes as well (resistance is usually low when the resistor is cool, and as the temperature increases, so does resistance).

Using Test Meters

Voltmeters measure voltage difference (**voltage drop**).
Ammeters measure current (rate of flow) in amperes. Small currents are measured using **galvanometers**.

Multimeters can measure voltage, current and resistance in a circuit.


Voltmeter


Multimeter


Resistors

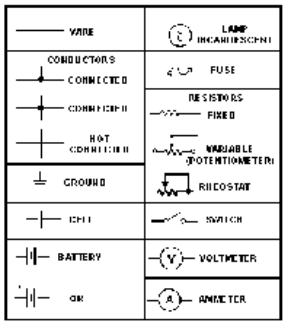
Types of Resistors

Different resistors are used for different applications, especially in electronics. There are many styles, sizes and shapes. The two most common are the wire-wound and carbon-composition types.

2.3 Analyzing and Building Electrical Circuits

Engineers and designers of electrical circuits use symbols to identify components and connections. A drawing made with these symbols is called a **schematic** or **schematic diagram**.

Circuit Drawings



Basic circuit symbols

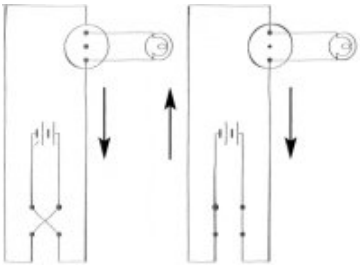
All circuit diagrams have four basic parts:

- **sources** - provides energy and a supply of electrons for the circuit
- **conductors** - provides a path for the current
- **switching mechanisms** - controls the current flow, turning it off and on, or directing it to different parts of the circuit
- **loads** - converts electrical energy into another form of energy

Circuit Analysis Example - Bulldozer

The toy bulldozer has 2 loads, a motor and a bulb. 2 1.5V cells act as the energy source. A switching mechanism connects to 4 wires.

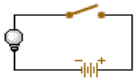
The circuit diagram →

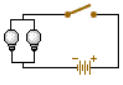


Forward **Backward**

Parallel and Series Circuits

http://www.autoshop101.com/trainmodules/elec_circuits/circ101.html

A series circuit provides only one path  for the current to flow, whereas,

a parallel circuit provides multiple pathways  .

Applications of Series and Parallel Circuits

House Wiring - uses parallel circuits

Microcircuits (Integrated Circuits) - **transistors** are used with three layers of specially treated silicon, with the middle layer (receiving a small voltage, allowing it to control the voltage in the outer layers, allowing them to act as switches. Microcircuits are made up of transistors and resistors and are built on an extremely small scale.

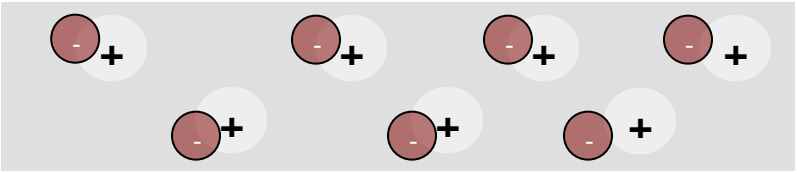
Integrated circuits put all of the components in one chip, reducing the size of the circuit.

2.1 Controlling the Flow Of Electrical Current

1. Electricity can be conducted by a gas. A good example of this is neon, which glows
   - **A. purple**
   - **B. orange-pink**
   - **C. yellowish-white**
   - **D. red**

2. These types of conductors have no resistance to electron flow and therefore are considered to be perfect conductors. They are...
   - **A. metallic conductors**
   - **B. magnetic conductors**
   - **C. superconductors**
   - **D. superior conductors**

3. Conductors and insulators can be modeled in diagrams that show how electrons respond to voltage.



This diagram illustrates …
   - **A. a non-resistant material with voltage applied**
   - **B. an insulator material with voltage applied**
   - **C. a conductor with no voltage applied**
   - **D. a conductor with voltage applied**

4. A door can be used as a model to show how difficult it would be for electrons to flow. The door model represents...
   - **A. voltage**
   - **B. current**
   - **C. resistance**
   - **D. amperage**

5. Solutions can also be resistors. The more charged particles in a solution,
   - **A. the more molecules it has**
   - **B. the more resistance it has**
   - **C. the less resistance it has**
   - **D. the fewer molecules it has**

6. A lie detector indicates that a person is telling a lie because there is
   - **A. a decrease in resistance**
   - **B. an increase in resistance**
   - **C. no change in conductivity**
   - **D. a decrease in conductivity**

7. A variable resistor is a control device that allows you to change the resistance in a circuit. It is also called a
   - **A. thermopile**
   - **B. rheostat**
   - **C. thermostat**
   - **D. thermocouple**

2.2 Modeling and Measuring Electricity

8. A waterfall can be used to model current, voltage and resistance. If the waterfall has a large number of very large boulders, it models greater …

A. voltage
B. current
C. amperage
D. resistance

9. A certain condition needs to be met in order to prove the mathematical link between voltage, current and resistance as represented by Ohm's Law. The condition is that

A. temperature must be constant
B. measurement must be accurate
C. calculations must be precise
D. resistance must be created

10. Using Ohm's Law calculate how much **current** is created when a **120 V** battery creates the current through an **85 ohm** resistor.

Use this shortcut formula to solve the problem

A. O.5 A
B. 1.4 A
C. 2 A
D. 4.5 A

11. Voltage is the potential difference across two points. Many electricians refer to the potential difference across a resistor or device as...

A. micrometer
B. voltage drop
C. resistance
D. voltmeter

12. Current is the rate of flow of charged electrons in a conductor, and is measured in …

A. amperes
B. volts
C. ohms
D. milli-volts

13. Resistance varies with the length, length and thickness of the wire used for resistance. In general, resistance increases as the

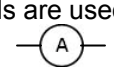
A. length and thickness increases
B. length and thickness decreases
C. length increases and thickness decreases
D. length decreases and the thickness increases

2.3 Analyzing and Building Electrical Circuits

14. Every circuit has four basic parts. The component that controls the flow of the electricity is the...

A. source
B. conductor
C. switch
D. load

15. Symbols are used to represent the electrical components in a schematic diagram.

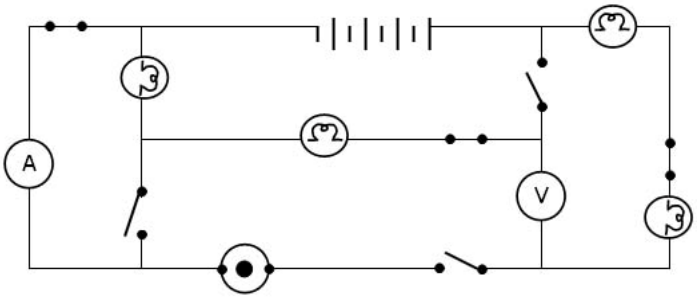
This symbol  is used to represent...

- **A. amps**
- **B. automatic**
- **C. ammeter**
- **D. a single cell**

16. A circuit that has only one pathway for the electricity to flow is called a
- **A. series circuit**
- **B. parallel circuit**
- **C. integrated circuit**
- **D. schematic circuit**

17. In a parallel circuit, when additional resistors are added, the total resistance of the circuit is
- **A. unchanged**
- **B. increased**
- **C. decreased**
- **D. doubled**

18. Use this diagram of an electrical circuit to answer this question.



The following loads will use the electrical energy in this circuit …
- **A. 2 lamps, 1 motor and the ammeter**
- **B. 4 lamps and the voltmeter**
- **C. ammeter, voltmeter and motor**
- **D. everything will use electrical energy because they are all part of the circuit**

19. Solid state components are used in many electronic devices. These are made from a solid material that has no moving parts. They are also called...
- **A. resistors**
- **B. transistors**
- **C. micro-components**
- **D. photo-conductors**

20. A microcircuit, or an integrated circuit, has microscopic transistors which act as…
- **A. loads**
- **B. conductors**
- **C. resistors**
- **D. switches**

(Do the following questions in the space provided)

Questions

Draw a **schematic diagram** using: 2 batteries, 2 lamps, 1 motor and 4 switches
The circuit you make should enable each lamp and the motor to be switched on and off separately, without affecting the other loads, and also allows for all of the loads to be turned on and off all at once.

Draw a **schematic diagram** using: 1 9V battery, 2 lamps, 1 variable resistor, and 1 switch. The circuit you make should be able to adjust the brightness of the lamps and switch them all on and off all at once. (Optional: include a device that will monitor the resistance in the circuit, when the variable resistor is used)

Science in Action Textbook (pgs. 318-342)

3.0 Devices and systems convert energy with varying efficiencies

Energy is found in many forms. Measuring energy inputs and energy outputs allows you to calculate the efficiency of devices and systems.

3.1 Energy Forms and Transformations

The scientific definition of energy is the ability to do work.
The four most common forms of energy are:

- **chemical** - this is energy stored in chemicals. It is potential or stored energy. It is released when the chemicals react.
- **electrical** - this is energy of charged particles. Electrons are negatively charged and electrical energy is transferred when these charged particles travel from place to place.
- **mechanical** - this is the energy possessed by an object because of its motion or its potential to move.
- **thermal** - this is the total kinetic energy of a substance. The faster the particles move the higher the kinetic energy.

Chemical Energy

Chemical energy is the energy found in chemicals, including food. **Glucose** molecules are used in your body cells to produce thermal energy and mechanical energy. Chemical energy can also be converted into mechanical and sound energy (a CD player). Chemical energy can also be transformed into mechanical energy, with heat and light (dynamite).

Transformations Involving Chemical and Electrical Energy

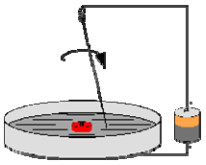
Examples of Devices that convert Energy from one form to another include:

Input Energy	Device	Output Energy
electrical	toaster	thermal
chemical	flashlight	electrical, then light and thermal
electrical	blender	mechanical
chemical	battery-operated clock	electrical, mechanical and sound

Transformations Between Thermal and Electrical Energy

A **thermocouple** is a device that can convert thermal energy into electrical energy. It consists of two different metals (bimetal) joined together that conduct heat at slightly different rates. When heated, the difference in conduction results in electricity flowing from one metal to the other. Thermocouples are useful for measuring temperatures in areas that are difficult to access or too hot for a regular liquid-filled thermometer. Ovens and heaters do the opposite. They convert electrical energy into thermal energy.

3.2 Energy Transformations Involving Electrical and Mechanical Energy



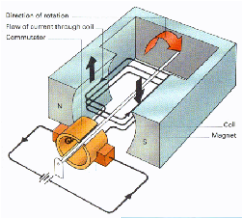
Deflection of a compass needle using electrical current showed that there is a relationship between electricity and magnetism. **Oersted** found that the current created a magnetic field around the wire.

Faraday constructed the first motor.

Simple Motor

Electric Motors

By coiling (copper) wire around a (iron) metal core a strong electromagnet can be made. When attached to an electrical source it will produce a strong magnetic field. To keep this electromagnet spinning in a magnetic field, the direction that the current is traveling through the coil must be switched. This is accomplished by with a gap, which allows the polarity of the electromagnet change just before it aligns with the permanent magnet.



Many electric motors use a commutator (a split ring that breaks the flow of electricity for a moment and then reverses the flow in the coil, when the contact is broken, so is the magnetic field) and brushes (contact points with the commutator) to reverse the flow of electricity through the magnetic field. The armature (the rotating shaft with the coil wrapped around it) continues to spin because of momentum, allowing the brushes to come into contact once again with the commutator.

St. Louis Motor

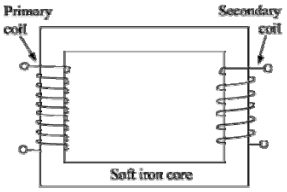
The Steering Analogy

Turning a steering wheel is similar to turning the armature in a motor. At some point you have to release the wheel and start again. This is what the commutator allows the armature to do.

Direct and Alternating Current

Some motors run on direct current (DC). It is 'direct', because the electricity flows in only one direction. Alternating current (AC) flows back and forth 60 times per second.

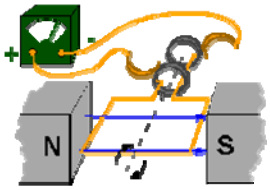
Transformers are used to change the amount of voltage with hardly any energy loss. Voltage change is necessary because the most efficient way to transmit current over long distances is at high voltage and then reduced when it reaches its destination, where it will be used.



A **step-up transformer** increases voltage, while a **step-down transformer** reduces voltage.

Generating Electricity

Michael Faraday discovered **electromagnetic induction** in 1831. He demonstrated that moving a conducting wire through a magnetic field by moving it back and forth through the field, Faraday created the first electricity-producing generator, which could generate electrical current.



Massive coils of wire rotating in huge generators can produce enough electricity to power an entire city.

Generating DC and AC

A **DC generator** is much the same as a DC motor. The spinning armature produces the electricity (if electricity is passed through a DC generator, it will spin like a motor). The central axle of an **AC generator** has a loop of wire attached to two slip rings. The current is switched as the loops move up and down alternatively through the magnetic field. The slip rings conduct the alternating current to the circuit through the brushes (the brush and ring assembly allows the whole loop to spin freely). In large AC generators many loops of wire are wrapped around an iron core.

3.3 Measuring Energy Input and Output

Power

Power *is the rate at which a device converts energy*. The unit of power is the **watt** (**W**), which is equal to 1 **joule** per second. For an electrical device the power is the current multiplied by the voltage.

(**P**) Power in watts (**I**) current in amperes
(**V**) voltage in volts

P = I x V **I = P / V** **V = P / I**

Shortcut $\frac{P}{I\ V}$

Energy

The power rating of a device can be used to determine the amount of energy the device uses. Multiply the power rating by the time the device is operating.

(**E**) Energy in joules (**P**) Power in watts (J/s)
(**t**) time in seconds

E = P x t **P = E / t** **t = E / P**

Shortcut $\frac{E}{P\ t}$

Kilowatt Hours is used as a unit for energy. The energy calculation is the same, except that hours are substituted for seconds and kilowatts (**kW**) are substituted for watts.

Electricity meters measure the energy used in kilowatt hours and then bills you for every kilowatt hour used.

Energy Dissipation

Energy is neither created nor destroyed. It doesn't appear and then disappear, but transformed from one form to another. This is known as the **Law of Conservation of Energy**.
No device is able to be 100% efficient in transforming energy.
Most often, the energy is lost, or dissipated as **heat**. Mechanical systems also dissipate energy to their surroundings, but not as obvious as the heat loss. Much of the dissipated energy is **sound**.

Understanding Efficiency

The **efficiency** of a device is the ratio of the useful energy that comes out of a device to the total energy that went in. The more input energy converted to output energy, the more efficient the device is.

$$\text{\% Efficiency} = \frac{\text{Joules of useful output}}{\text{Joules of input energy}} \times 100\%$$

Most of the energy transformed in a light bulb is wasted as heat.
(5% is **light** energy, while 95% is **heat**)

Comparing Efficiencies

Comparing efficiencies of devices the energy cost and their environmental impact can be determined.

Florescent lights are about 4x more efficient than incandescent lights.

Arc-discharge lights are even more efficient (streetlights).

Hybrid gasoline-electric vehicles are more efficient than gas-powered vehicles.

3.4 Reducing the Energy Wasted by Devices

Devices, which have an **energy-efficient design**, are an important consideration for the consumer, because these devices use less electricity. Energy costs money and it also affects the environment, so reducing energy consumption is a good practice.

Limits to Efficiency

Electric heater come very close to being 100% efficient, but devices, which convert electricity to other forms, can never be 100% efficient. Some energy is lost, or dissipated in a form that is not useful output. Friction causes thermal energy to be lost, or dissipated in many devices.

Increasing Efficiency

Increasing the efficiency of a device depends on its purpose. The easiest way to increase efficiency in many devices is to **reduce friction**, as much as possible. **Insulating** a device from heat loss is also another practical way to increase efficiency. Using **capacitors** in electrical circuits is also another way to increase efficiency.

3.1 Energy Forms and Transformations

1. Electrical energy can be produced from other forms of energy, or it can be converted into other kinds of energy. The conversion in a battery is
   - **A. chemical energy into mechanical energy**
   - **B. mechanical energy into electrical energy**
   - **C. chemical energy into electrical energy**
   - **D. solar energy into electrical energy**

2. Toasters, electric kettles and coffee makers are appliances in the home that convert electrical energy into …
   - **A. mechanical energy**
   - **B. thermal energy**
   - **C. chemical energy**
   - **D. sound energy**

3. A device which converts thermal energy into electrical energy is a
   - **A. thermostat**
   - **B. photoelectric cell**
   - **C. piezoelectric crystals**
   - **D. thermocouple**

4. A device which converts light energy into electrical energy is a ...
   - **A. thermostat**
   - **B. photoelectric cell**
   - **C. piezoelectric crystals**
   - **D. thermocouple**

5. Allison wanted to make a thermocouple. She took two pieces of copper wire and twisted them together. She then attached the ends to a galvanometer. Heating the other ends of the copper wire, she observed that there was no electrical current produced.
What did she do wrong?
   - **A. She didn't heat it long enough.**
   - **B. She connected the wires to the galvanometer backwards.**
   - **C. She didn't use different kinds of wire.**
   - **D. She didn't use a 'hot enough' flame.**

6. Based on the main purpose for which it is used, electrical devices can be grouped into four main categories, which include all of the following except.
   - **A. heat-producing**
   - **B. light-producing**
   - **C. chemical-producing**
   - **D. sound-producing**

3.2 Energy Transformations Involving Electrical and Mechanical Energy

7. Drills, saws, vacuums, fans and food processors are all examples (applications) of this type of energy conversion …
   - **A. electrical energy to mechanical energy**
   - **B. mechanical energy to thermal energy**
   - **C. electrical energy to chemical energy**
   - **D. mechanical energy to sound energy**

8. Your house electricity enters through an electric meter. It records your usage of electricity, which is then recorded by a meter person, who reads the dials on the face of the electric meter. Your electricity usage is recorded in these units.

A. volts
B. watts
C. amperes
D. kilowatts

9. When electrical energy passes over a compass, this happens to the compass needle. It

A. spins
B. is deflected
C. rotates clockwise
D. rotates counterclockwise

10. These reverse the direction of flow in the electromagnetic coil of a motor...

A. power source and armature
B. armature and brushes
C. commutator and brushes
D. commutator and armature

11. Mr. Jones was trying to make an electromagnetic coil to demonstrate the power it has. His coil worked, but not very well. The most likely reason was because the

A. coil was made of copper wire
B. battery was brand new
C. metal core was too thin
D. battery was dead

3.3 Measuring Energy Input and Output

Identify the **Electricity RULE** not being observed in each of the next three scenarios

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12. "The problem with this computer game", said Matt, "is that the power bar keeps popping its circuit. I think that I need a better power bar, so I can play my game without interruption."

A. Don't use electricity near water
B. Improper or unsafe equipment
C. Keep a safe distance high voltage
D. Don't use more electricity than recommended

13. While sitting at his desk, Albert was playing with the electric cord to the stereo. The little bits of plastic he was able to rub off exposed the copper wire, giving him a shock.

A. Don't use electricity near water
B. Improper or unsafe equipment
C. Keep a safe distance high voltage
D. Don't use more electricity than recommended

14. Mr. Jones was cutting his lawn with his new electric lawn mower. He even continued, when it started to rain, because this model was able to pick up wet clippings with ease

A. Don't use electricity near water
B. Improper or unsafe equipment
C. Keep a safe distance high voltage
D. Don't use more electricity than recommended

---

15. It is necessary for Urban power companies to reduce voltage to communities. They are able to do this with a step-down transformer. This type of transformer reduces voltage because...

A. the primary coil is larger than the secondary coil
B. the secondary coil is larger than the primary coil
C. it is coiled in reverse directions
D. it is coiled with more wires

16. The primary difference between direct and alternating current is that direct current .

A. flows in only one direction
B. flows back and forth 10 times per second
C. flows back and forth 30 times per second
D. flows back and forth 60 times per second

3.4 Reducing the Energy Wasted by Devices

17. Michael Faraday's discovery of electromagnetic induction in 1831, led to this ...

A. transformer
B. generator
C. battery
D. split ring comutator

18. A kitchen clock is usually left on all day. It has a power rating of 4 watts. With the cost of electricity, in Alberta, $0.11 per kilowatt hour, what is the cost of operating the clock for one year?

A. $ 385.44
B. $ 38.54
C. $ 3.85
D. $ 0.39

19. A ghetto blaster has a power rating of 28 watts. If it was on each day (all day) during an average month (30 days) and the cost of electricity, in Alberta, is $0.11 per kilowatt hour. What is the cost of operating the ghetto blaster for one month?

A. $ 221.78
B. $ 22.18
C. $ 2.22
D. $ 2217.60

20. The efficiency of a device is the ratio of the useful energy that comes out of a device to the total energy that goes in. A light bulb gives off 5J of useful light energy for every 100J of electrical energy used to make it work. What is the efficiency of the light bulb?

A. 105 %
B. 95 %
C. 20 %
D. 5 %

Science in Action Textbook (pgs. 344-342)

4.0 The use of electrical energy affects society and the environment

4.1 Electrical Energy Sources and Alternatives

The burning of **fossil fuels** (oil, coal, or natural gas) generates 65% of electric power.

Using Heat to Generate Electricity

Coal is mined, crushed into a powder, blown into a combustion chamber and burned to release heat. This heat boils water and superheats the resulting steam to a high temperature and pressure, which then turns a **turbine**. The turbine shaft rotates large electromagnetic coils in the **generator** to produce electricity.
In a nuclear reactor, atoms of a heavy element, usually uranium, are split (**nuclear fission**) in a chain reaction, which releases an enormous amount of energy.
Heat from the Earth's core can also be used to generate electricity. This **geothermal energy** (hot water and steam) is channeled through pipes to drive turbines - connected to generators, which produce the electricity.
Biomass is another type of fuel used to generate electricity. The gases produced from the decomposition of garbage in landfills can be used as fuel for stem-driven generators.

Waste heat from many industrial processes is used to produce steam generated electrical power. This process is called **cogeneration**.

Using Water to Generate electricity

Hydro-electric power plants generate 20% of the world's electricity. **Gravitational energy** is transformed into electrical energy.

Alternative Energy Sources

- **Tides** - moving water can power turbines, which then run generators. When the tide comes in, the water is trapped in large reservoirs and then allowed to flow out past turbines.

- **Wind** - this energy is harnessed by large propeller-type blades, which turn a shaft - connected to a generator.

- **Sunlight** - **Solar cells** (made from silicon) enable the energy from the sun to be transformed (**photoelectric effect**) into electricity.

- **Batteries** - from small portable batteries to **rechargeable** and most recently to the **fuel cells** all provide an electrical source by using chemical reactions within the cells.

Renewable and Nonrenewable Energy

Coal is a **non-renewable** resource (it cannot be replaced, as it is used up). Other **fossil fuels** are non-renewable as well.

Renewable resources can be replenished over and over again. These types of resources include; **wind energy**, **solar energy**, **tidal energy**, **biomass energy**, **geothermal energy**. **Tree harvesting** can also be renewed, but it takes a much longer period of time to renew this resource.

4.2 Electricity and the Environment

Air pollution

The burning of fossil fuels releases problem substances into the atmosphere.

- **Fly ash**, from the burning of coal, is carried up the smokestack and released into the atmosphere.
- **Sulfur Dioxide (SO_2)** - causes acid rain
- **Nitrogen oxides (NO)** - causes air pollution
- **Carbon dioxide (CO_2)** - is the cause of global warming.

Other Environmental Effects

- **Strip-mining** techniques removes all plants and animals from large areas of land resulting in **habitat and species destruction**.
- **Oil and Gas wells** can often give off poisonous gases.
- **Steam turbines** often release warm water into nearby lakes and rivers. The increase in water temperature can affect the local marine ecology and can kill fish.
- **Mines and refineries** that produce nuclear fuel can also cause damage to the environment, because of the radioactive waste.
- **Dams**, **wind farms** and **solar cell arrays** can destroy large areas of ecological habitat.
- **Tidal power plants** can disrupt the habitat of fish and other marine life.

Conserving Energy and Nonrenewable Resources

Fossil fuel reserves are decreasing, but with less reliance on these fuels we will be able to see a decrease in pollution. Conserving energy can be accomplished a little at a time.

This device helps to calculate the use of electricity in your home and can show you how much money you are using to pay for it. By knowing this, you will likely be motivated to find ways to lower your costs. Finding ways to lower our dependence on fossil fuels and finding alternative fuel sources is a decision that will determine much of what our future environment will be like.

A Sustainable Future

Sustainability means using resources at a rate that can be maintained indefinitely. If sustainability is not achieved, future generations will suffer. A sustainable approach often means a different way of getting what you want. Personal decisions can affect sustainability, even if it seems like it's only on a small scale.

4.3 Electrical Technology and Society

Benefits of Electrical Technologies

Electrical technologies have improved our standard of living. Most improvements or inventions have come as a result of a desire to improve **speed**, **efficiency** or **convenience**. This has resulted in freeing up people's time to do other things.

Drawbacks of Electrical Technologies

More technology means more resources are needed to manufacture and operate them, making sustainability more difficult to achieve. As technology advances, obsolete devices become waste, adding to our problems of waste disposal. Some technologies are too expensive for some countries to adopt, leading to isolation and exclusion.

Computers and Information

Computers have revolutionized the way we accomplish many tasks, including writing, calculations and communications. Computers use **binary numbers** (**0, 1**) to store and transmit data which has led to the **digital technology** era.

Electricity and Computers

Electrical current is used in one way or another in storing or transmitting information. Lasers, photo-detectors, and electrical pulses all enable electronic devices to complete the tasks they are made to do.

A computer **hard drive** - uses electrical pulses to record and transmit information, by using an aluminum or glass **disk**, with a thin layer of magnetic material that spins at 300km/h. The electrical pulses are sent to an arm with read and write **heads**, which are magnetic coils that magnetize spots on the spinning disk.

- **Reading** - magnetic spots induce current in the electromagnetic coil, reproducing 0's and 1's in the original signal and are sent to the computer's processor.

- **Writing** - electrical signals are responded to from the computer's processor.

Electrical Transmission of Information

Electrical signals are sent from computer to computer throughout the world, making the storage and transmission of information compact, easy and relatively cheap. Concerns about this include; access, privacy and safety. Misleading or false information is also a problem and the 'information explosion' has created other storage, handling and access problems. Search engines help locate some of the information you may be looking for, but they cannot access everything.

4.1 Electrical Energy Sources and Alternatives

1. 65% of electrical energy around the world is generated by the burning of …
   - **A. wood**
   - **B. hydrogen**
   - **C. fossil fuels**
   - **D. dead plants**

2. To generate electrical energy, coal is used to produce steam that drives this …
   - **A. transformer**
   - **B. generator**
   - **C. turbine**
   - **D. condenser**

3. Garbage is another source of fuel used to generate electrical energy. The particular type of garbage used is called …
   - **A. bio-sludge**
   - **B. biomass**
   - **C. bio-matter**
   - **D. bioaccumulation**

4. Water can also be used to generate electrical energy. The energy conversion is …
   - **A. mechanical to gravitational to electrical**
   - **B. electrical to mechanical to gravitational**
   - **C. gravitational to electrical to mechanical**
   - **D. gravitational to mechanical to electrical**

5. The International Space Station uses this type of energy to generate electricity for use on the station ...
   - **A. chemical**
   - **B. solar**
   - **C. wind**
   - **D. tidal**

6. A single windmill produces a small amount of electricity, but many connected together can generate a large amount of electricity. Many windmills connected together are called wind…
   - **A. farms**
   - **B. clusters**
   - **C. groups**
   - **D. arrays**

7. A fuel cell uses this to generate electricity …
   - **A. hydrogen**
   - **B. oxygen**
   - **C. carbon dioxide**
   - **D. nitrogen**

4.2 Electricity and The Environment

8. Many of the usable fuel resources we have, that are nonrenewable, are being used up. One of the following is a renewable resource.

A. coal
B. natural gas
C. wood
D. methane gas

9. By-products, from the generation of electrical energy, can be harmful to living organisms and to the environment. One such by-product reacts with water to produce ACID RAIN. The chemical that does this is …

A. sulfur dioxide
B. nitrogen oxide
C. carbon dioxide
D. sulfuric oxide

10. Alberta uses a large amount of coal to generate electricity because it can be mined very easily. Strip mining has this negative impact …

A. the original natural environment cannot be fully restored
B. all species of animals lose their habitat permanently
C. soil contamination occurs and cannot be reversed
D. dangerous chemicals can leach into the water table

11. Sustainability means using resources at a rate that ...

A. will eventually deplete them
B. can be maintained indefinitely
C. can generate more through regeneration
D. will compensate and eliminate waste

12. Using less energy will ensure that we will have energy in the future. Which of the following saves the most energy?

A. Buying gas at the cheapest price
B. Using natural gas as a fuel
C. Buying an electric car
D. Buying a solar car

13. The very first electrical communication took place in 1844. Samuel Morse developed a series of dots and dashes (short and long electrical signals) to send messages from one place to another. The device that helped him accomplish that was the …

A. telephone
B. phonograph
C. telegraph
D. simple computer

14. There are many advantages to improving electrical technologies. Saving time, space and speed are just a few. However, one drawback of electrical technology advancement is …

A. convenience
B. sustainability
C. expense
D. independence

4.3 Electrical Technology and Society

15. Technology has revolutionized the way we do things. The single most device that is able to convert all information into numbers, is the computer. These numbers, which are ones and zeros are called …

A. binary
B. bits
C. bytes
D. data

16. Storing and transmitting the information that is converted into numbers is accomplished by different technologies. A compact CD player is able to scan these numbers with the use of a ...

A. silicon chip
B. laser
C. electromagnetic coil
D. photodetector

17. A hard drive in a computer is able to read and write information. The transmission of information happens when the hard drive sends information to the central processor after it …

A. stores the information
B. writes the information
C. converts the information
D. reads the information

18. Access to technology has become an issue because some countries

A. are too poor to get wired
B. do not have the expertise to get involved
C. have too many 'hackers' who interfere
D. have unrestrictive laws enabling anyone to do what they want

Search engines were designed to sort out the ***'information overload'*** on the Internet.
Describe an advantage of a Search Engine and a disadvantage.

Advantage - _____

_____

_____

Disadvantage - _____

_____

_____

Science In Action 9

Unit 4 Electrical Principles and Technologies

Section 1.0 Electrical Energy can be transferred and stored

- **Static** electricity (electrically charged particles not flowing)
- **Current** electricity (flowing charged particles)
- **Voltage** - a measure of how much electrical energy each charged particle has. **Current** – rate of charged particle flow
- Safety with electrical energy is vital
- Electricity can be produced with chemical reactions and stored in cells – **Cells** combine to form **batteries**

Section 2.0 Technologies used to transfer and control current

- Different levels of **resistance** can be provided by different substances
- **Conductors** allow electricity to flow more easily than **insulators**
- Electrical resistance is measured in **ohms. Voltage** is measured in **volts** and current is measured in **amperes.**
- **Ohm's Law** – current flowing through a conductor is proportional to the voltage applied to it
- **Voltmeters** measure (voltage), **Ammeters** (current), **Ohmmeters** (resistance), **Multimeters** (measure all three)
- **Series Circuit** (1 pathway) **Parallel Circuit** (multiple pathways)

Section 3.0 Devices and Systems convert energy

- **Energy forms**: chemical, thermal, mechanical, electrical
- Energy can be t**ransformed** from one form to another
- **Motors** convert electrical energy to mechanical energy
- **Power** is the rate at which a device converts energy (current*voltage)
- **Input energy** and useable **output energy** are compared to determine **efficiency**
- Reducing **waste energy** increases efficiency

Section 4.0 Using electrical energy affects society and the environment

- Alternative energy sources: **fossil fuels, nuclear, geothermal, biomass, hydroelectric, tides, wind and solar**
- Energy sources can be **renewable** or **non-renewable**
- Electrical generation produces by-products that harm the environment
- Energy can be conserved with responsible use and reduction choices
- **Sustainability** – using resources at **indefinite** maintenance rate

Electrical Principles and Technologies

Unit Review

1.0 *Electrical Energy can be transferred and stored*

[Go over the **Unit Summary: on p. 360,** as you review this unit **]**

Explain the difference between **Static Electricity** and **Current Electricity**.

_____

_____

What is **Voltage**?

_____

_____

Describe **safety precautions** you should be aware of when working with electricity.

_____

_____

_____

_____

_____

_____

How is electrical energy produced from **chemicals**?

_____

_____

Describe the difference between a '**dry cell**' and a '**wet cell**'.

_____

_____

_____

_____

2.0 *Technologies can be used to transfer and control electrical current*

What is a **conductor**?

_____

_____

What is an **insulator**?

_____

_____

What is **resistance**?

_____

_____

What units are **resistance**, **voltage** and **current** measured in?

_____

_____

_____

_____

What is **Ohm's Law**?

_____

_____

What devices are used to measure **resistance**, **voltage** and **current**?

_____

_____

_____

_____

Illustrate and explain the difference between a **series circuit** and a **parallel circuit**?

_____

_____

_____

_____

3.0 *Devices and systems convert energy with varying efficiencies*

What are the four most **common forms of energy**?

How is **thermal energy** transformed into **electrical energy**?

How is **electrical energy** transformed into **mechanical energy**?

How is **power** calculated?

How is **energy** calculated?

What is **efficiency** and how is it calculated?

How can **efficiency** be improved?

_____

_____

_____

_____

4.0 *The use of electrical energy affects society and the environment*

Describe **alternative sources** of energy.

1 – **Fossil fuels** - _____

2 - _____

3 - _____

4 - _____

5 - _____

6 - _____

7 - _____

8 - _____

What is the difference between **renewable** and **non-renewable** energy sources?

_____

_____

What harmful **by-products** result from electrical generation and how do they affect the environment?

_____

_____

_____

_____

How can electrical energy be **conserved**?

_____

_____

What does **sustainability** mean?

_____

_____

If you are not sure about some of the concepts in this Unit, and the questions in the Unit Review, go over the answers to the questions with your teacher before you begin the Unit Test.

Electrical Principles and Technologies – Unit Test

1.1 Static Electricity

1. When charged objects are brought close to uncharged objects, this occurs …
   - **A. separation**
   - **B. attraction**
   - **C. neutralization**
   - **D. atomization**

2. When you feel or see a spark while touching a doorknob – after rubbing your feet across a carpet, the spark is referred to as …
   - **A. static spark**
   - **B. electric charge**
   - **C. static discharge**
   - **D. electrical discharge**

3. This device cleans the air and recovers products from the smoke coming out of smokestacks by the static charge it produces. The device is called …
   - **A. a particle accelerator**
   - **B. an electric generator**
   - **C. an electrostatic precipitator**
   - **D. a catalytic converter**

1.2 Current Electricity

4. An electrical current can only be produced if there is a …
   - **A. large quantity of particles**
   - **B. a steady flow of charged particles**
   - **C. a safe supply of energy**
   - **D. discharge of electricity**

5. Very small amounts of electrical energy are measured by a voltmeter in millivolts, which equal …
   - **A. 100 volts**
   - **B. 1000 volts**
   - **C. 1 one hundredth of a volt**
   - **D. 1 one thousandth of a volt**

6. High-voltage transmission lines often give off an eerie blue glow. Sailors saw this same glow around the tips of ships' masts just before storms. They called it …
   - **A. Blue Mist Rain**
   - **B. St. Elmo's Fire**
   - **C. Sun Spot Sparkle**
   - **D. Mystic Glow**

1.3 Electrical Safety

7. When lightning hits an area where there is sand and rock, these glass-lined tubes can be created. They are called …
   - **A. stalagmites**
   - **B. stalactites**
   - **C. fulgurites**
   - **D. fusinites**

8. The dangers of electrical shock can vary depending on the situation. Which of the following would be the most dangerous (most likely to get a nasty shock!) …

A. Touching an electric fence on a hot summer day while wearing running shoes.
B. Touching an electric fence when you are barefoot in a rainstorm.
C. Touching a metal fence on a hot summer day while wearing running shoes.
D. Touching a metal fence when you are barefoot in a rainstorm.

9. A fuse and a circuit breaker interrupt a circuit when there is too much current flowing. The disadvantage of the fuse is that it …

A. can be easily repaired
B. has to be replaced when it works
C. doesn't work on really small overloaded circuits
D. can be used over and over – taking a long time to wear out

1.4 Cells and Batteries

10. Lead and zinc are usually used as the metal electrodes in a wet cell, such as a car battery. The sulfuric acid electrolyte reacts with the metal electrodes to make the battery produce electrical energy. Identify the statement that explains this correctly

A. The electrolyte gradually eats the lead electrode giving it a negative charge
B. The electrolyte gradually eats the zinc electrode giving it a negative charge
C. The electrolyte gradually eats the lead electrode giving it a positive charge
D. The electrolyte gradually eats the zinc electrode giving it a positive charge

11. A rechargeable battery can be recharged because the …

A. chemical reactions can be reversed
B. electrodes can be reversed
C. electrolyte is being replaced
D. wet cells are drying out

12. Less expensive products can be coated with a thin layer of an expensive metal (like gold) to make them look more expensive and to make them last longer (helps prevent rusting). This process is called…

A. electricity
B. electroplating
C. electrolysis
D. electro refining

2.1 Controlling the Flow of Electrical Current

13. Electricity can be conducted by a gas. A good example of this is neon, which glows

A. purple
B. orange-pink
C. yellowish-white
D. red

14. Solutions can also be resistors. The more charged particles in a solution,

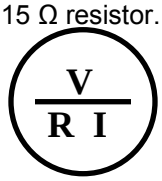
A. the more molecules it has
B. the more resistance it has
C. the less resistance it has
D. the fewer molecules it has

15. A lie detector indicates that a person is telling a lie because there is
A. a decrease in resistance
B. an increase in resistance
C. no change in conductivity
D. a decrease in conductivity

2.2 Modeling and Measuring Electricity

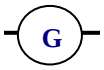
16. A waterfall can be used to model current, voltage and resistance. If a fast flowing waterfall has a large number of very large boulders, it models greater resistance. Resistance is represented by …
A. the speed of the water
B. the size of the waterfall
C. the size of the boulders
D. the height of the waterfall

17. Using Ohm's Law (R = V / I) calculate how much current is created when a 30 V battery creates the current through a 15 Ω resistor. Use this shortcut formula to solve the problem
A. O.5 A
B. 2 A
C. 45 A
D. 1.5 A



18. Resistance varies with the length, length and thickness of the wire used for resistance. In general, resistance increases as the
A. length and thickness increases
B. length and thickness decreases
C. length increases and thickness decreases
D. length decreases and the thickness increases

2.3 Analyzing and Building Electrical Circuits

19. Symbols are used to represent the electrical components in a schematic diagram. This symbol 

is used to represent ...

A. gauge of wire
B. generator
C. galvanometer
D. gap

20. A circuit that has only one pathway for the electricity to flow is called a
A. series circuit
B. parallel circuit
C. integrated circuit
D. schematic circuit

21. Solid state components are used in many electronic devices. These are made from a solid material that has no moving parts. They are also called...
A. resistors
B. transistors
C. micro-components
D. photo-conductors

3.1 Energy Forms and Transformations

22. Electrical energy can be produced from other forms of energy, or it can be converted into other kinds of energy. The conversion in a battery is
   A. chemical energy into mechanical energy
   B. mechanical energy into electrical energy
   C. chemical energy into electrical energy
   D. solar energy into electrical energy

23. A device which converts thermal energy into electrical energy is a
   A. thermostat
   B. photoelectric cell
   C. piezoelectric crystals
   D. thermocouple

24. Based on the main purpose for which it is used, electrical devices can be grouped into four main categories, which include all of the following except.
   A. heat-producing
   B. light-producing
   C. chemical-producing
   D. sound-producing

3.2 Energy Transformations Involving Electrical and Mechanical Energy

25. Drills, saws, vacuums, fans and food processors are all examples (applications) of this type of energy conversion …
   A. electrical energy to mechanical energy
   B. mechanical energy to thermal energy
   C. electrical energy to chemical energy
   D. mechanical energy to sound energy

26. When electrical energy passes over a compass, this happens to the compass needle. It
   A. spins
   B. is deflected
   C. rotates clockwise
   D. rotates counterclockwise

27. Mr. Jones was trying to make an electromagnetic coil to demonstrate the power it has. His coil worked, but not very well. The most likely reason was because the
   A. coil was made of copper wire
   B. battery was brand new
   C. metal core was too thin
   D. battery was dead

3.3 Measuring Energy Input and Output

28. It is necessary for Urban power companies to reduce voltage to communities. They are able to do this with a step-down transformer. This type of transformer reduces voltage because...
   A. the primary coil is larger than the secondary coil
   B. the secondary coil is larger than the primary coil
   C. it is coiled in reverse directions
   D. it is coiled with more wires

29. The primary difference between direct and alternating current is that direct current .
    A. flows in only one direction
    B. flows back and forth 10 times per second
    C. flows back and forth 30 times per second
    D. flows back and forth 60 times per second

3.4 Reducing the Energy Wasted by Devices

30. A kitchen clock is usually left on all day. It has a power rating of 4 watts. With the cost of electricity, in Alberta, $0.11 per kilowatt hour, what is the cost of operating the clock for one year?
    A. $ 385.44
    B. $ 38.54
    C. $ 3.85
    D. $ 0.39

31. A ghetto blaster has a power rating of 28 watts. If it was on each day (all day) during an average month (30 days) and the cost of electricity, in Alberta, is $0.11 per kilowatt hour. What is the cost of operating the ghetto blaster for one month?
    A. $ 221.78
    B. $ 22.18
    C. $ 2.22
    D. $ 2217.60

32. The efficiency of a device is the ratio of the useful energy that comes out of a device to the total energy that goes in. A light bulb gives off 5J of useful light energy for every 100J of electrical energy used to make it work. What is the efficiency of the light bulb?
    A. 105 %
    B. 95 %
    C. 20 %
    D. 5 %

4.1 Electrical Energy Sources and Alternatives

33. Garbage is another source of fuel used to generate electrical energy.
    The particular type of garbage used is called
    A. bio-sludge
    B. biomass
    C. bio-matter
    D. bioaccumulation

34. Water can also be used to generate electrical energy. The energy conversion is …
    A. mechanical to gravitational to electrical
    B. electrical to mechanical to gravitational
    C. gravitational to electrical to mechanical
    D. gravitational to mechanical to electrical

35. A single windmill produces a small amount of electricity, but many connected together can generate a large amount of electricity. Many windmills connected together are called wind…
    A. farms
    B. clusters
    C. groups
    D. arrays

4.2 Electricity and The Environment

36. Sustainability means using resources at a rate that ...
- **A. will eventually deplete them**
- **B. can be maintained indefinitely**
- **C. can generate more through regeneration**
- **D. will compensate and eliminate waste**

37. Using less energy will ensure that we will have energy in the future. Which of the following saves the most energy?
- **A. Buying gas at the cheapest price**
- **B. Using natural gas as a fuel**
- **C. Buying an electric car**
- **D. Buying a solar car**

38. The very first electrical communication took place in 1844. Samuel Morse developed a series of dots and dashes (short and long electrical signals) to send messages from one place to another. The device that helped him accomplish that was the …
- **A. telephone**
- **B. phonograph**
- **C. telegraph**
- **D. simple computer**

4.3 Electrical Technology and Society

39. Storing and transmitting the information that is converted into numbers is accomplished by different technologies. A compact CD player is able to scan these numbers with the use of a ...
- **A. laser**
- **B. silicon chip**
- **C. photodetector**
- **D. electromagnetic coil**

40. A hard drive in a computer is able to read and write information. The transmission of information happens when the hard drive sends information to the central processor after it …
- **A. stores the information**
- **B. writes the information**
- **C. converts the information**
- **D. reads the information**

Identify the Electricity RULE not being observed in each scenario below

41. "The problem with this computer game", said Matt, "is that the power bar keeps popping its circuit. I think that I need a better power bar, so I can play my game without interruption."
- **A. Don't use electricity near water**
- **B. Improper or unsafe equipment**
- **C. Keep a safe distance high voltage**
- **D. Don't use more electricity than recommended**

42. Mr. Jones was cutting his lawn with his new electric lawn mower. He even continued, when it started to rain, because this model was able to pick up wet clippings with ease
- **A. Don't use electricity near water**
- **B. Improper or unsafe equipment**
- **C. Keep a safe distance high voltage**
- **D. Don't use more electricity than recommended**

ADDITIONAL Questions

(Use the space below) ----- (10 marks)

Search engines were designed to sort out the 'information overload' on the Internet.
Describe an advantage of a Search Engine and a disadvantage.

Advantage - _____

_____

Disadvantage - _____

_____

Circuits

Illustrate the following symbols that are often used in a schematic diagram

9V Battery	**lamp**	**rheostat**	**motor**

Draw a **schematic** of a parallel circuit. (2 Marks)

It should have: 2 lamps, each of which can be turned off separately by its own switch,
1 lamp, which can be dimmed or brightened with a rheostat,
1 buzzer, which can be controlled independently by a switch,
and 1 switch, which will shut everything off at once.

Complete these **Numerical Response Questions** in this booklet …

NR1 - A motor has an internal resistance of 12.1 Ω. The motor is in a circuit with a current of 4.0 A

What is the voltage?

	.	.	
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

NR2 - A current of 400 mA runs through a bulb that is connected to 25V.

What is the resistance of the bulb?

	.	.	
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

3. Match the form with its description

There are four common forms of energy:
1 - Chemical
2 - Electrical
3 - Mechanical
4 - Thermal

_____ stored

_____ charged

_____ moving

_____ kinetic

	.	.	
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

4. There are many different alternative energy sources including:
1 – Tidal
2 – Wind
3 – Solar
4 – Waterfall

Match the Type of alternative energy you would most likely find in each region.

_____ Alta

_____ N.S.

_____ B.C.

_____ Ont.

	.	.	
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

Unit D Electrical Principles & Technologies Section Quiz *ANSWER KEYS*

Section 1 Quiz

1	B	7	B	13	D	19	C	25	D	31	D
2	D	8	C	14	B	20	D	26	C	32	B
3	C	9	D	15	B	21	C	27	B		
4	B	10	B	16	A	22	B	28	A		
5	B	11	A	17	C	23	B	29	C		
6	D	12	A	18	C	24	C	30	C		

Section 2 Quiz

1	B	4	C	7	D	10	B	13	C	16	C
2	C	5	A	8	A	11	A	14	C	17	B
3	C	6	B	9	B	12	A	15	A	18	D
Bonus Question	The circuit must be a parallel circuit with switches operating the lamps and the motor separately, as well as a switch that will control the lamps and the motor at the same time.										

Section 3 Quiz

1	C	5	C	9	B	13	B	17	B
2	B	6	C	10	C	14	A	18	C
3	D	7	A	11	C	15	A	19	C
4	B	8	D	12	D	16	A	20	D

Section 4 Quiz

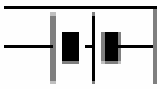
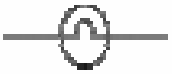
1	C	4	D	7	A	10	A	13	C	16	B
2	C	5	B	8	C	11	B	14	C	17	D
3	B	6	A	9	A	12	D	15	A	18	A
Bonus Question	There are other responses that may also be correct, besides these. **Advantages** – find information fast, sorts and organizes information based on popularity of information **Disadvantages** – not reliable, selective in what is available										

Unit 4
Electrical Principles and Technologies

Unit Test – Answer Key

	Question Number						
Page 1	1	2	3	4	5	6	7
	B	D	C	B	D	B	C
Page 2	8	9	10	11	12	13	14
	B	B	B	A	B	B	C
Page 3	15	16	17	18	19	20	21
	A	C	B	A	C	A	B
Page 4	22	23	24	25	26	27	28
	C	D	C	A	B	C	A
Page 5	29	30	31	32	33	34	35
	A	C	C	D	B	D	A
Page 6	36	37	38	39	40	41	42
	B	D	C	A	D	D	A

Short Answers	Advantages	Disadvantages
	- able to locate many sources - quick and convenient	- unreliable - limited database

9V Battery	lamp	rheostat	motor
			

Circuit Diagram

Student answers will vary but should correctly illustrate a parallel circuit

Numerical Response

1	2	3	4
48.4	62.5	1234	2143