 Topic 1 – Electrical Charges

1. When are materials said to be electrically charged? Materials are positively charged if they have an uneven number of protons and electrons.

2. How could you produce an electric charge? Give an example of an electrically charged object and how it behaves. When two different materials are rubbed or moved close together an electrical charge may be produced eg. A balloon rubbed on hair.

3. What is a more accurate way of referring to static electricity? A more accurate way of referring to static electricity is to call it an unbalanced charge.

4. When an object is said to be positively charged it has a shortage of electrons.

5. State the Three Laws of Charges:
   - Similar charges repel
   - Opposite charges attract
   - Charged objects attract neutral objects

6. What is the difference between a conductor and an insulator? Give two examples of each. Conductors allow electrons to move easily through them while insulators stop the flow. Metals are conductors and rubber is an insulator.

7. What are the advantages of replacing conductors with superconductors? The advantages of using superconductors are they can carry a higher charge with less volume and no loss of energy. eg. 114kg of super conductive wire is able to carry the same charge as 8200kg of copper wire.

8. An electric discharge can be dangerous because it can cause electrical shocks, damage electrical equipment or lead to fires or explosions.

9. You can neutralize conductive materials by grounding the object or using no static sprays.
10. How can you prevent electrostatic build up on an object? *If you use bounce or anti-static sprays.*

11. What are some situations where electrostatic forces have been put to work? *Electrostatic forces can be put to work in electrostatic painting, air-cleaning, ion generators and photo copiers.*

**Topic 2 – Electricity Within a Circuit**
1. What are the four basic elements in all circuits? Give an example of each.
   - **Source** - battery
   - **Conductors** - wires
   - **Load** - light bulb
   - **Control** - switch

2. In a circuit diagram what would be the symbol for:
   - cell - 
   - battery: 
   - conductive wire - 
   - switch - 
   - ammeter - 
   - lam: 
   - motor - 
   - resistor - 
   - galvanometer - 
   - volt meter - 

3. What are the basic rules for drawing a circuit diagram?
   - Use a pencil and a ruler
   - Have straight lines and square corners
   - Use a square or rectangular shape
   - If possible do not cross conductors
   - Draw neatly and use a consistent size for symbols

4. When we measure the number of electrons passing a given point in the circuit we describe the current in **amps** or **milliamps**

5. Which household appliances use the highest number of amps? The electric stove uses 40 amps of power.

6. What supplies the energy in a battery? The energy of a battery comes from chemical energy.
7. The difference in energy between one part of a circuit and another can be measured in **Joules**, **Volts** or **millivolts**.

8. How can electric currents be explained by comparing them to water systems?
   - **Electricity flows like water through a system.**
   - The reservoir = battery.
   - The pipes = the wires.
   - The tap = a switch
   - The water wheel = the light bulb

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**Topic 3 – Resisting the Movement of Charge**

1. What is the relationship between conductors and the level of resistance? **Good conductors are poor resistors and good resistors are poor conductors.**
2. Resistance can be measured using an ohmmeter or by calculating the ratio of voltage across a load by the current through the load. What is the formula for resistance?

\[ R = \frac{V}{I} \]

3. What is the resistance of a light bulb if a 12V battery sends a current of 3 amps through it? Show your calculations.

\[ R = \frac{V}{I} = \frac{12V}{3A} = 4\Omega \]

4. How are resistors useful in an electric circuit? **Resistors are useful in a circuit as they can produce light or heat and control the amount of current in the circuit.**

5. In your own words explain how a variable resistor works and give an example of one? **A variable resistor can change the current in a circuit eg. dimmer switch – volume control or surge protector.**

5. What is the difference between a series circuit and a parallel circuit? **A series circuit has only one pathway for electricity to move through while a parallel circuit will have two or more.**
6. Draw a series circuit with a battery of two cells, two light bulbs and a switch.

7. Draw a parallel circuit with a three-cell battery, two light bulbs and one switch that will turn off both lights.

8. What is the best type of circuit for home use? Explain why this is true. We usually use parallel circuits in our homes as we can then have one appliance on without the others.

9. How are household circuits protected from overheating if too many appliances are plugged in at the same time? We use fuses and circuit breakers in our homes to prevent overheating.

10. Would a thick electrical cord or a thin one be better for carrying a large electric current? Why? Thick cored are better for carrying a large electric current because it would have less resistance and would not over heat.

Topic 4 – The Energy Connection
1. Energy can appear in many forms. Name **six** common forms of energy.

- Mechanical
- Thermal
- Chemical
- Radiant (Sound/light)
- Electrical
- Nuclear

2. What are some uses of a thermocouple?

   Safety device for gas appliances such as furnace or hot water tank

3. Explain how a thermoelectric generator works? What is a situation where they might be used?

   This is an apparatus that has a group of thermopiles connected usually in series. A thermopile is a group of thermocouples connected in series. A thermocouple is a pair of different metal wires joined together that will create a current when heated up. The more thermal energy transferred to the thermocouples and thermopiles (thermoelectric generator) the more electrical potential energy created within the electrons that will flow from one metal to the other.

4. What happens when electricity passes through a piezoelectric crystal? What is one application of this?

   The crystal will expand or contract. This is used in speakers to generate movement of the diaphragm, which will push air through an opening to create a sound.

5. If you squeeze a piezoelectric crystal what is produced? Name a device that uses this reaction.

   A voltage is produced and examples include piezo microphones and BBQ igniters.

6. What is a LED and where might you find one?

   A light Emitting Diode and these are found on displays of DVD players and other electronic devices, more recently being used for LED televisions.

7. Why are solar cells usually combined to cover a large area?

   The greater the area to collect the radiant energy of the sun
8. What produces the electric shock in a South American freshwater eel? It has an electric organ that is made up of specialized cells that can create a potential difference (cells are called electroytes).

**Topic 5 – Portable Power**

1. What are the main components found in any voltaic cell? What does each of them do? 

   A pair of electrodes and an electrolyte. The electrodes are made of different types of metal where one of them likes electrons so it will pull electrons from the other electrode. In the process, the electrode that gives up the electrons creates ions that go into the electrolyte solution.

2. How must cells in a battery be hooked up to produce the most power? 

   In Series because the voltage is additive so the current also increases.

3. Name four common types of cells explain if they are dry or wet cells and one of the things they are commonly used for.

   a. Zinc Carbon Cell
   b. Alkaline Cell
   c. Zinc Air Cell
   d. Lead Acid Cell

4. How does a fuel cell work? 

   Oxygen and hydrogen are combined without combustion and the result is electricity and water.
5. What are the advantages of using fuel cells rather than combustion engines or batteries?

- No significant waste (water is created as a waste product);
- life span is not limited to the chemicals in them, you can add more; Much more efficient compared to combustion engines.

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Topic 6- Generators and Motors

1. Most of our electricity comes from the conversion of mechanical energy to electricity. What are four types of electrical generators?

- AC Generator
- DC Generator
- Thermoelectric generator

2. What did Hans Christian Oerstead notice about electricity and compass needles?

- When a compass is brought close to a current carrying wire, the needle turns to point perpendicular to the wire, regardless of the direction of north.

3. What are three ways of increasing the strength of an electromagnet?

- Increase the current, Increase the number of windings in the coil or wrap the wire for the coil around a piece of iron.

4. What happens to the poles of an electromagnet when the direction of the flow of electricity is changed?

- The polarity of the induced magnet also switches.

5. What parts are needed to make a generator and explain how they produce electricity?

- Permanent Magnet, Coil of wire connected to a commutator, brushes, load. When then coil is turned between the field of the permanent magnet, electrons move in the coil and are transferred out the commutator through the brushes to the load.
6. In North America most generators produce alternating current. What is it and why is it better than direct current for household use? _______________

   Current alternates directions in AC. Used because it is easier to step up and step down.

7. How are alternators and dynamos related? ____________________________

   They both produce electrical current. Alternators create alternating current, dynamos create direct current.

8. Motors use electricity to produce motion. What cause the armature in a motor to spin? ____________________________

   The interaction of the induced magnet from electrons moving through the coil and the permanent magnet.

9. A generator can store energy? Explain why you agree or disagree with this statement. ____________________________

   Disagree, it can only create energy once it is caused to move by an external force.

10. How are electricity and magnetism related? ____________________________

    When electrons move, they create a magnetic field around them.
1. How is the voltage changed in AC currents? Why might you want to do this?  
   _By using step up and step down transformers. Step up transformers are used to have a large supply of electrical potential energy (voltage) ready for multiple substations._

2. Circuit breakers and fuses are safety components in every home. How do they work?  
   _They stop the flow of electrons if too much current is pulled by the load(s). The breaker is a bimetallic strip that heats up as current increases and this causes a switch to flip which stops the flow of current in that branch. A fuse has a wire that melts if the current is too high for that circuit (fuse must be replaced)._  

3. How do we get an electrical circuit when only one cord goes to each appliance?  
   _There are two prongs. One prong brings electrons in from the panel (hot side) and the other one connects to the ground (neutral side)._  

4. What is the basic component in digital devices and how are they grouped in computers and calculators?  
   _Transistors which are digital switches. The on and off state creates a binary code that tells the computer or calculator to perform a specific function._  

5. What is a watt? How is it calculated?  
   _This is a measurement of the power an object uses calculated by multiplying voltage and current._  

6. The formula for power is $P=I \times V$. How could you use this formula to find the watts of electricity used by a hairdryer that uses 120V and has 8.33A? Show your calculations.  
   
   $P = IV$
   
   $= (8.33 \text{A})(120 \text{V})$
   
   $= 999.6 \text{W}$
   
   $= 1000 \text{ W}$
7. How is the power used in a household calculated? ________________
   By taking readings of the power meter on the outside of the house. The end of the previous months reading is subtracted from the end of the current months reading to determine kWh consumed.

8. How is the amount you owe, on your electric bill calculated each month? ________________The kWh is multiplied by the cost per kWh.

9. What two things can the EnerGuide label on new appliances tell you? ________________The average power consumed over one years use by the appliance you are looking at. It also gives the power consumed for one year by the most efficient model and the least efficient model so that you have a comparison of how efficient the model you are purchasing is.

10. Energy efficiency refers to the % of energy going into an appliance is used to do useful work. When looking at the possible ways to light a rooms what is the energy efficiency of:

   - incandescent bulbs ________________5% 
   - halogen bulbs ________________15% 
   - fluorescent tubes ________________20%

11. What are four safety precautions you do in your home to prevent fires or injuries from electricity? ____________________________

   - Do not overload circuit
   - Never work on or clean appliances while plugged in
   - Replace frayed or worn cords
   - Never use appliance close to a water sources (sink or tub).

12. What are some rules to follow to protect yourself from injuries related to electricity outdoors? ____________________________

   - Never allow your body to come in contact with power lines
   - Never use ungrounded or frayed cords
   - Do not operate electric equipment outdoors when it’s raining
   - Use the Call Before You Dig hotline
1. What are two non-renewable and two renewable materials that can be burned in a thermo-electric generating plant?
   ________________
   Non-renewable: Coal and Natural Gas
   Renewable: Biomass such as trees, waste, plants, wood …

2. What are three problems of burning coal to produce electricity? ____
   Open pit mining disturbs vegetation and ecosystem, greenhouse gases emitted, acid rain created, visible particles are emitted through smoke stacks (soot).

3. What are one advantage and one disadvantage of burning natural gas rather than coal to produce electricity?
   ________________
   Natural gas produces fewer oxides of nitrogen and sulfur which contribute to acid rain.

4. In a hydroelectric plant how does the water get enough force to spin the turbines? How can this cause an environmental problem? __
   Using gravitational potential energy by making a dam to hold back a large reservoir of water. This floods the land upstream which removes those ecosystems.

5. What are the problems relating to the use of thermo-nuclear electric generators?
   ____________________
   The waste produced is radioactive for 1000’s of years and we are not using more than 99% of the energy in the fuel rods.

6. What is an example of a big cogeneration project found in Alberta? __
   Poplar Creek Power Plant (by Fort McMurray)

7. Why are alternate sources of energy like wind, sun and tides likely to become more widely used?
   ____________________
   Because fossil fuels are becoming harder and more expensive to extract from the ground, inevitably we will run out of fossil fuels.
8. What are some ways you could store energy for a calm or cloudy day if you were using solar or wind power? You could use a battery to store energy from when it is sunny or windy out.

9. Why is geothermal energy not more widely used in Canada? Because large amounts of thermal energy are needed to drive a turbine. This energy is generally harvested in areas that have volcanic activity like Iceland.

10. Which method of producing electricity would be the most environmentally friendly for southern Alberta? Wind Energy