Name _____
Class _____
Parent/Guardian signature

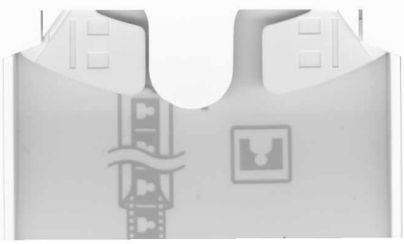
_____

Unit D
Electrical Principles and Technologies

Key Concepts

- ☐ forms of energy
- ☐ energy transformation
- ☐ generation of electrical energy
- ☐ electric charge and current
- ☐ circuits
- ☐ electrical energy storage
- ☐ energy transmission
- ☐ measures and units of electrical energy
- ☐ electrical resistance and Ohm's law
- ☐ renewable and nonrenewable energy

- ☐ Interpret the use of devices to convert various forms of energy to electrical energy, and electrical energy to other forms of energy
- ☐ Identify examples of mechanical, chemical, thermal (heat) and electrical energy
- ☐ investigate and evaluate the use of different chemicals, chemical concentrations and designs for electrical storage cells *(e.g., build and test different forms of wet cells*
- ☐ modify the design of an electrical device, and observe and evaluate resulting changes *(e.g., investigate the effect of changes in the orientation and placement of magnets, commutator and armature in a St. Louis motor or in a personally-built model of a motor)*
- ☐ assess the potential danger of electrical devices, by referring to the voltage and current rating (amperage) of the devices; and distinguish between safe and unsafe activities
- ☐ distinguish between static and current electricity, and identify example evidence of each
- ☐ identify electrical conductors and insulators, and compare the resistance of different materials to electric flow *(e.g., compare the resistance of copper wire and nickel-chromium/Nichrome wire; investigate the conduction of electricity through different solutions; investigate applications of electrical resistance in polygraph or lie detector tests)*
- ☐ use switches and resistors to control electrical flow, and predict the effects of these and other devices in given applications *(e.g., investigate and describe the operation of a rheostat)*
- ☐ describe the nature of electrical current; and explain the relationship among current, resistance and voltage *(e.g. use a hydro-flow model to explain current, resistance and voltage)*
- ☐ measure voltages and amperages in circuits, and calculate resistance using Ohm's law *(e.g., determine the resistance in a circuit with a dry cell and miniature light; determine the resistances of copper, nickel-chromium/Nichrome wire, pencil leads and salt solution)*
- ☐ Identify and estimate energy inputs and outputs for example devices and systems, and evaluate the efficiency of energy conversions
- ☐ apply appropriate units, measures and devices in determining and describing quantities of energy transformed by an electrical device *(e.g., measure amperage and voltage, and calculate the number of watts consumed by an electrical device, using the formula P = IV [power (in watts) = current (in amps) voltage (in volts)]; calculate the quantity of electric energy, in joules, transformed by an electrical device, using the formula E = P t [energy (in joules) = power (in watts) time (in seconds)])*
- ☐ investigate and describe techniques for reducing waste of energy in common household devices *(e.g., by eliminating sources of friction in mechanical components, using more efficient forms of lighting, reducing overuse of appliances as in "overdrying" of clothes)*
- ☐ identify and evaluate alternative sources of electrical energy, including oil, gas, coal, biomass, wind, waves and batteries *(e.g., identify renewable and nonrenewable sources for generating electricity; evaluate the use of batteries as an alternative to internal combustion engines)*
- ☐ identify concerns regarding conservation of energy resources, and evaluate means for improving the sustainability of energy use



1. The _____ has a positive charge and the _____ has a negative charge. (1)

2. What is **static** electricity? (1)

_____

_____

3. List the laws of **Electrical Charges (3)**
   A. _____
   B. _____
   C. _____

4. What do each of these letters stand for? (2.5)
   A. A _____
   B. V _____
   C. I _____
   D. R _____
   E. W _____

5. Read about the different types of energy starting on page 319. Fill in the table with the missing information. Please be careful as sometimes there is more than one type of output energy. (3)

Examples of Devices the Convert Energy from one Form to Another		
Input energy	**Device**	**Output energy**
	Hair straightener	
electrical		mechanical
	oven	
Chemical		Sound, electrical, mechanical

6. Look at the diagram of the battery. Imagine that **each** cell in this battery carries a total of 500mA. Use this information to answer the following questions:

   a. How are the cells arranged in this battery (series or parallel)? How do you know? (1)

   _____

   b. What would you have to change in order to generate higher **amperage**? (1)

   _____

   c. What is the **maximum amperage** this battery can carry? Why? (1)

   _____

/13.5

7. You are helping a friend calculate the resistance in ohms Ω of a piece of unknown wire. You, being a superior student make a circuit consisting of a brand new 12-V battery, two pieces of the unknown wire, and an ammeter. You get a reading of 0.6 A on the ammeter. What is the resistance in ohms? Show your work. (2 marks)

8. Use the four steps to answer the questions below:

identify known quantities
identify unknown quantity
choose and write down correct formula
solve the problem and show work and units

A. What voltage is applied to a 6.8 Ω resistor if the current is 1.5A (1)

B. A voltage of 50 V is applied across a 25 Ω resistor. What is the current through the resistor? (1)

C. The current running through a starter motor is 260 000 mA. If this motor is connected to a 26 V battery, what is the resistance of the motor. (2 marks)

D. A bulb of 40Ω resistance is in a circuit powered by a 8V battery. What is the current in this circuit? (1)

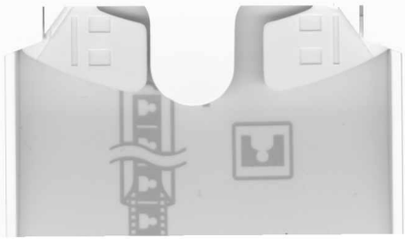
a. What would the current be if you changed to a 80 Ω bulb, a 20 Ω bulb (keeping the voltage the same). (1)

b. What is the relationship between resistance and current? (1)

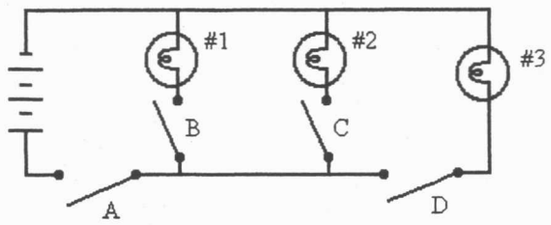
c. What would the current be if you changed to a 4V battery, a 16V battery (keeping the resistance 40Ω ? (1)

d. What is the relationship between voltage and current? (1)

/11



Question 9 has to do with circuit diagrams. Please **THINK** before you answer.



9. List the switches that **have to be closed** in order for the following to happen: (3)

   A. Light bulb #1 is lit, the rest off. _____

   B. Light bulbs #1 and #2 are lit, light bulb 3 off. _____

   C. Light bulbs #1 and #3 are lit, light bulb 2 off. _____

10. Construct a schematic drawing of a parallel circuit consisting of two batteries of four cells each, two motors and a bulb in parallel. Draw enough switches that control the devices separately as well as simultaneously. There should also be a resistor and a variable resistor in series with one switch to turn both on or off. (4) *Use separate sheet or margin*

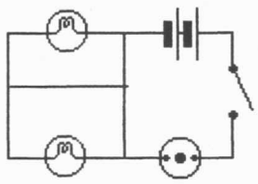


Diagram A

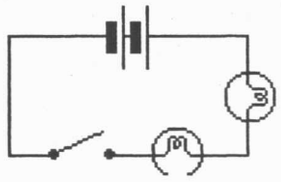


Diagram B

11. Compare diagrams **A** and **B** to answer the questions below: (4)

   A. Which diagram is representative of a parallel circuit?_____

   B. Which diagram is representative of a series circuit? _____

   C. Using the brightness of the light bulbs as an example, what is the difference between a parallel and a series circuit?

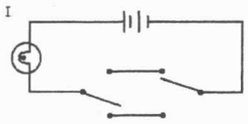
_____

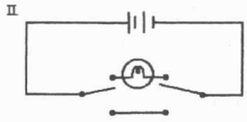
_____

   D. In diagram A of the motor is removed and the switch is closed, what happens to the two light bulbs? Why?

_____

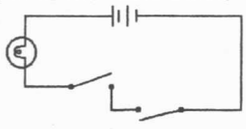
_____

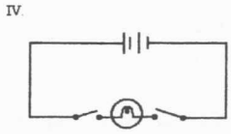




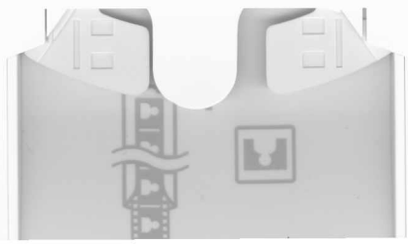
12. Which diagram shows the light on or off from either end of a hallway? (1)

13. Fill in the table below:





/12



Energy Form	Description
Electrical energy	
	The energy stored in chemicals. This is a form of potential or stored energy. This energy is released when chemicals react.
Thermal energy	
	The energy possessed by an object because of its motion or its potential to move.

14. On one day, a household used a clothes dryer for 2 hrs, a colour TV for 2.5 hours, a vacuum for 210 minutes and a toaster for 30 minutes.
    A. What was the total energy these appliances consumed that day? (in kWh)

OMIT

    B. If electrical energy costs 7.5 cents, what was the total cost of the energy used?

15. If each appliance was on for 2.5 hours, what would be the total kWh?

Electrical appliance	Power rating
Stove	12 000 W
Clothes dryer	4 600 W
Kettle	1 500 W
Toaster	1 000 W
Coffee maker	600 W
Vacuum	500 W
Colour TV	200 W
Desk lamp	60 W
Clock	4 W

16. Using the power formula **P = V x I**, answer the three questions.

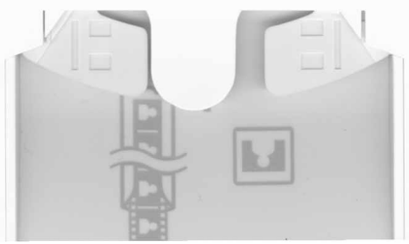
identify known quantities
identify unknown quantity
choose and write down correct formula
solve the problem and show work and units

a. The current running through a toaster connected to a 120 V source is 8.0 A. What is the power of this device? (1)

b. A 120 V motor draws 4.5 A of current. What is the voltage across the motor? (1)

c. A 12 000 W stove is connected to a 240 V source. What is the current flowing through the stove? (1)

/7



17. A 800 W hotplate adds 4 kJ of energy to a container or water while heating for 10 minutes. How efficient is the heating process?
Remember : Efficiency = output energy/input energy x 100%. (2)

18. List two ways you can increase the efficiency of a device. (2)

_____

_____

19. What is the difference between a **fuse** and a **circuit breaker**? (1)

_____

20. List the six parts of a dry cell and provide the function for each. (3)

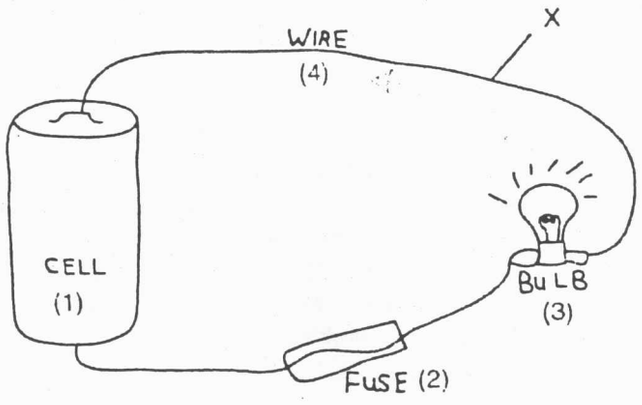
a. _____
b. _____
c. _____
d. _____
e. _____
f. _____

21. What is the difference between a **dry cell** and a **wet cell**? List ONE example for each type. (2)

_____

_____

A student builds a circuit with a glowing bulb. She then sketches what she has built:



22. Match each circuit component, as numbered above, with the primary function that it performs. Use each number ONLY ONCE. (4)

_____ converts electrical energy to another form

_____ conducts current

_____ provides a potential difference

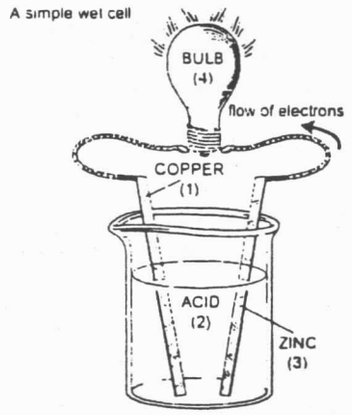
_____ melts if current levels are too high

/14

23. Trace the flow of electrons through the four items in the circuit, starting from point X in the diagram. Indicate the proper order by placing the numbers of the components from left to right in the spaces below. (1)

_____ _____ _____ _____

Use the following information and diagram to answer questions 24 and 25.



24. Match each wet-cell component, as numbered above with the names of the wet-cell and circuit components below. (1)

_____ _____ _____ _____

negative electrode | positive electrode | electrolyte | load

25. What would happen to the wet-cell if the following were changed: (3)
    a. Change the zinc electrode to a copper electrode _____
    b. Change the electrolyte to a salt water solution _____
    c. Change the electrolyte to pure water _____

Use the following information to answer questions 26 - 29

As student uses a 400-W electric chainsaw continuously during 100 minutes of cutting wood. The chainsaw is approximately 40% efficient at converting energy.

26. How much energy did the chainsaw consume while cutting the wood. (1)

27. What energy transformation does the chainsaw perform? (1)

_____ to _____

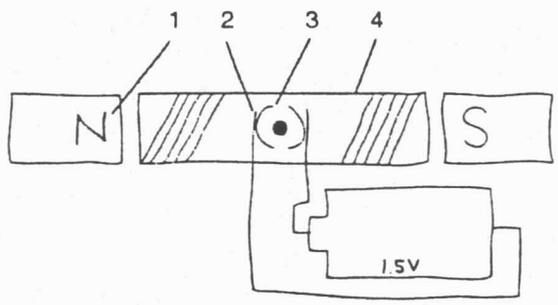
/7

28. The level of efficiency of the chainsaw is approximately by 40%. In what form is much of the energy lost? _____ (1)

29. Suppose during a day of wood cutting the chainsaw consumes 8.5 MJ of electrical energy . Considering the efficiency of the chainsaw, how much useful energy did the saw produce? (2)

Use the following information to answer questions 30 and 31.

A student drew a sketch of an electric motor as follows.



30. Label the parts of the motor indicated in the diagram by matching the numbers in the diagram with the following parts. (1)

_____	_____	_____	_____
commutator	brush	magnet	armature

31. The student disconnected the dry cell and then manually turned the axle of the motor. When she connected the wires leaded from the motor t a voltmeter, she noticed that the motor created voltage as she turned the shaft. This result can be evidence of what? (1)

Use the following information to answer question 32.

The following energy transformation was collected from a series of devices:

- ✓ A jet boat produces 128 kJ of mechanical energy from 1020 kJ of input chemical energy.
- ✓ An incandescent light produces 56 J of light energy from 850J of input electrical energy
- ✓ A luxury can produces 88 kJ of mechanical energy from 1000 kJ of input chemical energy
- ✓ A motorbike produces 348 J of mechanical energy from 1220 J of input chemical energy.

32. Rank the device from most to least efficient. DO this by placing the numbers 1 (most efficient) to 4 (least efficient) in the spaces below. (1)

_____	_____	_____	_____
jet boat	light	luxury car	motorbik

/6

Use the following information to answer question 33.

A group of students made a list of the characteristics of energy for a research project:

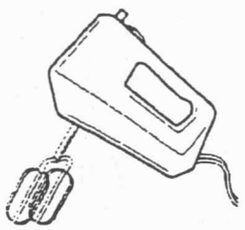
1. Heat trapped from hot rock within Earth's crust provides energy for electricity generation.
2. Devices harness the energy released by atomic fission for use in electrical generation.
3. Generating plants capture the energy of falling water.
4. Biodegradable waste from landfill serves as the energy source.

33. Match the characteristics with the proper energy source. (1)

_____	_____	_____	_____
nuclear	hydro-electricity	geothermal	biomass

Use the following information to answer questions 34 & 35.

A student purchases a new electric mixer for food preparation. This model has a single detachable mixing wand, and plugs into a standard home electrical outlet.

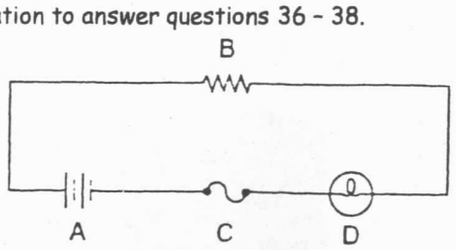


34. To what part of the motor of the electric mixer do you attach the mixing wand?
_____ (1)

35. This mixer's purpose is to perform what energy transformation? (1)

_____ to _____

Use the following information to answer questions 36 - 38.



36. Match the circuit's components below with their labels by placing the appropriate letters in the spaces below. (1)

_____	_____	_____	_____
lamp	battery	resistor	fuse

/4

37. Which of the components in the circuit is a safety feature? _____ (1)

38. The lamp in the circuit puts out approximately 112 J of light energy for every 2000 J of electrical energy put into it. What is the efficiency of the lamp? (2)

39. Explain the difference between a **magnet** and an **electromagnet**? (1)

_____

_____

40. What are the **three** things needed to make an **electromagnet**? (3)

A. _____

B. _____

C. _____

41. What two things can you do to the electromagnet in order to increase its magnetism? (2)

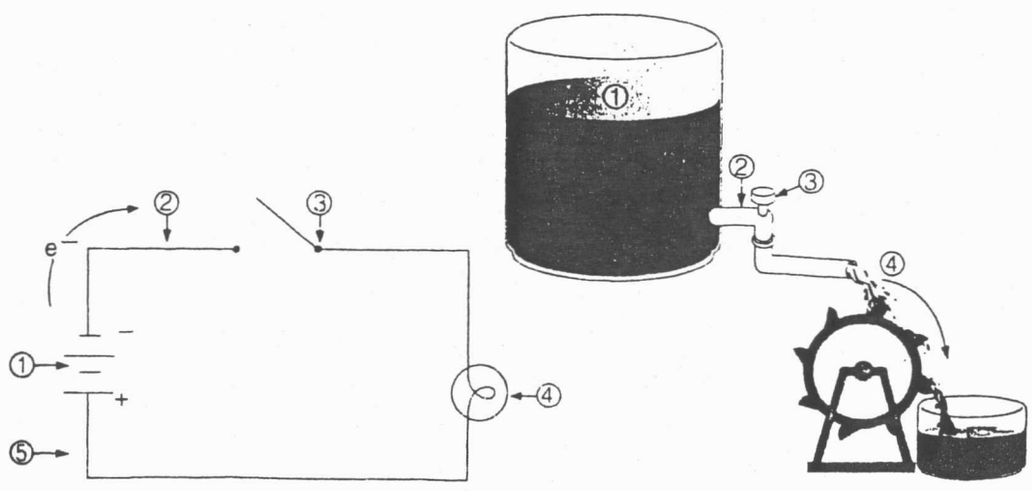
a. _____

b. _____

Rivers of Electricity

Use the diagram below to answer question 42.

Electric circuits are often compared to water systems. Electric charge flows through the parts of the circuit, just as water flows through pipes or along a river channel. The energy of the moving charge is changed to different forms as current passes through the load, just as the energy of moving water can be harnessed as it flows downhill. *See next page for the question*



/9

42. Write the water (hydraulic) related term from the column of terms on the right that best typifies each electric term next to it. For each pair of terms, describe why you think they are similar. (3)

A. load	**_____ pump**
B. switch	**_____ pressure**
C. electric current	**_____ pipe**
D. voltage	**_____ water wheel**
E. battery	**_____ valve**
F. conductor (WIRE)	**_____ flow rate**

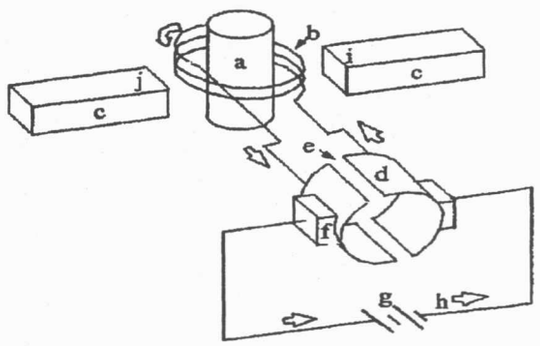
_____

_____

_____

43. Examine the electric motor shown here in schematic form and identify the labeled parts. Hints are given to assist you. (5)

(a) spinning part _____
(b) wire coil is an _____
(c) not temporary _____
(d) alternates flow _____
(e) non-conductor _____
(f) paints on charge _____
(g) current type _____
(h) terminal charge _____
(i) the end _____
(j) if "i" is a north _____



44. If item "g" on the device above were to be replaced with an electrical load, and part "a" was turned by hand, this would then be a(n) _____. (1)

45.

46. Write the term that matches on the line; *electrical code, binary code, EnerGuide transistor, watt, power, fluorescent. (3.5)*

(a) _____ operating instructions
(b) _____ a switch
(c) _____ standard to be met
(d) _____ unit of power
(e) _____ energy over time
(f) _____ consumer info.
(g) _____ glowing

/12.5