Student's Name _____ Date _____ Class _____

Student Sheet PA.1: What's Inside Electric Devices?

Directions: Use this student sheet to complete Investigation PA.1.

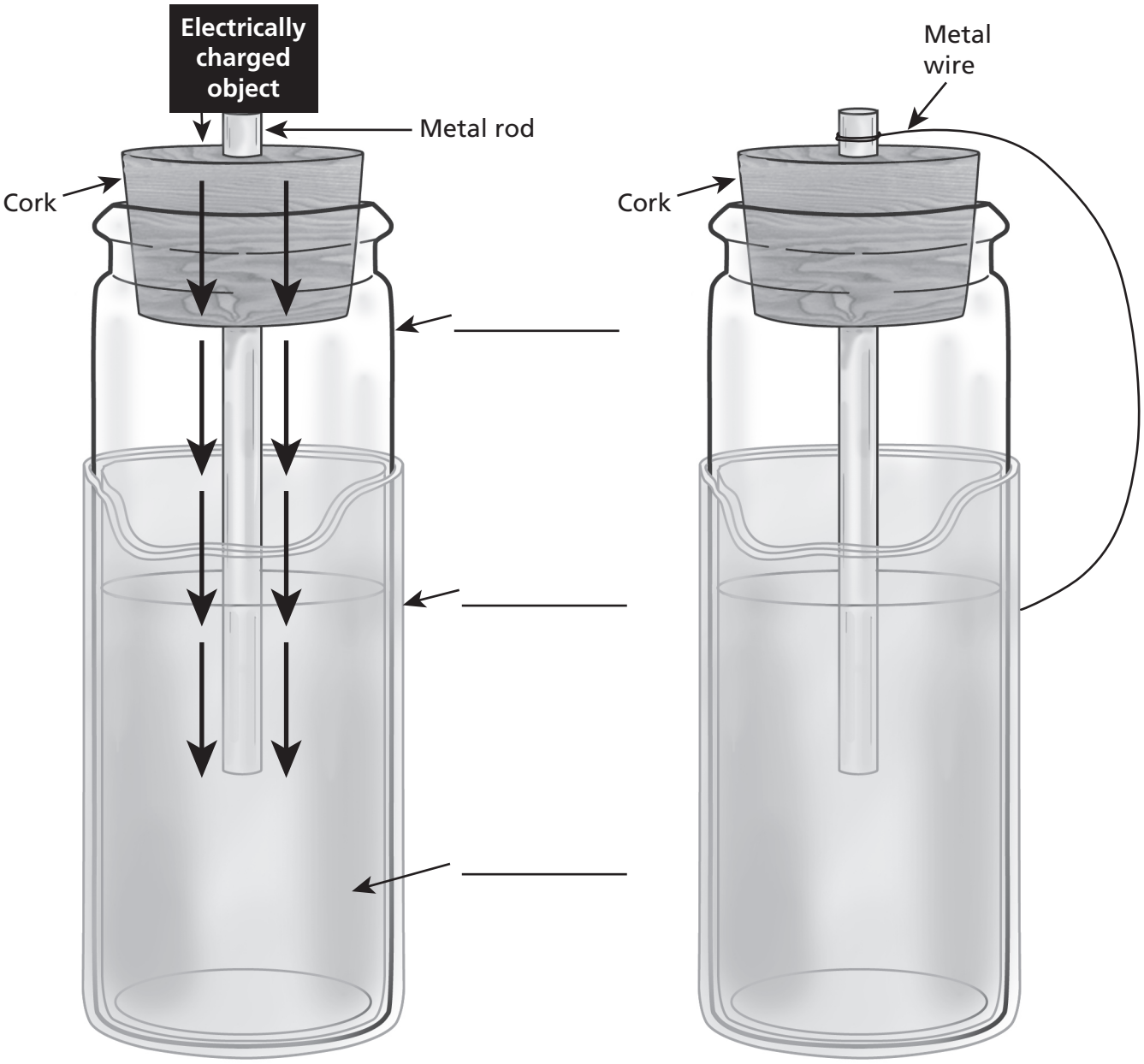
Table A. What's Inside?

Device	What It Does	Power Source	Number of Components	Components List	Drawings of Components of Device

Student's Name _____ Date _____ Class _____

Student Sheet 1.GS: Modeling a Leyden Jar Experiment

1. Use appropriate symbols and labels to show the flow, storage, and release of electrical energy to complete the diagrams.



2. Describe in words what is happening in each figure above.

_____

_____

_____

Student's Name _____ Date _____ Class _____

Student Sheet 1.3: Batteries and Current in Circuits (page 1 of 2)

1. Identify the independent and dependent variables in your investigation.

Independent Variable	Dependent Variable

2. Write a hypothesis about how changing the number of batteries will affect the current.

_____

_____

_____

3. Write a short procedure describing how you will change the batteries and measure the current. Include a schematic for your test circuit(s).

_____

_____

_____

_____

4. Make a prediction about what you will observe once you have changed the number of batteries in the circuit and closed the switch.

_____

_____

_____

5. Draw a data table to record your data. Carry out your procedure, and enter your data in your table and note any observations you make during your experiment.

_____

_____

_____

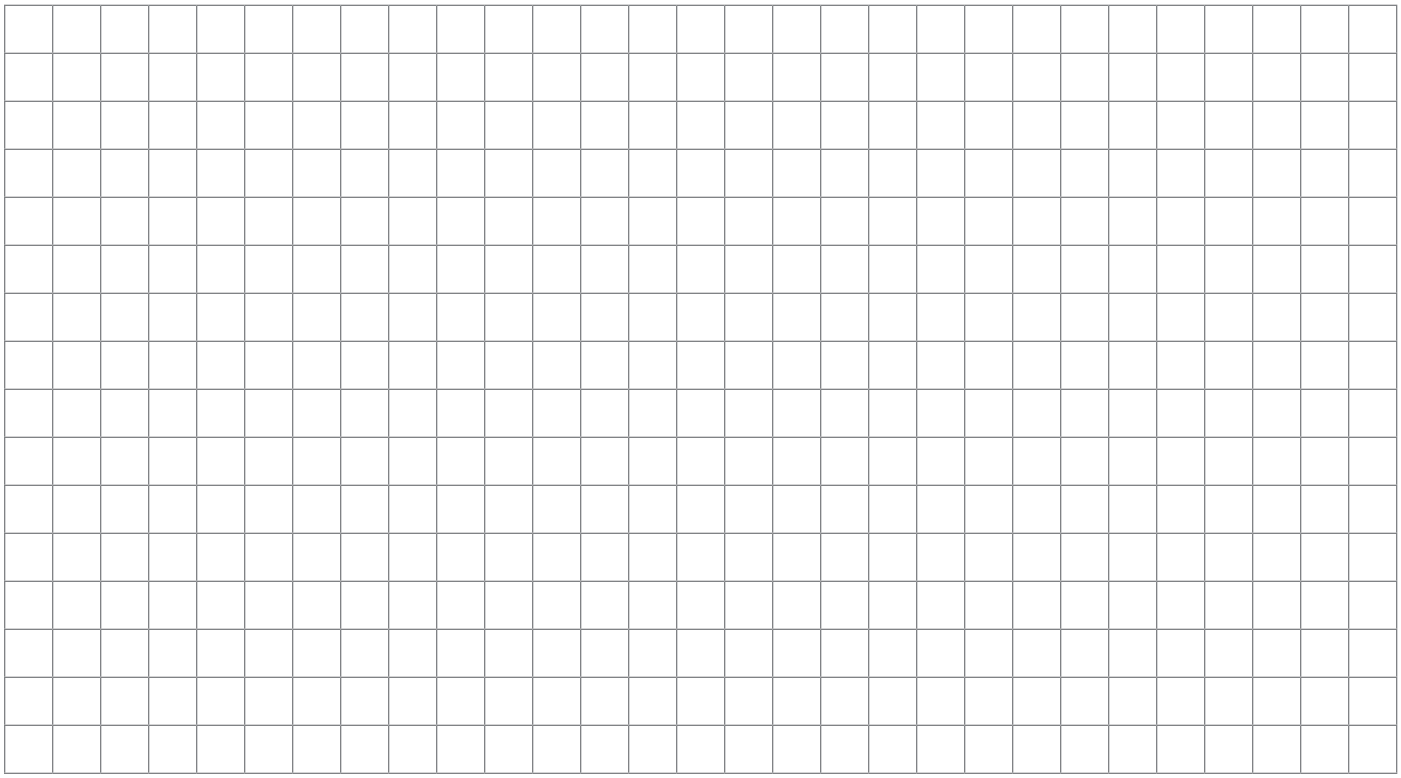
_____

Student's Name _____ Date _____ Class _____

Student Sheet 1.3: Batteries and Current in Circuits (page 2 of 2)

6. Display your data on the graph below:

Title: _____



7. Analyze your data and write a conclusion about how changing the number of batteries affected the current. Support your conclusion with evidence. _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Student's Name _____ Date _____ Class _____

Student Sheet 2.1: The Resistance of Circuit Components (page 1 of 2)

1. Record your data from Investigation 2.1, Steps 2–6.

Voltage across Resistor A: _____ Current through Resistor A: _____ Resistance: _____

Voltage across Resistor B: _____ Current through Resistor B: _____ Resistance: _____

Show all calculations here:

2. Write your answers to the following questions, and then discuss your answers with the class:

a. What did you conclude about the relative resistance of the two resistors?

_____

_____

_____

b. How was current related to resistance in each of the circuits you built?

_____

_____

_____

c. How would you describe the function of a resistor in a circuit?

_____

_____

_____

Student Sheet 2.1: The Resistance of Circuit Components (page 2 of 2)

3. Use the equation for power and your knowledge of Ohm's law to calculate power for the circuits in this investigation. Then use those answers to calculate the voltage across the resistors.

Show all calculations here:

Student's Name _____ Date _____ Class _____

Student Sheet 2.2: Wires and Resistance

1. Record your data from Investigation 2.2 in Table A.

Table A. Measuring Wire Resistance

Wire Gauge	Wire Length	Voltage Across the Wire	Current	Resistance

2. Predictions: _____

_____

_____

_____

_____

3. Conclusion: _____

_____

_____

_____

_____

Student's Name _____ Date _____ Class _____

Student Sheet 2.3: Electric Devices and Resistors (page 1 of 2)

Resistance of Resistor A: _____

Resistance of Resistor B: _____

1. Hypothesis: _____

_____

_____

Independent variable: _____

Dependent variable(s): _____

Predictions: _____

2. Record your observations from Investigation 2.3 Step 7 in Table A and explain whether your predictions were or were not correct.

Table A. Observations of Fan Speed

Observation of Fan Speed with Resistor A	Observation of Fan Speed with Resistor B

Were your predictions correct? Why or why not?

_____

_____

_____

_____

_____

_____

Student's Name _____ Date _____ Class _____

Student Sheet 2.3: Electric Devices and Resistors (page 2 of 2)

3. Discuss the questions below with your group and then record your answers.

VOLTAGE = CURRENT × RESISTANCE	**POWER = CURRENT × VOLTAGE**

a. Based on your knowledge of Ohm's law and how power is calculated, is the power used by the fan greater when Resistor A or Resistor B is in the circuit? Explain your answer.

_____

_____

_____

_____

_____

_____

b. Do your observations of the fan's speed support your answer? Why or why not?

_____

_____

_____

_____

_____

_____

c. Do your data and observations support your hypothesis? If so, how? If not, why not?

_____

_____

_____

_____

_____

_____

Student's Name _____ Date _____ Class _____

Student Sheet 4.2: Constructing an Argument with Evidence

Scientific arguments are based on evidence from data and reasoning from known scientific principles. You will use evidence and reasoning to write an argument that answers the question, **Where does the kinetic energy of a spinning coil motor come from?** You will write your final argument in your science notebook. Be prepared to share your argument with the class.

The questions below will help you organize evidence from Investigation 4.2 to build your argument. After you have completed them, write your response to the prompt above in your science notebook.

1. What happens in the bare and insulated copper wires when they are connected to the battery in the closed circuit? Explain your answer. _____

_____

_____

2. What happens to the properties of the coiled wire in the closed circuit? Explain your answer.

_____

_____

3. What part of your motor had kinetic energy when the switch was closed? Explain your answer.

_____

_____

_____

4. What was the role of the flexible magnet in your spinning coil motor? Explain your answer.

_____

_____

_____

5. What energy transformations can you identify in your closed circuit. _____

_____

_____

_____

_____

Student's Name _____ Date _____ Class _____

Student Sheet 6.1: Examining Convex Lenses (page 1 of 2)

Directions: Complete this student sheet as you conduct the experiments in Investigation 6.1.

1. Record your observations and measurements of the appearance of the letters on the page as you move the thicker convex lens. _____

2. Write a description of what you observe when you look through the thicker lens at the other side of the classroom or out the window. _____

3. Write a paragraph explaining how light bends to produce one of the images you saw through the lens. As needed, use a simple model to help you explain this phenomenon. _____

Student's Name _____ Date _____ Class _____

Student Sheet 6.1: Examining Convex Lenses (page 2 of 2)

4. Record your observations and measurements of the appearance of the letters on the page as you move the thinner convex lens. _____

_____

_____

_____

5. Write a description of what you observe when you look through the thinner lens at the other side of the classroom or out the window. _____

_____

_____

6. Write a paragraph explaining why you think your observations differed for the two lenses. Use the concept of refraction in your explanation. _____

_____

_____

_____

_____

7. After reading *Building Your Knowledge*: "How a Convex Lens Focuses Light," revise your answer to question 6 above as needed. Write your revised answer here. _____

_____

_____

_____

_____

8. Which lens has a longer focal length? How do you know?

_____

_____

_____

_____

Student's Name _____ Date _____ Class _____

Student Sheet 8.GS: Graph Paper

Student's Name _____ Date _____ Class _____

Student Sheet 9.1: Reaction Time Data

Directions: Record your data from Investigation 9.1 in Table A. Use Table B to convert distances (cm) to reaction times (s).

Below Table A, record your average reaction time.

Table A. Reaction Time Data Table		**Trial**									
		1	2	3	4	5	6	7	8	9	10
Response	Distance (cm)										
	Time (s)										

Average reaction time: _____

Table B. Reaction Time Conversions

Distance (cm)	Time (sec)		Distance (cm)	Time (sec)
1	0.05		17	0.19
2	0.06		18	0.19
3	0.08		19	0.20
4	0.09		20	0.20
5	0.10		21	0.21
6	0.11		22	0.22
7	0.12		23	0.22
8	0.13		24	0.22
9	0.14		25	0.23
10	0.14		26	0.23
11	0.15		27	0.23
12	0.16		28	0.24
13	0.16		29	0.24
14	0.17		30	0.25
15	0.17		31	0.25
16	0.18		32	0.26

Student's Name _____ Date _____ Class _____

Student Sheet 10: Echolocation (page 1 of 2)

1. Suppose a dolphin sends an echolocating click into a bed of kelp that absorbs much of the sound and reflects only a little. Will the reflected signal be quieter than the outgoing signal? Will it give the impression of coming from much farther away than it is? Explain your answers.

_____

_____

_____

_____

_____

Table A. Hearing Ranges for Selected Animals

Species	Hearing Range
Humans	64–23,000 Hz
Dogs	67–45,000 Hz
Cats	45–64,000 Hz
Mice	1,000–91,000 Hz
Gerbils	100–60,000 Hz
*Bats	2,000–110,000 Hz
*Beluga whales	1,000–123,000 Hz
*Porpoises	75–150,000 Hz
Goldfish	20–3,000 Hz
Owls	200–12,000 Hz
Chickens	125–2,000 Hz

*Capable of echolocation
Source: www.lsu.edu/deafness/HearingRange.html

2. On the grid on page 2 of this student sheet, arrange the hearing-frequency bands listed in Table A, making a bar graph that shows the ranges over which various species can hear, and note areas where more than two bars overlap. Use hertz (Hz) as the x-axis.

3. Look at the bar for mice. As far as we know, mice do not echolocate. However, their hearing extends nearly to the range of the echolocators'. Why might mice have evolved to hear such high-frequency noises if they are not echolocating?

_____

_____

_____

_____

4. Examine your graph. What is the likely top frequency range for noises intended as communication, rather than echolocation? Explain your answer.

_____

_____

_____

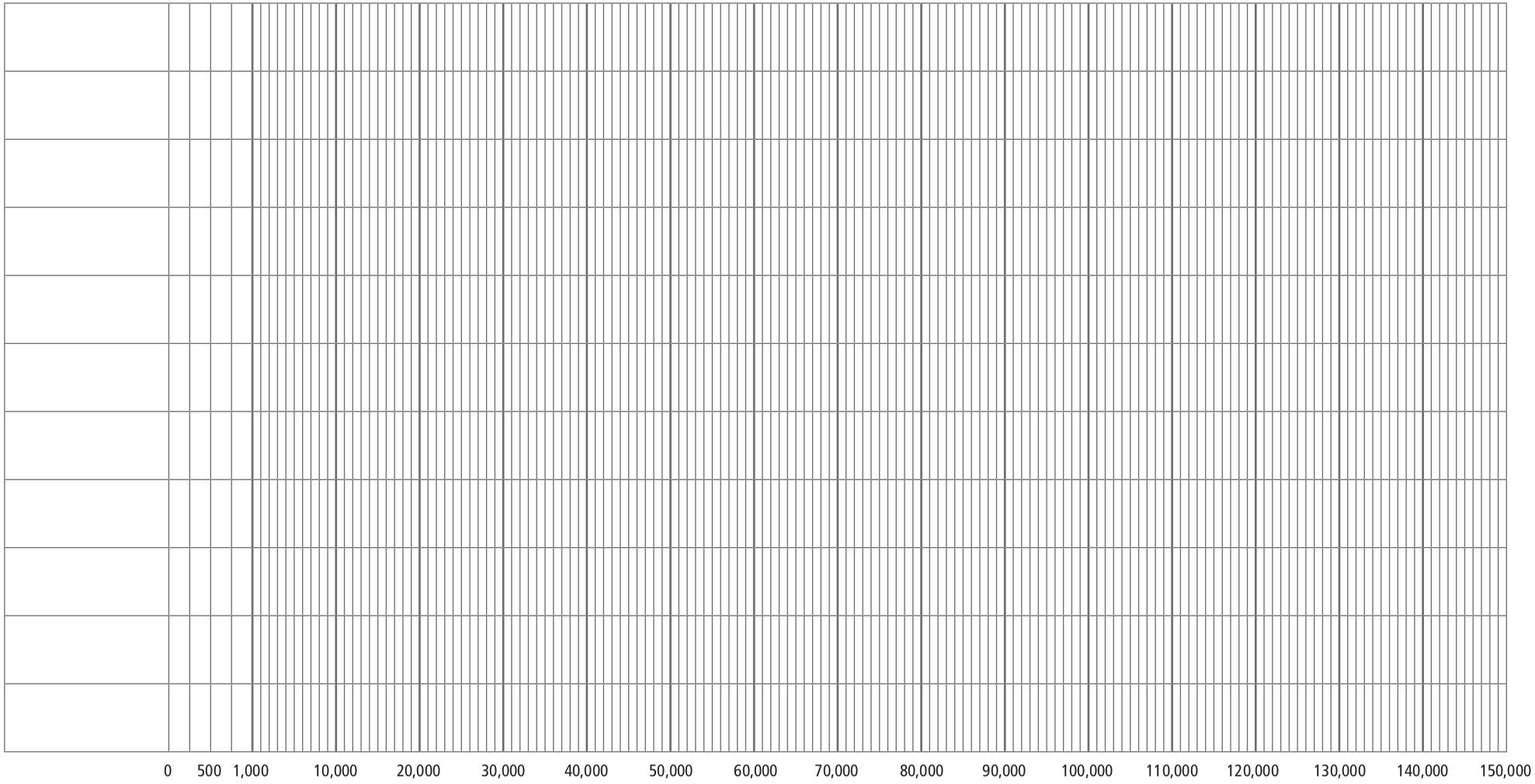
_____

5. Can chickens hear what you say?

_____

_____

_____



Student's Name _____ Date _____ Class _____

Student Sheet 11.1a: Analysis of Medical Imaging Technologies

	Benefit(s)	Potential Risk(s) to Patients	Cost to Patient (Per Scan)	Average Equipment Purchase Cost
X-ray			$100	$8,000
Computed Tomography (CT Scan)			$700	$25,000
Magnetic Resonance Imaging (MRI)			$800	$150,000
Positron Emitted Tomography (PET Scan)			$2,000	$100,000
Ultrasound			$200	$4,500

Student's Name _____ Date _____ Class _____

Student Sheet 11.1b: Diagnostic Protocol

Illness/Injury and Patient Information	Devices to Avoid	Reason to Avoid	Preferred Devices	Reason Preferred
Suspected lung tumor, adult, pregnant, no medical implants				
Suspected brain tumor, adult, no pregnancy, no medical implants				
Suspected broken rib, adult, no pregnancy, no medical implants				
Suspected growth in the abdomen, adult, no pregnancy, metal knee replacement				
Suspected osteoporosis (bone-weakening disease), elderly adult, unknown if patient has medical implants				
Suspected irregular kidney structure, infant				
Suspected heart disease, adult, no pregnancy, metal hip implant				
Suspected torn ligament, child				
Suspected broken arm, child				

Student's Name _____ Date _____ Class _____

Student Sheet A.1a: Equipment Planning

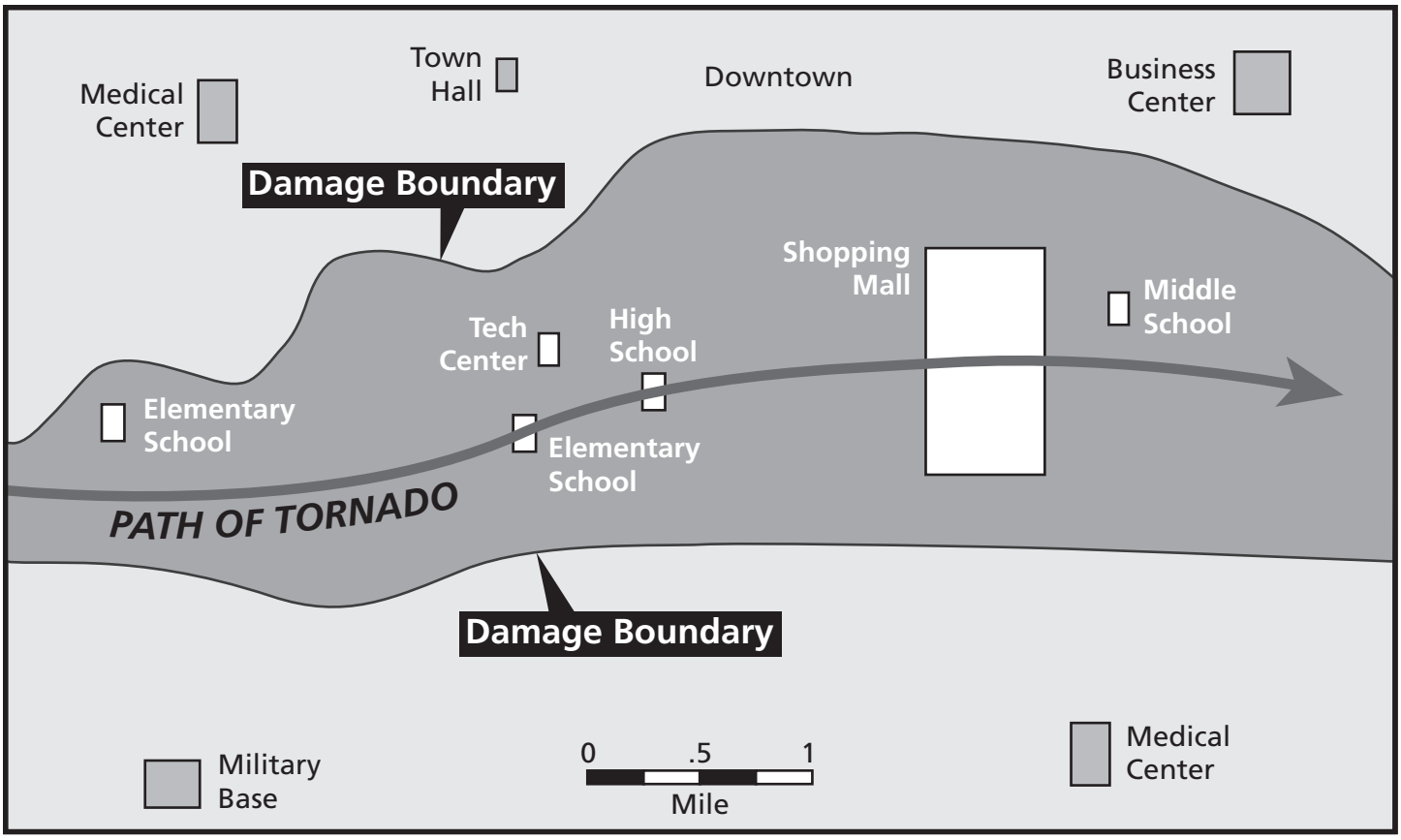
Directions: Use this student sheet to complete the Performance Assessment.

Table A. Available Equipment

Available Equipment	General Function of Equipment	Possible Use in Remote Medical System
Circuit systems kit (any kit components that you have used in this unit)		
Full-size halogen lightbulbs		
Clamp lamps		
Flashlights with batteries		
Extension cords (various sizes)		
Wet-cell car batteries with voltage converters		
GPS receiver (battery powered)		
Portable EKG		
Portable AED		
Portable ultrasound equipment with data transfer capabilities		
Portable X-ray machine with data transfer capabilities		
Satellite phone with email and data transfer capabilities		

Student's Name _____ Date _____ Class _____

Student Sheet A.1b: Map of Disaster Area



Student's Name _____ Date _____ Class _____

Student Sheet A.2a: Written Assessment Questions (page 1 of 2)

Multiple Choice

1. What happens in a simple circuit that includes a battery when the circuit is closed?

A. Electric charges flow through the empty space inside the hollow wires.

B. Electric charges flow through the metal core of the wires.

C. Electric charges build up in the battery and do not flow through the wires.

D. Electric charges are used up in the battery and do not flow through the wires.

2. What happens with energy in an electric motor when it is part of a closed circuit?

A. Energy is created by the motor as long as the motor is on.

B. Energy is used up in the motor until all the energy is gone.

C. Energy is transformed in the motor from kinetic energy to chemical energy.

D. Energy is transformed in the motor from electrical energy to kinetic energy.

3. Which of the following best describes an action potential in a neuron?

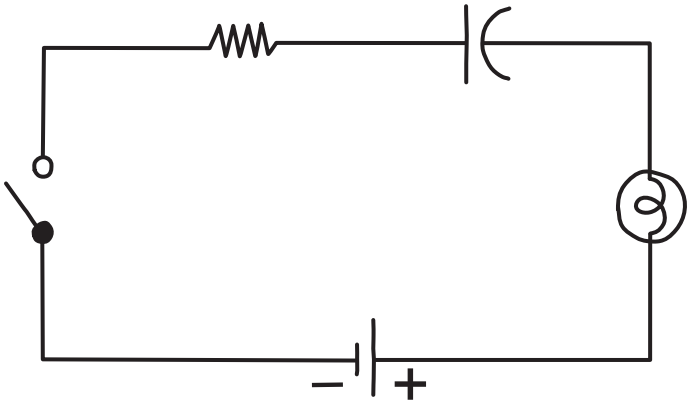
A. A constant current that flows through the axon

B. A rapid voltage change that travels along the axon

C. A transmission of light waves along the axon

D. A transformation of sound waves into light waves in the axon

4. Which of the following changes would you make to the circuit below if you were trying to minimize the transformation of electrical energy into thermal energy?



A. Remove the resistor

B. Remove the capacitor

C. Add another resistor

D. Add another capacitor

Student's Name _____ Date _____ Class _____

Student Sheet A.2a: Written Assessment Questions (page 2 of 2)

Constructed Response

5. Imagine you need to send multiple copies of data over a long distance and with high accuracy. Would it be better to use digital or analog data? Give two reasons for your answer.

6. Why is it useful for engineers designing complex systems to test several different design solutions or several different modifications to a solution? Respond in a short paragraph.

7. A wire that is part of a closed circuit is placed near a magnet. The table below shows the change in electromagnetic force when the amount of current flowing through the wire is changed.

Current (Amperes)	Force (Newtons)
0.20	0.001
0.25	0.00125
0.30	0.0015
0.35	0.00175
0.40	0.002

Design a graph to display the data in the table on the grid provided on your answer sheet. Then, in a few sentences, describe the relationship shown in the graph between current and electromagnetic force. Make sure that someone could understand the relationship by looking at the graph alone, or by reading the sentences alone.

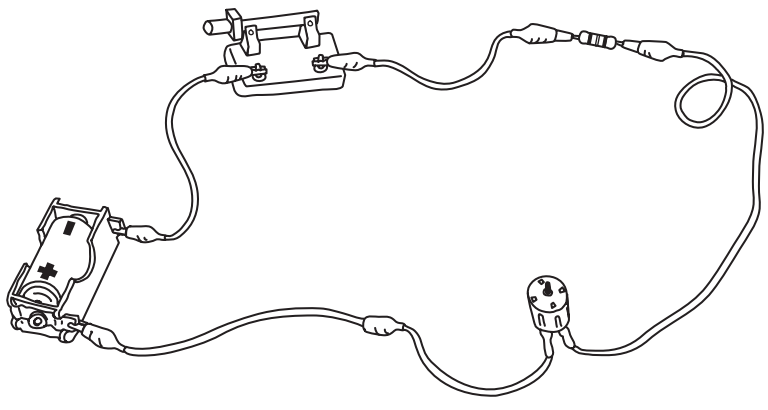
8. A student studying echolocation presents the following argument to the class: "Dolphins are better at echolocation than bats because sound waves travel faster through water, where dolphins live, than through air, where bats live." Write two questions you might ask this student to better determine whether or not the argument is likely to be correct.

9. Create four simple hand-drawn models of what happens to light waves in each of the interactions with matter listed below. For each interaction, assume that the light wave starts out traveling through the air. Label your model with the all the type(s) of matter and any boundaries or surfaces you have shown. In one or two sentences below each model, explain the representations you used and what they show.

a. Reflection **c.** Transmission

b. Refraction **d.** Absorption

10. In a short paragraph, describe any and all changes in energy that would happen in the circuit shown at right when the switch is closed.



Student's Name _____ Date _____ Class _____

Student Sheet A.2b: Written Assessment Answer Sheet (page 1 of 2)

Multiple Choice

Directions: Circle the letter of your answer choice.

1. A B C D

2. A B C D

3. A B C D

4. A B C D

Constructed Response

5. _____

_____

_____

_____

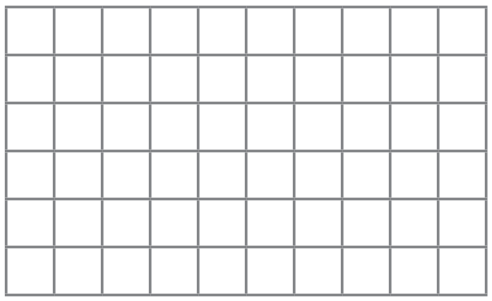
6. _____

_____

_____

_____

7.



_____

_____

_____

_____

_____

8.

1. _____

_____

2. _____

_____

Student's Name _____ Date _____ Class _____

Student Sheet A.2b: Written Assessment Answer Sheet (page 2 of 2)

9. a. Reflection:

_____

_____

_____

_____

b. Refraction:

_____

_____

_____

_____

c. Transmission:

_____

_____

_____

_____

d. Absorption:

_____

_____

_____

_____

10. _____

_____

_____

_____

_____