Identifying Conductors & Insulators
Teacher Facilitation Notes

In General . . .

- Project the slide deck in edit mode–do not show it as a slideshow.
- Hide the speaker notes before projecting. (View/Show Speaker Notes)
- Hide the toolbar. (Click on the up arrow at the right end of the tool bar.)
- Call on students to read the various content shown on slides.
- For each investigation, assemble the needed materials for each group and place in a central location for ease of distribution.
- Duplicate copies of the data sheets for each student.

Materials Needed Per Group:

<u>Engage–Defining Conductors and Insulators</u>

Chart paper
Marker

<u>Explore, Part 1–Electrical Conductors and Insulators</u>

Projection system
Computer with connection to Internet

<u>Explore, Part 2–Thermal Energy Conductors and Insulators</u>

Wooden spoon, 1
Plastic spoon, 1
Metal Spoon, 1
Baggie, 1
Chocolate chips, 4-6
Beakers (100-250 mL)
Tweezers, 1
Stopwatch, 1
Toothpicks, 4-5
Paper towels
Very warm water

<u>Elaborate: Designing a Thermal Insulator</u>

Card stock, 1 sheet
Tape, 1 meter
Small snack baggie
Iron nails
Newspaper
Cotton balls
Aluminum foil
Paper clips
Steel wool
Sand
Foam peanuts
Felt square, 1
Glue
Scissors
Snack baggie, 1

<u>Evaluation</u>

Markers

Other Materials

Student Recording Sheets
Pencils
Science Notebooks
Nets for Solid Geometric Shapes, 1 net per group
Triple Beam Balance
Conductor Graphic Organizer, 1 per student
Insulator Graphic Organizer, 1 per student

Identifying Conductors & Insulators
Teacher Facilitation Notes, p. 2

Engage: Defining Conductors and Insulators

- Lead students through a 3 -2 -1 Bridge* thinking routine:
  - Have students turn to a blank page in their science notebooks and write the title “Identifying Conductors and Insulators” at the top of the page.
  - Under this title, have them divide the page into 2 columns. Label the first column “Before Learning” and the second column “After Learning”.
  - Using the first column, instruct the students to write down 3 vocabulary terms or thoughts they have about the topic of conductors and insulators.
  - Next, they write down 2 questions they have about the topic.
  - Finally, they write 1 metaphor or simile about the topic. Give them a sentence starter such as, “I think conductors and insulators are like _____ because _____. Tell students that they will revisit this page after the lesson to compare what they knew with what they learned.
- Read through the information on the Engage slides and watch the video about conductors and insulators. Discuss as desired.

***NOTE:** This thinking activity comes from Project Zero, Harvard University Graduate School of Education.

Explore, Part 1: Electrical Conductors and Insulators

- Click on the illustration of the light bulb and follow the link to open the PHET simulation. Click on Intro to get started.*
- Build an open circuit using 1 battery, 1 bulb, and 3 wires. Ask the students if the bulb is lit. Call on volunteers to explain why the bulb doesn’t light up.
- Click the down arrow at the bottom of the navigation box to find the objects to test (starting with the dollar bill.)
- Drag the dollar bill to the open space in the circuit. Manipulate the wires as needed. Ask the student if the dollar bill completes the circuit and causes the bulb to glow. Why does the circuit stay open?
- Have them look at the first row in their data sheet table. The first line is done for them. Discuss how they will identify each object and how they will give evidence for their answers.
- Click on the dollar bill and then click on the yellow trash can that appears at the bottom of the page.

***NOTE**: If you are unfamiliar with using this simulation, take time to explore it prior to using it with the students.

Identifying Conductors & Insulators
Teacher Facilitation Notes, p. 3

Explore, Part 1: Electrical Conductors and Insulators, continued

- Click on the next object to test. Have students complete the table as you build the circuits. (When you have tested the dollar, paper clip, and coin, click the down arrow again for more objects to test.)**
- Ask what the objects that are conductors have in common. Ask what the objects that are insulators have in common. Guide students to the generalizations that metals are good conductors, while plastic, paper, organisms, and wood are good insulators. Ask students why they think electric wires are covered with plastic or rubber.
- Discuss as desired.

****NOTE:** The pencil completes the circuit because the "lead" is made of graphite, a metal that conducts electricity. Ask students what would happen if we tried to use the wood of the pencil instead of the lead.

Explore, Part 2: Thermal Energy Conductors and Insulators

- Remind students of appropriate science lab rules before beginning this investigation:
  - Do not eat anything without permission.
  - Tie back long hair.
  - No horseplay around chemicals or hot water.
- Depending on the students' ability levels, let the groups work through the investigation independently or go through it step by step with each group conducting their own investigation.
- Facilitate a class discussion using questions like the ones below:
  - What happened when the chocolate chips sat on the spoons for 2 minutes?
  - Why do you think this happened?
  - Which material (wood, plastic, or metal) is the best conductor of thermal energy? What evidence do you have to support this conclusion?
  - Which material (wood, plastic, or metal) is a good insulator of thermal energy? What evidence do you have to support this conclusion?
- Discuss as desired.

***NOTE**: Try to get spoons that are approximately the same size.

Identifying Conductors & Insulators
Teacher Facilitation Notes, p. 4

Explain: Talking about Conductors and Insulators

- Read through the introductory slides with the students. Discuss as desired.
- If desired, guide students through the following procedures to create folded graphic organizers to explain what they have learned.
  - Title a blank left-side page in your science notebook, *Conductors*. Title the opposite blank page, *Insulators.*
  - Cut out the two templates along the dotted lines. Fold on the solid lines.
  - Complete each tab as directed.
  - Glue or tape the back of the folded organizer on the prepared pages.
  - Below each organizer, have the students write a 1-2 sentence summary of what they learned about conductors and insulators.
- Discuss as desired.

Elaborate

- Prior to beginning this lesson, duplicate a copy of 1 geometric shape net for each group (some nets may be used more than one time).
- Read through the design brief with the students. Discuss as desired.
- Read and discuss the criteria and the constraints for this activity. Allow time for students to discuss the problem and possible solutions.
- Give each group a net for a solid geometric figure. If necessary, demonstrate how to cut out, fold, and tape or glue the nets to make a solid shape. Demonstrate finding the volume of the shape by using the formula on the handout. Assist student with assembly and calculations as needed.
- Let groups share the volume of their shapes with the whole class. Discuss which shape might hold the greatest amount of insulating materials and why that is important in their container.
- Have all of the materials in a central location for ease of distribution.
- Let them work in groups to complete the design challenge. Circulate among the groups as they work, asking questions and redirecting thinking as needed.
- Once all of the groups have completed their containers, let them test their ability to insulate against thermal energy.
- Create a class chart on the board or a piece of chart paper. On this chart, you will record the “Before” and “After” masses of the ice cubes in the containers.
- Give each group an ice cube in a snack baggie. Have them find the mass of the ice cube and the baggie and record it on the class chart.
- Either display the testing directions or give them orally to the groups.

Identifying Conductors & Insulators
Teacher Facilitation Notes, p. 5

Elaborate, continued

- Follow these directions to test the container:
  - Place the baggie with the ice cube in the container you made.
  - Place ONE insulating material around the ice cube in the container. Close your container and tape it shut.
  - Take the container outside. Return to the classroom and set a timer for 5-10 minutes.
  - After the time is up, get the container. Open it up and pour out any liquid water. Find the mass of the ice cube and the baggie now. Record the mass in your science notebook.
- Lead a Design Showcase for students to display and explain their projects. They should also tell what insulating material they used and how much the mass of their ice cube changed, if any. If applicable, point out the relationship between insulating materials and the changes in the masses of the ice cubes.
- Discuss as desired.

Evaluate

- Have students turn back to the page in their notebooks with the 3-2-1 chart that they created.
- In the second column, “After Learning”, have them follow the same procedure as before.
  - Write down 3 vocabulary terms or thoughts they have about the topic of conductors and insulators.
  - Write down 2 questions they still have about the topic.
  - Write 1 metaphor or simile about the topic using the same sentence starter as before.
- Guide students in making connections between their initial thinking and their thinking after completing the learning activities. Discuss why their thinking may have shifted based on their new knowledge.
- Let students complete the quiz independently.
- Discuss evaluation activities as desired.

Identifying Conductors & Insulators

Name: KEY

Evaluation

1. Circle the materials below that would make good conductors of electrical energy.

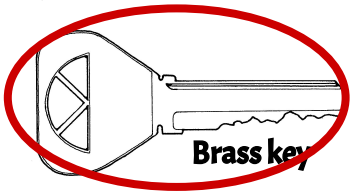

Paper clip

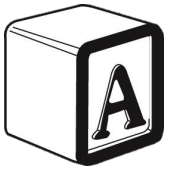
Glue stick


Glass test tube


Copper paper fastener


Metal binder clip


Brass key



Wooden block


Glass Marble

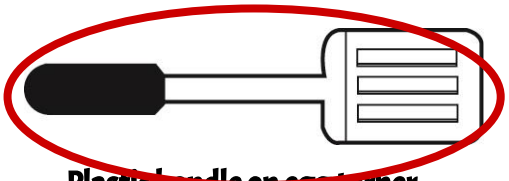
2. Circle the materials below that would make good insulators of thermal energy.

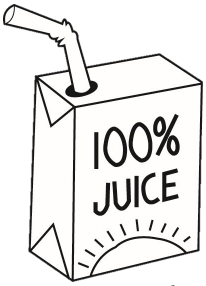

White cotton T-shirt


Metal tea strainer


Foam cup

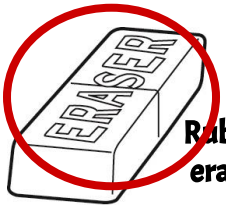
Copper penny


Plastic handle on egg turner



Paper juice box

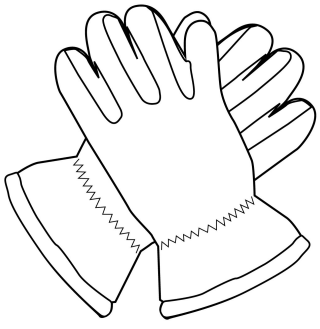

Iron skillet



Rubber eraser

3. People who work with electricity often wear gloves to protect themselves. Do you think they should wear gloves made of aluminum foil or rubber? Explain your thinking.

People who work with electricity should wear gloves made of rubber. Aluminum foil is a conductor of electrical energy. Rubber is an insulator against the flow of electrical energy.



Identifying Conductors & Insulators

Name: KEY

Evaluation, page 2

4. Match each vocabulary term to its correct definition.

__A__ Insulator __B__ Conductor

A. A material that allows thermal or electrical energy to flow through it easily	B. A material that slows or stops the flow of electricity or thermal energy

5. Why would a student going on a field trip wrap his cold water bottle in several layers of paper towels before putting it in his backpack? The paper will act like–

A an insulator to keep his water bottle from leaking

B a conductor to keep his water bottle cold

C an insulator to keep his water bottle cold

D a conductor to keep his water bottle full

6. Circle all the materials that would light the bulb if they were connected to the wires where the question mark is.

F Silver spoon

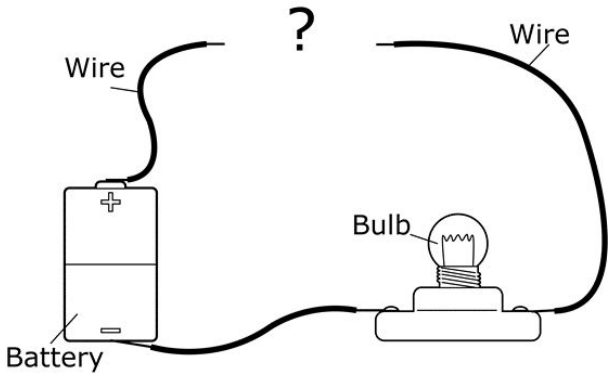
G Craft stick

H Piece of aluminum foil

J Rubber glove

K Copper penny

L Plastic block



7. Why is the frying pan pictured here made of iron and not plastic?

The frying pan is made of iron so that it can conduct thermal energy to cook food put in it. Plastic would not conduct thermal energy to the food.

Identifying Conductors & Insulators

Name: _____

Explore, Part 1: Electrical Conductors and Insulators

Question
What types of materials make good conductors or insulators of electricity?

My Hypothesis

Object	Insulator/ Conductor	Evidence
Dollar bill	Insulator	The light bulb is not lit.
Paper clip		
Coin		
Wire		
Eraser		
Pencil		
Hand		
Dog		

My Conclusions: What types of materials are better conductors of electricity? What types of materials do not conduct electricity well?

Identifying Conductors & Insulators

Name: _____

Explore, Part 2: Thermal Energy Conductors and Insulators

Question
What types of materials make good conductors or insulators of thermal energy?

My Hypothesis

Type of Spoon	Prediction (Conductor/Insulator)	Actual Results (Conductor/Insulator)
Plastic		
Wooden		
Metal		

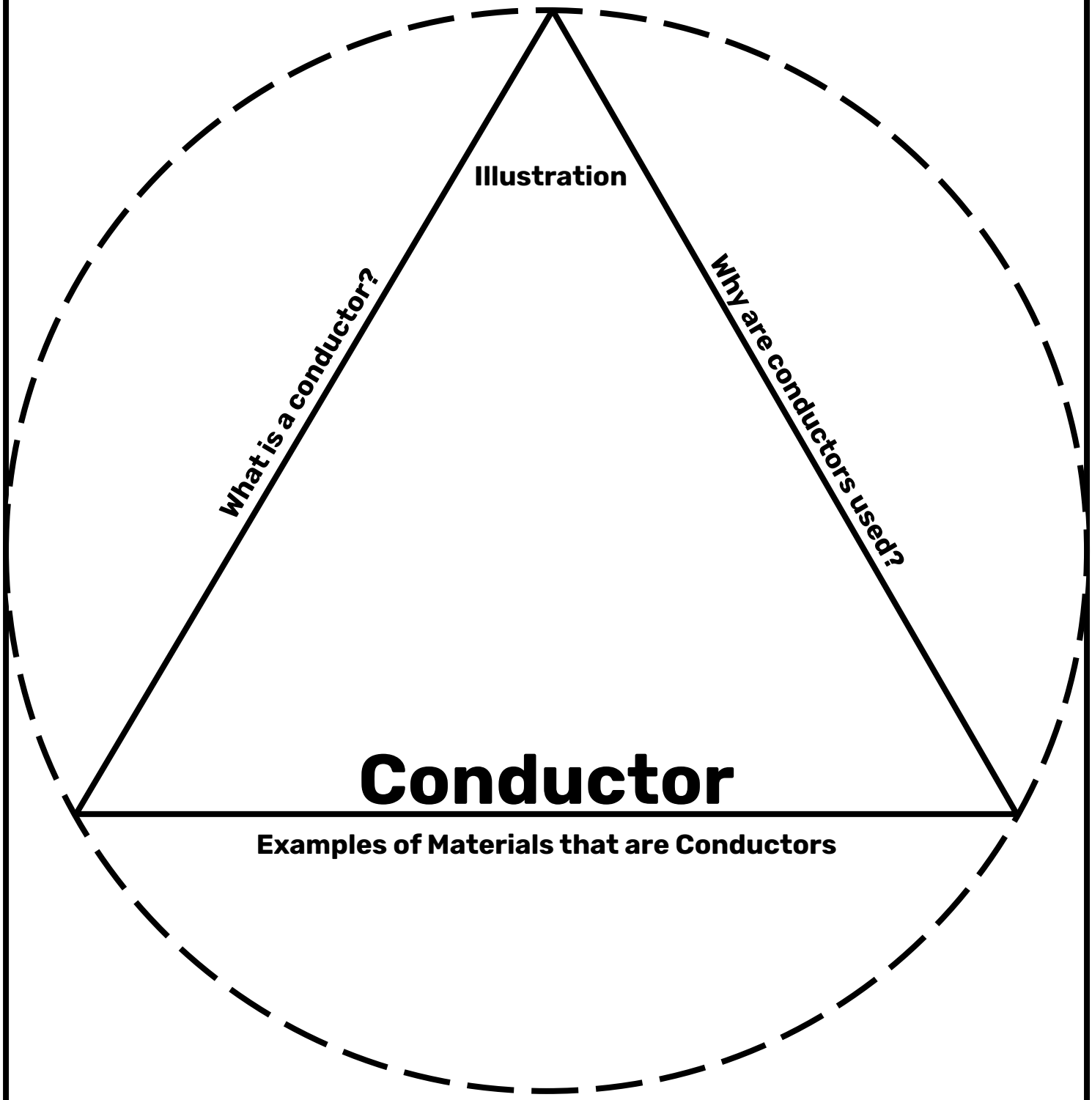
1. Is the chocolate chip hard or soft at the beginning of the investigation?

2. Did any of the chocolate chips change after sitting on the spoons for 2 minutes? How?

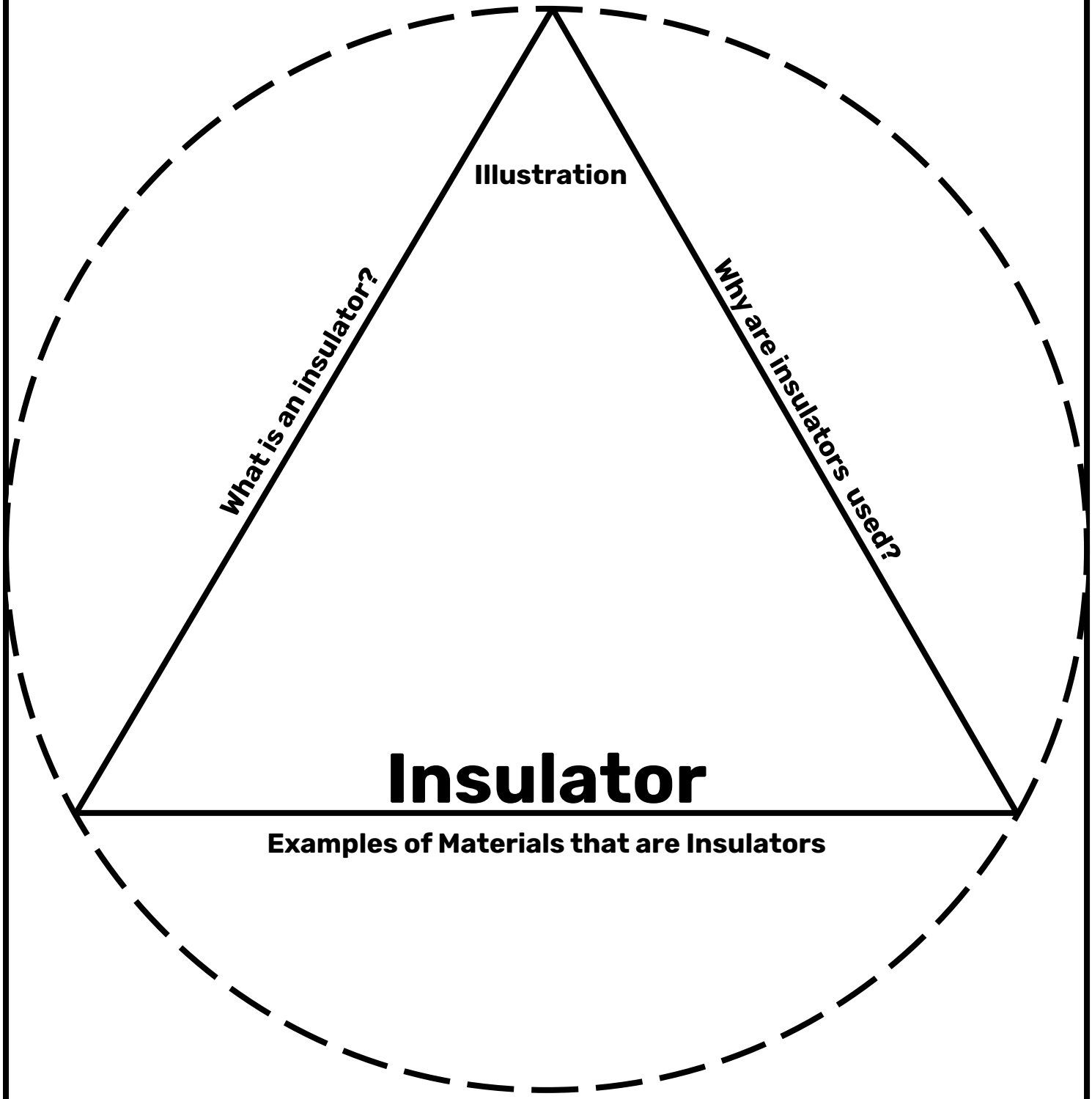
3. Which chip changed the most? Which chip changed the least? Why do you think this is true?

My Conclusions: Which materials make good conductors of thermal energy? Good insulators?

Identifying Conductors & Insulators
Conductor Folded Graphic Organizer Template



Identifying Conductors & Insulators
Insulator Folded Graphic Organizer Template



Identifying Conductors & Insulators

Name: _____

Elaboration: Designing a Thermal Insulator

Thermal Insulating Container

Design and construct a container to keep an ice cube from melting for the longest time possible.

Materials

(You may use these materials in constructing your container.)

Tape, 1 meter	Scissors	Glue
Card stock, 1 sheet	Small snack baggie	Ruler

(Circle up to 3 of these materials to use in insulating your container.)

Iron nails	Newspaper	Cotton balls
Aluminum foil	Paper clips	Steel wool
Sand	Foam peanuts	Felt square, 1

Exploring the Volume of Solid Shapes

Shape	Volume (cm^3)
Cube	
Triangular prism	
Rectangular prism	
Square pyramid	

Which container had the greatest volume?

Which container had the least volume?

Identifying Conductors & Insulators

Name: _____

Elaboration: Designing a Thermal Insulator

Design

1. What shape container will your group construct? Why did you choose that shape?

2. Draw a sketch of what your container will look like.

3. What packing materials will you use in your container?

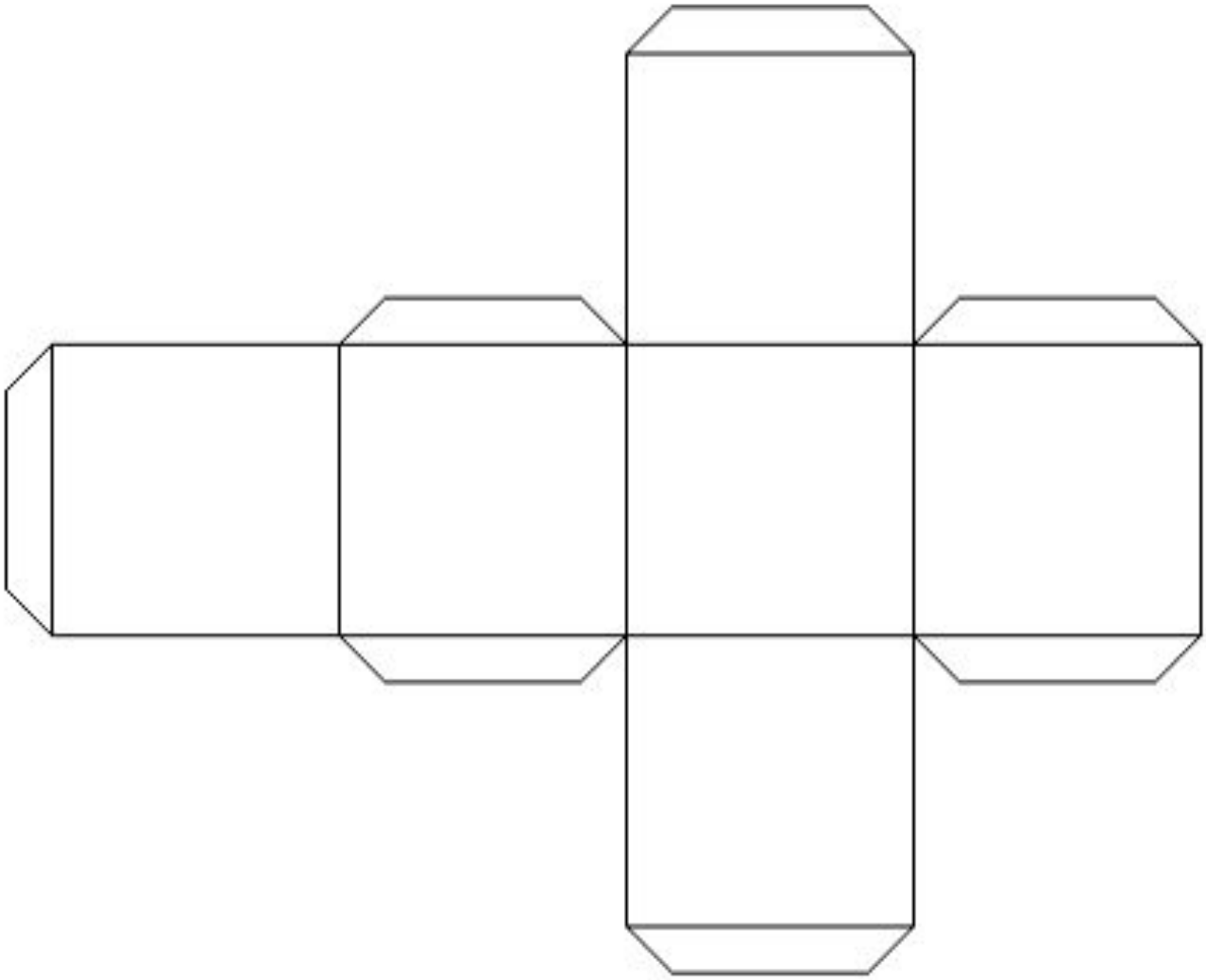
4. Can you use an unlimited amount of packing material? Why or why not?

5. How long was your ice cube in the container outside?

6. How much water (melted ice) did you pour out of the baggie?

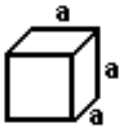
7. Was your thermal insulator successful? Explain your answer using evidence from your investigation.

Identifying Conductors & Insulators
Net for a Cube



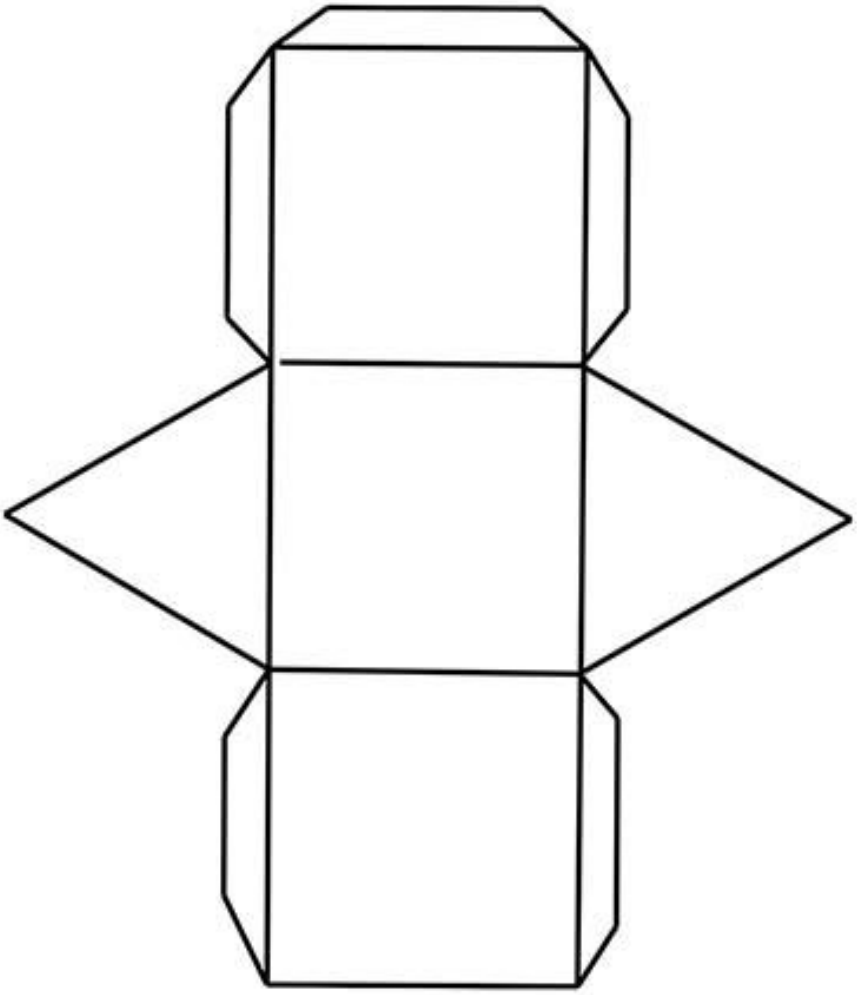
Formula for Finding the Volume of a Cube

L x W x H = volume

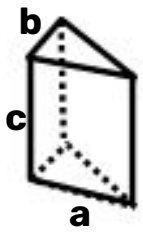


(Length x Width x Height = volume^3)

Identifying Conductors & Insulators
Net for a Triangular Prism



Formula for Finding the Volume of a Triangular Prism

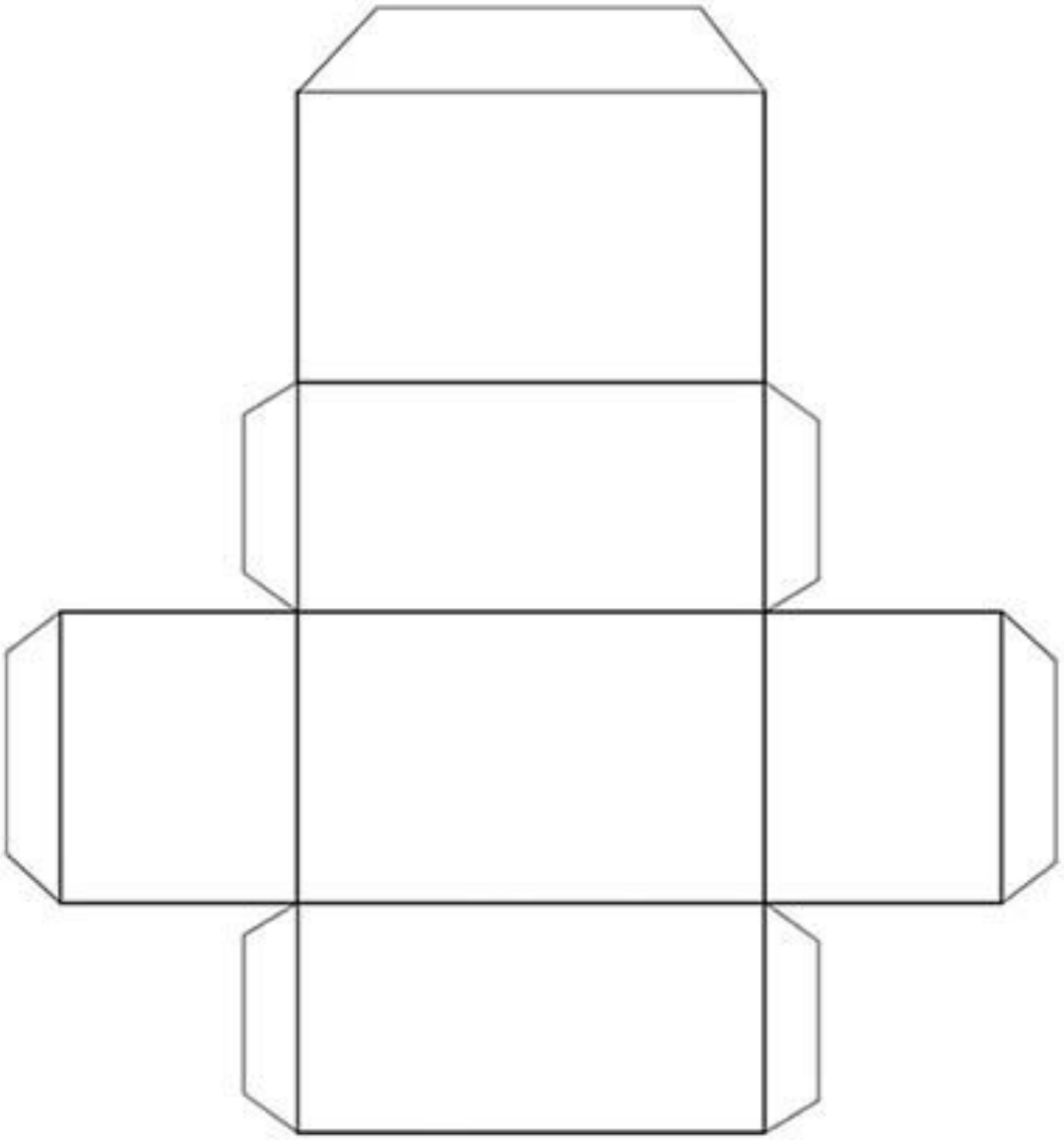


½ x (L x W x H) = volume

½ x (Length x Width x Height) = volume^3

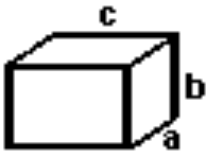
1. **Multiply the length x width x the height.**
2. **Divide product by 2.**

Identifying Conductors & Insulators
Net for a Rectangular Prism



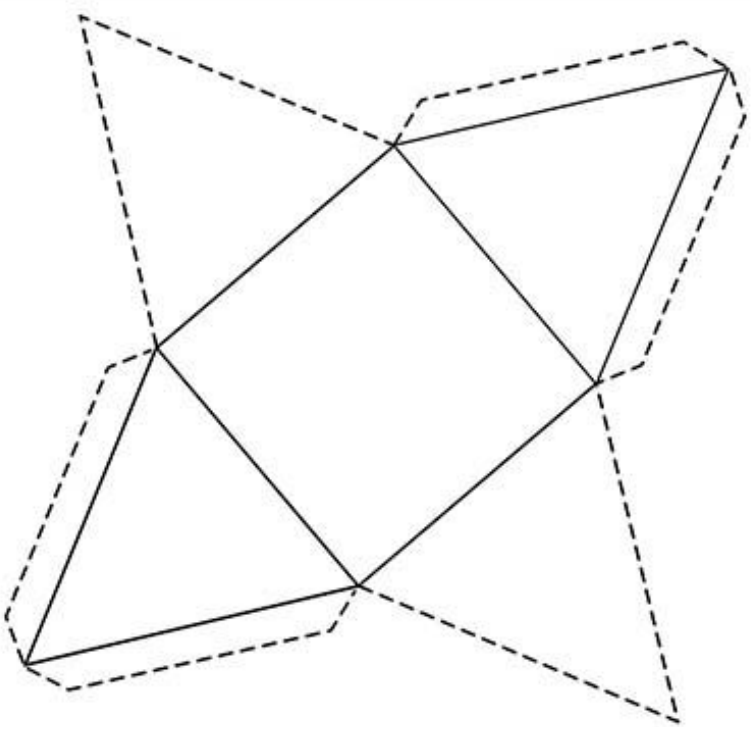
Formula for Finding the Volume of a Rectangular Prism

L x W x H = volume



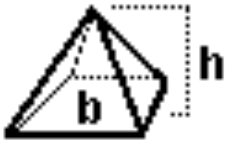
(Length x Width x Height = volume^3)

Identifying Conductors & Insulators
Net for a Square Pyramid



Formula for Finding the Volume of a Square Pyramid

⅓ (b x b x H = volume



⅓ x (Base x Base x Height = volume^3)

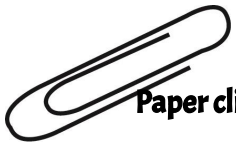
1. **Multiply base x base x height.**
2. **Divide product by 3.**

Identifying Conductors & Insulators

Name: _____

Evaluation

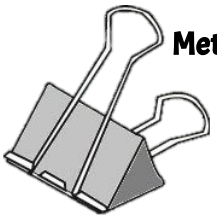
1. Circle the materials below that would make good conductors of electrical energy.

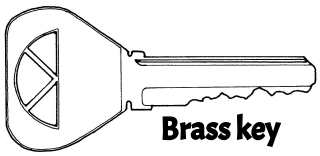

Paper clip

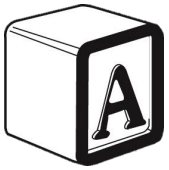
Glue stick


Glass test tube


Copper paper fastener


Metal binder clip

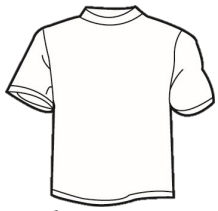

Brass key



Wooden block


Glass Marble

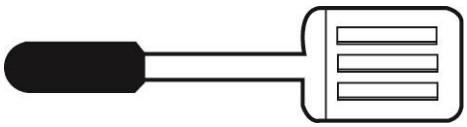
2. Circle the materials below that would make good insulators of thermal energy.

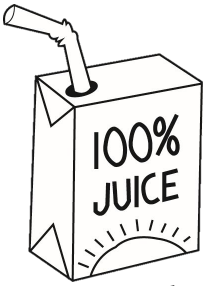

White cotton T-shirt


Metal tea strainer


Foam cup

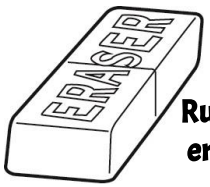
Copper penny


Plastic handle on egg turner



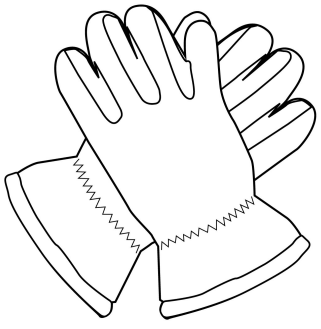
Paper juice box


Iron skillet



Rubber eraser

3. People who work with electricity often wear gloves to protect themselves. Do you think they should wear gloves made of aluminum foil or rubber? Explain your thinking.



Identifying Conductors & Insulators

Name: _____

Evaluation, page 2

4. Match each vocabulary term to its correct definition.

_____ **Insulator** _____ **Conductor**

A. A material that allows thermal or electrical energy to flow through it easily	B. A material that slows or stops the flow of electricity or thermal energy

5. Why would a student going on a field trip wrap his cold water bottle in several layers of paper towels before putting it in his backpack? The paper will act like–

A an insulator to keep his water bottle from leaking

B a conductor to keep his water bottle cold

C an insulator to keep his water bottle cold

D a conductor to keep his water bottle full

6. Circle all the materials that would light the bulb if they were connected to the wires where the question mark is.

F Silver spoon

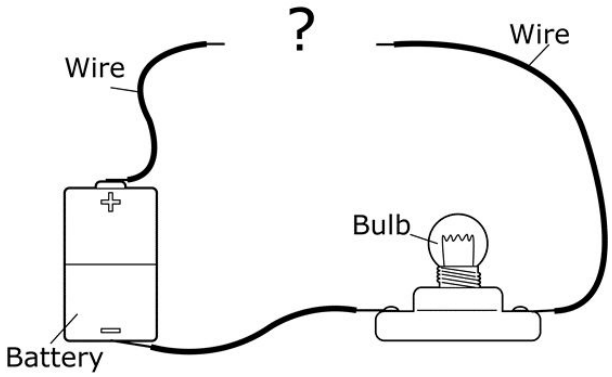
G Craft stick

H Piece of aluminum foil

J Rubber glove

K Copper penny

L Plastic block



7. Why is the frying pan pictured here made of iron and not plastic?