

Answer Key

The answers provided below are examples. While individual responses may differ depending on the specific activities the student chooses, these examples serve as a guide to help both teachers and students understand the general objectives of the tasks.

Volume

Card 1:

The value of 1L in mL:

1 liter (L) is equal to 1000 milliliters (mL).

If 150 mL are poured out from a 1L bottle, how much is left in the bottle?

Since 1 liter is equal to 1000 mL, and 150 mL are poured out, the amount left in the bottle is:

$$1000 \text{ mL} - 150 \text{ mL} = \mathbf{850 \text{ mL}}.$$

If a glass holds 200 mL, how many glasses can be filled from the 1L bottle?

If the bottle holds 1000 mL, and each glass holds 200 mL:

$$1000 \text{ mL} \div 200 \text{ mL} = \mathbf{5 \text{ glasses}}$$
 can be filled from the 1L bottle.

Which would you use to measure the water in a bathtub, milliliters or liters?

You would use **liters** to measure the water in a bathtub, as bathtubs hold a large amount of water and liters are a more practical unit for large volumes.

Card 2:

1. Understanding the Meniscus:

- When using a graduated cylinder, students should recognize that the meniscus forms due to the interaction between the liquid and the surface of the cylinder. If the liquid forms a concave meniscus (as water does), the correct measurement is taken from the bottom of the meniscus. If the meniscus is convex (which is less common, often seen with liquids like mercury), the measurement is taken from the top.
- The teacher should ensure that students grasp this concept and can apply it when measuring the volumes.

2. Accurate Volume Measurement:

- Students should practice filling a graduated cylinder to the specific levels listed and then correctly record the readings based on the position of the meniscus.

Expected answers for the task:

- Fill the cylinder to **20 mL**: The reading should show exactly 20 mL at the bottom of the concave meniscus.
- Fill the cylinder to **35 mL**: The reading should show 35 mL at the bottom of the concave meniscus.
- Fill the cylinder to **42 mL**: The reading should show 42 mL at the bottom of the concave meniscus.

- Fill the cylinder to **17 mL**: The reading should show 17 mL at the bottom of the concave meniscus.

The goal of the activity is for students to demonstrate precision in reading liquid volumes, taking care to note the meniscus correctly and filling the graduated cylinder to the required levels accurately.

Card 3:

The relationship between milliliters (mL) and cubic centimeters (cm³) is **1 mL = 1 cm³**. Therefore, the volume measured in milliliters can be directly converted to cubic centimeters.

Steps for the Task:

1. **Initial Water Measurement (V1):**
Fill the graduated cylinder with water and record the initial volume (V1).
2. **Second Water Measurement (V2):**
Carefully submerge the object in the water without spilling any, and then record the new water level (V2).
3. **Volume Calculation:**
The volume of the object is the difference between the second and first measurements:
Object's Volume = $V2 - V1$
4. **Record the Volume in cm³:**
Since 1 mL = 1 cm³, the calculated volume in milliliters can be written as cubic centimeters (cm³).

Example Table Format for Student's Science Notebook:

Object	1st Measurement (V1)	2nd Measurement (V2)	V2 - V1	Object's Volume in cm ³
Quarter	(record V1 here)	(record V2 here)	V2 - V1	(result in cm ³)
Nail	(record V1 here)	(record V2 here)	V2 - V1	(result in cm ³)
Spoon	(record V1 here)	(record V2 here)	V2 - V1	(result in cm ³)
Eraser	(record V1 here)	(record V2 here)	V2 - V1	(result in cm ³)
Bolt	(record V1 here)	(record V2 here)	V2 - V1	(result in cm ³)

Expected Accomplishments:

- Students will measure the initial volume of water (V1) in milliliters.
- After placing each object into the water, they will record the new water level (V2).
- Students will calculate the difference between V2 and V1 to determine the object's volume in cubic centimeters (cm³).

This activity demonstrates the principle of water displacement, allowing students to understand how to measure the volume of irregular objects in a practical and hands-on way. The teacher should expect students to display accuracy in their measurements and calculations.

Card 4:

Step-by-Step Procedure:

1. **Cut and Assemble the Cylinders:**

Students will cut out two paper cylinder patterns and use tape to form them into cylinder shapes. The key difference between these two cylinders could be their height or width.

2. **Measure Volume Using Rice:**

- **Fill the First Cylinder:** Pour rice into the first cylinder and then transfer the rice into the 50 mL beaker to measure the volume of the rice.
- **Record the Measurement:** Students should carefully note the amount of rice in milliliters (which is equivalent to cubic centimeters, cm^3).

3. **Repeat the Procedure with the Second Cylinder:**

- Repeat the steps with the second cylinder, filling it with rice and measuring the volume using the beaker.

Observations:

Expected Answer for the Observation:

- **Size of Cylinders vs. Volume:**

Students will likely notice that although the two cylinders may differ in height or width, the volume of rice each cylinder holds could be the same (assuming they were cut from the same pattern or designed to have the same surface area). This is an important observation about how shapes can differ in their dimensions but still enclose the same volume.

How to Create a Third Cylinder:

- **Guiding Question for Students:**

If you want to make a third cylinder that holds the same volume, what factors must remain the same?

- **Expected Answer for How to Make the Third Cylinder:**

To make a third cylinder that holds the same volume as the first two, students need to ensure that the overall surface area of the paper used for the third cylinder is the same as the other two. They can experiment by adjusting the height and width in inverse proportion: increasing the height while reducing the width, or vice versa, so that the overall enclosed volume remains constant.

Teacher's Goal:

- **Understanding Volume vs. Shape:**

The key lesson is that different shapes (cylinders with different dimensions) can hold the same volume. Students should understand that the height and width can vary, but as long as the overall surface area remains the same, the volume enclosed by the cylinder will also stay the same.

- **Experimentation:**

Encourage students to try making a third cylinder that also holds the same amount of rice, using their observations from the first two cylinders to guide their design. This will reinforce the concept of volume and spatial reasoning.

Mass/ Weight

Card 1:

- 1. The mass of a 3-year-old child**
 - **Unit:** Kilograms (kg)
 - **Estimate:** A 3-year-old child typically weighs around 12–15 kilograms (kg).
 - **Work:** The mass of a child is generally measured in kilograms since it exceeds 1000 grams.
- 2. The mass of a letter**
 - **Unit:** Grams (g)
 - **Estimate:** A letter (without a package) weighs approximately 10–20 grams.
 - **Work:** Since a letter's mass is relatively small, grams is the appropriate unit.
- 3. The mass of a pencil**
 - **Unit:** Grams (g)
 - **Estimate:** A typical pencil weighs around 5–10 grams.
 - **Work:** Small items like a pencil are measured in grams due to their light weight.
- 4. The mass of a sheet of paper**
 - **Unit:** Grams (g)
 - **Estimate:** A single sheet of A4 paper weighs about 4–5 grams.
 - **Work:** Since paper is very light, grams is the appropriate unit.
- 5. The weight of a large rock on the moon**
 - **Unit:** Kilograms (kg) (Note: This question refers to mass, but mentions "weight" on the moon. Weight is different depending on gravitational pull, but the mass remains constant.)
 - **Estimate:** If a large rock on Earth has a mass of around 100 kilograms, the mass would remain the same on the moon.
 - **Work:** Mass does not change with location, so kilograms is used for measuring large objects.
- 6. The mass of a computer**
 - **Unit:** Kilograms (kg)
 - **Estimate:** A desktop computer or laptop weighs about 1.5–5 kilograms, depending on the model.
 - **Work:** Computers are relatively heavy, so kilograms is the appropriate unit.
- 7. The mass of an insect**
 - **Unit:** Grams (g)
 - **Estimate:** A small insect, such as an ant, might weigh around 0.1–0.2 grams. Larger insects, like beetles, could weigh more, around 1–2 grams.
 - **Work:** Insects are small and light, so their mass is measured in grams.

Final Summary for Teacher:

Students should use **kilograms** for larger or heavier objects (like a child, rock, or computer) and **grams** for smaller or lighter objects (like a letter, pencil, paper, or insect). These reasonable estimates help develop their understanding of appropriate units of measurement for mass.

Card 2:

Answers will vary.

1. **Targeted Mass:** Each row indicates a specific mass (in grams) that you will try to find an item for.
2. **Item Column:** Find objects in the classroom that you estimate to be close to the targeted mass. Write down the name of each object in this column.
3. **Actual Mass Measurement:** Use a scale to measure the actual mass of the item. Record the mass twice for each item to see if there is any variation.
4. **Discussion with the Teacher:** After completing the measurements, compare the estimated item mass with the actual mass. Discuss whether the measurements were consistent between the two trials and if the selected items were close to the targeted mass.

This activity helps to improve your estimation skills and provides practice in using a scale to measure mass accurately.

Card 3:

Procedure Steps and Explanation:

1. **Prepare the Cacti:**
 - Cut out two sponge cacti (make sure they are the same size) and place one in each cup.
2. **Soak the Cacti:**
 - Pour **60 mL of water** into each cup with the sponge cactus. Allow them to sit for an hour so the sponges absorb the water.
3. **Weigh the Cacti:**
 - After an hour, carefully remove each sponge cactus and weigh them using the scale. Record the weight of each cactus in your science notebook.
4. **Cover One Cactus with Waxed Paper:**
 - Place both sponge cacti on a tray, and cover **one** of them with waxed paper to simulate the waxy coating found on many desert plants.
5. **Track the Weight Loss:**
 - Leave both sponge cacti for several days. Weigh both sponges at the same time each day and record their weight daily. This will allow you to track how much water each cactus loses over time.

Observation and Expected Results:

- **Did One Cactus Dry Faster Than the Other?**

The cactus that was **not covered with waxed paper** should dry faster. This is because the waxed paper prevents water loss by reducing evaporation, much like the waxy coating on desert plants helps them retain water.

Conclusion:

- **Adaptation of Desert Plants:**

Many desert plants have a **waxy coating** on their leaves or stems to minimize water loss in arid environments. The experiment demonstrates that the cactus covered with waxed paper (simulating this coating) loses water more slowly than the uncovered cactus. This

adaptation is crucial for desert plants, allowing them to conserve water in hot, dry conditions where water is scarce.

Students should conclude that the waxy coating helps reduce evaporation and water loss, which is vital for plant survival in desert climates. This reinforces the idea of how plants have adapted to their environment to conserve resources like water.

Card 4:

Equipment Needed:

1. **Graduated Cylinder:** To accurately measure 100 mL of water.
2. **Scale (Digital or Mechanical):** To measure the mass of the water.
3. **Beaker or Container:** To hold the water while measuring its mass.
4. **Tare Function (if available on the scale):** To remove the weight of the container from the measurement.

Step-by-Step Process:

1. **Measure the Water:**
 - Using a **graduated cylinder**, measure **100 mL** of water. Pour the water slowly to ensure you reach exactly 100 mL by reading the measurement at the bottom of the meniscus (the curve of the water in the cylinder).
2. **Prepare the Scale:**
 - Place the **empty beaker or container** on the scale.
 - **Tare the scale:** This function will set the scale to zero with the container on it, ensuring that only the mass of the water is measured (excluding the mass of the container).

Note: If your scale does not have a tare function, you will need to weigh the empty beaker first and record its mass. Later, you can subtract the mass of the beaker from the total weight to find the mass of the water.

3. **Measure the Mass of the Water:**
 - Pour the **100 mL of water** from the graduated cylinder into the beaker.
 - Record the mass shown on the scale. If the scale was tared, this number represents the mass of the water. If not, subtract the mass of the beaker from the total reading to get the mass of the water alone.
4. **Confirm the Relationship:**
 - Since **1 mL of water weighs approximately 1 gram** (under standard conditions), the expected mass of 100 mL of water should be **around 100 grams**. Compare your results with this known relationship.

After the Experiment:

1. **Was Your Process Complete?**
 - Review the steps you followed. Did you accurately measure both the volume of water and the mass? Did you account for the mass of the beaker or container?
2. **Would You Do Anything Differently?**

- Consider whether any adjustments would improve the accuracy of your measurements, such as using a more precise scale or ensuring the water measurement in the graduated cylinder was exact.

Conclusion:

- This process should give you the approximate mass of 100 mL of water, which should be close to **100 grams**. The experiment demonstrates the relationship between volume and mass for water (1 mL = 1 gram).

Temperature

Card 1:

Step 1: Record the Initial Temperature

For each thermometer (A, B, C, etc.), you will record the temperature shown. Let's assume the following temperatures are displayed:

- **Thermometer A:** 50°C
- **Thermometer B:** 40°C
- **Thermometer C:** 30°C

Step 2: Add 10°C to the Original Temperature

Now, for each thermometer, you need to calculate what the temperature would be if 10°C were added:

- **Thermometer A:**
Original = 50°C
New Temperature = 50°C + 10°C = **60°C**
- **Thermometer B:**
Original = 40°C
New Temperature = 40°C + 10°C = **50°C**
- **Thermometer C:**
Original = 30°C
New Temperature = 30°C + 10°C = **40°C**

Step 3: Subtract 5°C from the Original Temperature

Next, calculate the temperature if 5°C were subtracted from the original temperature:

- **Thermometer A:**
Original = 50°C
New Temperature = 50°C - 5°C = **45°C**
- **Thermometer B:**
Original = 40°C
New Temperature = 40°C - 5°C = **35°C**
- **Thermometer C:**
Original = 30°C
New Temperature = 30°C - 5°C = **25°C**

Step 4: Perform the Procedure

1. Heat Transfer Experiment:

- Place each object (stones, glass marbles, metal washers, pennies) inside a netting square and secure it with string.
- Submerge these items in the large container of **hot water** for 10 minutes.
- After 10 minutes, measure the temperature of the **hot water** using a thermometer and record this temperature.

2. Room Temperature Water:

- Fill 4 jars halfway with **room temperature water** and measure the starting temperature of each jar.
- Place each bagged item (stones, glass marbles, etc.) in its own jar and allow it to sit.

- Record the maximum temperature reached by the water in each jar after placing the heated objects.

Observations on Heat Transfer:

- **Heat Transfer Statement:** Based on this experiment, students will observe that **heat is transferred from the warmer object to the cooler water**. The hot objects (heated in the container of hot water) will transfer their heat to the room temperature water in the jars, causing the water's temperature to rise.
 - Objects with greater mass or higher specific heat capacity (such as metal washers) might cause a greater increase in water temperature, showing that different materials transfer heat at different rates.
 - Items with lower specific heat capacity, such as glass marbles, may result in less temperature change in the water.

Conclusion:

This activity demonstrates the principle of heat transfer: when two objects at different temperatures come into contact, heat flows from the warmer object to the cooler one until thermal equilibrium is reached.

Card 2:

Procedure and Explanation:

Materials:

- **Beaker:** To hold the ice cubes and salt.
- **6 Ice Cubes:** Starting point of the experiment.
- **25 mL Salt:** Salt will be used to lower the freezing point of the ice.
- **Thermometer:** To measure the temperature of the ice mixture.
- **Graph Paper:** To plot the temperature over time.
- **Clock with a Second Hand:** To track the time accurately.

Step-by-Step Process:

1. **Initial Setup:**
 - Place the **6 ice cubes** into the beaker.
 - Insert the **thermometer** into the beaker so that it touches the ice cubes.
 - Record the **initial temperature** of the ice and the **starting time** (in seconds). Plot this on your graph as your starting point (Time = 0 seconds, Temperature = initial temperature).
2. **Adding Salt:**
 - Pour **25 mL of salt** evenly over the ice cubes.
 - Record the temperature every **15 seconds** for the next **4 minutes** (240 seconds). Each temperature measurement should be recorded on your graph paper, with time on the x-axis and temperature on the y-axis.
3. **Plot the Graph:**
 - After 4 minutes of recording, **plot the points** (Time vs. Temperature) on your graph.

- The graph should show a general trend of **temperature decreasing** over time as the salt melts the ice by lowering its freezing point (due to freezing point depression).

Observation and Predictions:

1. **Prediction for the Next Minute:**

After observing the temperature change over 4 minutes, the temperature will likely continue to drop in the next minute, but the rate of decrease might slow down as the ice continues to melt and reaches a more stable equilibrium with the surrounding salt-water mixture. You can predict the temperature by observing the trend on the graph (e.g., a decreasing curve).

Prediction: The temperature will continue to decrease, but at a slower rate.

2. **What Happens if You Add 30 mL of Salt?**

Adding **more salt** (an additional 30 mL) would likely result in a further decrease in temperature, as the freezing point of the ice-water mixture is lowered even more. The additional salt provides more ions to disrupt the ice's freezing process, leading to more ice melting and potentially a further drop in temperature.

Hypothesis: If you add 30 mL of salt, the temperature will drop even further, possibly reaching temperatures well below the freezing point of pure water, depending on how much ice is left to melt.

Testing Your Hypothesis:

After making your predictions:

1. **Add 30 mL more salt** to the beaker.
2. Continue recording the temperature every 15 seconds for another 4 minutes, and plot the new temperature data on your graph.
3. Compare the new temperature data to your earlier results and observe whether your hypothesis was correct.

Conclusion:

Through this experiment, students will observe the effects of **freezing point depression**. Salt lowers the freezing point of water, causing the ice to melt and the temperature to drop as heat energy is absorbed in the melting process. The more salt added, the lower the freezing point, and the more the temperature can decrease until the system reaches a new equilibrium.

Card 3:

Procedure and Guidance for the Teacher:

Materials:

- **2 Celsius Thermometers:** To compare temperature readings.
- **Piece of Cloth:** To cover one thermometer's bulb when soaked in water.
- **Water:** Used to soak the cloth.
- **Science Notebook:** To record observations and temperature readings.

Step-by-Step Process:

1. **Set Up the Thermometers:**
 - Place two thermometers side by side in the same location.
 - Soak a **piece of cloth** in water and use it to cover the bulb of one of the thermometers. The other thermometer will be left uncovered.
2. **Initial Temperature Reading:**
 - Record the **initial temperatures** of both thermometers (the one with the wet cloth and the one without) in your **science notebook**. This represents the room temperature in the classroom.
3. **Place Thermometers in the Sun:**
 - Move both thermometers to a **sunny area** (such as a windowsill) and leave them there for **5 minutes**.
 - After 5 minutes, record the temperatures of both thermometers in your notebook.
4. **Place Thermometers in a Dark Closet:**
 - Next, move both thermometers to a **dark closet** and leave them there for another **5 minutes**.
 - After 5 minutes, record the temperatures of both thermometers again in your notebook.

Observation:

1. **What Did You Notice About the Temperatures?**
 - In the **sunny area**, the thermometer with the wet cloth will likely show a lower temperature compared to the uncovered thermometer. This is because the water in the cloth evaporates, causing the thermometer to cool down. Evaporation is an endothermic process (it absorbs heat), so the wet thermometer will cool down more than the dry one.
 - In the **dark closet**, both thermometers may have similar readings, as there is no sunlight to influence temperature, and the evaporation rate will be slower.
2. **What Does the Wet Cloth Represent?**
 - The **wet cloth** simulates **evaporative cooling**, much like how sweat cools the human body. When water evaporates, it absorbs heat from its surroundings, resulting in a cooling effect. This is why the thermometer with the wet cloth shows a lower temperature in the sunny environment.

Conclusion:

- The experiment demonstrates how **evaporation** can lead to cooling by absorbing heat from the surroundings. The wet cloth on the thermometer acts like an evaporative cooling system, similar to how sweat cools the body. In the sunny area, the thermometer with the wet cloth shows a lower temperature due to the heat absorbed during the evaporation process, while the uncovered thermometer shows a higher temperature as it heats up in direct sunlight.

Card 4:

Procedure Explanation and Expected Results:

Materials:

- **50 g of stones, glass marbles, metal washers, pennies:** Four different materials to be heated and tested.
 - **String and Cloth Netting:** Used to create small bags to hold each item.
 - **Water:** For both the hot water bath and the room temperature water in the jars.
 - **4 Jars:** To hold the room temperature water and the heated items.
 - **4 Thermometers:** To measure the temperature changes.
 - **Large Container:** For heating the items in hot water.
-

Step-by-Step Procedure:

1. **Prepare and Heat the Items:**
 - Place **each item** (stones, glass marbles, metal washers, and pennies) in a separate **cloth netting square** and secure it with string, leaving enough string to act as a handle.
 - Submerge the bagged items in a **large container of hot water** for **10 minutes**. Make sure the string handles remain out of the water.
 - After 10 minutes, measure and record the **temperature of the hot water**.
 2. **Prepare the Jars with Room Temperature Water:**
 - Fill each jar **halfway with room temperature water** and measure the initial temperature of the water in each jar. Record these measurements.
 3. **Transfer Heated Items to Jars:**
 - After removing the items from the hot water, place each bagged item into a separate jar of room temperature water.
 - Allow the items to sit in the jars for several minutes and record the **maximum temperature reached** by the water in each jar.
-

Observation:

After completing the procedure, students should observe the following:

- **Heat Transfer:** Each item (stones, marbles, washers, and pennies) will transfer heat to the room temperature water, causing the water temperature to rise.
 - **Different Heat Capacities:** The amount by which the water temperature increases will vary depending on the material. Materials with higher heat capacities (like metal washers and pennies) might raise the temperature more than materials with lower heat capacities (like stones or glass marbles).
-

Conclusion:

The experiment demonstrates the principle of **heat transfer**: when two objects at different temperatures are brought into contact, heat flows from the hotter object (the items from the hot water bath) to the cooler one (the room temperature water). Over time, the temperature of the water in each jar increases as it absorbs heat from the items.

Different materials transfer heat at different rates, depending on their specific heat capacities. This explains why the water's temperature increase varies across the jars. Materials like metal (washers, pennies) generally have a higher thermal conductivity, meaning they transfer heat more efficiently than materials like glass or stone.

Temperature

Card 1:

- **How many dm are in 3.42 km?**

- 1 km = 10,000 dm (since 1 km = 1000 m, and 1 m = 10 dm).
Answer: 34,200 dm.

- **How many cm are in 2.67 m?**

- 1 m = 100 cm.
Answer: 267 cm.

- **How many m are in 107.6 km?**

- 1 km = 1000 m.
Answer: 107,600 m.

- **How many mm are in 8.24 cm?**

- 1 cm = 10 mm.
Answer: 82.4 mm.

- **What would 45 mm be in cm?**

- 1 cm = 10 mm.
Answer: 4.5 cm.

- **What would 107 mm be in cm?**

- 1 cm = 10 mm.

Answer: 10.7 cm.

- **What would you use to measure the distance from Houston to Dallas?**

Answer: You would use **kilometers** (km) to measure the distance between cities.

- **What would you use to measure the width of a piece of hair?**

Answer: You would use **micrometers** (μm) or possibly **millimeters** (mm) for very fine measurements.

- **What would you use to measure the height of a building?**

Answer: You would use **meters** (m) to measure the height of a building.

- **What would you use to measure the length of a pencil?**

Answer: You would use **centimeters** (cm) to measure the length of a pencil.

Card 2:

Procedure and Guidance for the Teacher:

Materials:

- **4 Balloons:** Used to create balloon rockets.
- **2 m String:** Acts as the track for the balloon rocket.
- **4 Drinking Straws:** Each straw will be attached to a balloon and threaded through the string to guide the rocket.
- **4 Paper Clips:** Used for securing purposes if needed.
- **Tape:** To attach the straw to the balloon.
- **Scissors:** For cutting materials as needed.
- **Tape Measure:** To measure the distance the balloon rocket travels.

Step-by-Step Procedure:

1. **Set Up the Balloon Rocket:**
 - Thread a **straw** onto the **string**. This string will act as the track for the balloon rocket.
 - **Tape the straw** securely to the side of a **balloon** (the part you blow into).
 - **Secure both ends of the string** so it is stretched tight and straight (attach it to two stationary objects, such as chairs or desks).
2. **Launch the Balloon Rocket:**
 - Blow up the balloon, but do not tie it. Hold the opening closed so the air doesn't escape.
 - Once the balloon is fully inflated, let go of the opening and allow the balloon to shoot along the string as the air escapes.
3. **Measure the Distance:**
 - Use the **tape measure** to record the distance the balloon rocket travels along the string.
 - Record this distance in your **science notebook**.

Observation:

- **What Did You Need to Do to Make the Balloon Go the Farthest?**
 - **Maximizing Air in the Balloon:** The more air you blow into the balloon, the more potential energy it stores. This will allow the balloon rocket to travel farther as the air is released.

- **Minimizing Friction:** Ensure the string is as **tight and straight** as possible to reduce friction that could slow the balloon down. A looser string will create more resistance, causing the balloon to travel a shorter distance.
- **Alignment of the Balloon:** Make sure the balloon and the straw are properly aligned. If the straw is crooked or taped unevenly, it may cause the balloon to veer off course or slow down.
- **Smooth Release:** A smooth and consistent release of the balloon's air will give it a better chance to travel farther. Avoid pinching or releasing the balloon too abruptly.

Conclusion:

The balloon rocket travels farther when it is **filled with more air** and when the string is **tight and friction is minimized**. The experiment demonstrates how stored potential energy (in the inflated balloon) is converted to kinetic energy as the air is released, propelling the balloon forward. Factors such as air pressure, friction, and alignment all affect how far the balloon can travel.

Card 3:

Procedure and Guidance for the Teacher:

Materials:

- **Small Toy Car:** Used for the experiment.
- **4 Metal Washers:** To be added as weight to the toy car.
- **Tape:** To secure the washers to the car.
- **Chair:** To prop the ramp.
- **Meter Stick:** For measuring the distance the car travels.
- **Piece of Wood (Ramp):** Used to create an inclined plane for the car to roll down.

Step-by-Step Procedure:

1. **Initial Test with No Washers:**
 - Set up the **ramp** at an angle against the chair.
 - Place the **toy car** at the top of the ramp, let it go, and allow it to roll down freely.
 - Measure and record the **distance the car traveled** from the bottom of the ramp using the meter stick.
2. **Add 1 Washer to the Car:**
 - Tape **1 metal washer** securely to the car.
 - Place the car at the top of the ramp, release it, and measure the **distance** it traveled from the bottom of the ramp.
3. **Continue Adding Washers:**
 - Repeat the experiment by taping **2 washers**, then **3 washers**, and finally **4 washers** to the car.

- Each time, release the car from the top of the ramp and measure the distance it travels from the bottom.

Observation:

- **Create a Graph:**

- On the **x-axis**, plot the number of washers added to the car (0, 1, 2, 3, 4).
- On the **y-axis**, plot the **distance traveled** by the car.
- After plotting the data points, connect them to observe the relationship between the weight of the car and the distance it traveled.

Conclusion:

- **Relationship Between Weight and Distance:**

- As more washers (weight) are added to the toy car, you may notice a change in the distance the car travels. Heavier cars often experience **more friction** with the surface, which can **reduce the distance** traveled. However, in some cases, added weight might help the car gain more momentum, especially if there is less friction and the ramp is smooth.
- The specific outcome will depend on the **surface conditions** and **friction** involved in the experiment. In general, however, added weight often results in less distance due to **increased friction** between the car and the surface. Students may conclude that **more weight** might **slow down** the car, reducing the distance it can travel after descending the ramp.

This experiment provides a practical demonstration of how **mass** and **friction** influence motion and distance in real-world applications.

Card 4:

Procedure and Guidance for the Teacher:

Materials:

- **Meter Stick:** For measuring the distance walked.
- **Partner:** To assist with recording the number of paces.
- **Calculator:** To perform the calculations for determining the length of each pace.

Step-by-Step Procedure:

First Method:

1. **Measure 10 Meters:**

- Use the meter stick to measure and mark a **10-meter distance** on the ground.

2. **Count the Paces:**

- Have one person walk the 10-meter distance while the other person counts the number of paces.
- Be precise, and if the final step is a partial step, record it as a decimal (e.g., **14.5 paces**).

3. Calculate the Length of Each Pace:

- Divide the **10 meters** by the **number of paces** taken to determine the average length of one pace.
- Record the result in two ways: in **meters per pace** and **centimeters per pace**.
- Example: If 14.5 paces were taken over 10 meters, the calculation is:
$$\frac{10 \text{ meters}}{14.5 \text{ paces}} = 0.69 \text{ meters per pace}$$
$$\frac{10 \text{ meters}}{14.5 \text{ paces}} = 0.69 \text{ meters per pace}$$
$$= 0.69 \text{ meters per pace or } 69 \text{ centimeters.}$$

Second Method:

1. Walk 10 Paces:

- This time, walk exactly **10 paces**, and use the meter stick to measure the total distance traveled.

2. Calculate the Average Pace:

- Divide the total **distance traveled** by **10 paces** to get the average length of one pace.
- Record the result in two ways: in **meters per pace** and **centimeters per pace**.
- Example: If the total distance walked in 10 paces is **6.92 meters**, the calculation is:
$$\frac{6.92 \text{ meters}}{10} = 0.69 \text{ meters per pace}$$
$$\frac{6.92 \text{ meters}}{10} = 0.69 \text{ meters per pace}$$
$$= 0.69 \text{ meters per pace or } 69 \text{ centimeters.}$$

Observation and Reflection:

1. Compare the Results:

- Were the results the same or different when using the two methods? Ideally, the results should be very similar, since both methods are measuring the average length of your pace.

2. Which Method is More Accurate?

- **First Method:** This method is more straightforward, measuring a set distance (10 meters) and dividing by the number of paces taken. This method might be more accurate because you are working with a fixed known distance and reducing variability.
- **Second Method:** While this method also provides good results, it could introduce slight measurement inaccuracies, especially if the total distance traveled over 10 paces is measured imprecisely.

Conclusion: The first method is likely to be more accurate because it involves a fixed known distance (10 meters) and reduces potential errors that could arise from measuring the total distance walked.

Experimental Design

Card 1:

Kate and Sara can design a simple experiment to test whether peat moss can absorb almost 20 times its own weight in water. Here's a suggested list of equipment and a step-by-step procedure they can follow to conduct the experiment.

Equipment:

1. **Peat moss** (a small sample for testing)
2. **Digital scale** (to measure the weight of the dry peat moss and water)
3. **Graduated cylinder** or measuring cup (to measure the amount of water added)
4. **Beaker or bowl** (large enough to hold peat moss and water)
5. **Paper towels** (to remove excess water)
6. **Spoon or tweezers** (to handle the peat moss)
7. **Timer** (optional, to ensure enough time is given for absorption)

Procedure:

1. **Weigh the dry peat moss:**
Begin by using the digital scale to weigh a dry sample of peat moss. Record the weight in grams.
2. **Prepare the water:**
Using a graduated cylinder or measuring cup, measure a known quantity of water that is much more than 20 times the weight of the peat moss. This will ensure there's enough water available for the peat moss to absorb fully.
3. **Add water to the peat moss:**
Place the dry peat moss in the beaker or bowl. Slowly add water from the measured supply, making sure to saturate the peat moss.
4. **Allow time for absorption:**
Let the peat moss sit for 5-10 minutes to ensure it has had enough time to absorb as much water as it can.
5. **Remove excess water:**
After the absorption period, gently lift the peat moss out of the water using a spoon or tweezers. Place it on paper towels and lightly blot the peat moss to remove any water that wasn't absorbed (surface water).
6. **Weigh the wet peat moss:**
Weigh the peat moss again using the digital scale. Record the new weight.
7. **Calculate water absorbed:**
Subtract the initial weight of the dry peat moss from the final weight of the wet peat moss. This difference is the weight of the water absorbed by the peat moss.
8. **Compare to the original statement:**
To verify the statement, calculate how many times the absorbed water weight compares to the dry peat moss weight. For example, if the dry peat moss weighs 5 grams and the absorbed water weighs 100 grams, the peat moss has absorbed 20 times its weight in water ($100 \div 5 = 20$).

By following these steps, Kate and Sara can test whether peat moss can indeed absorb 20 times its own weight in water and either confirm or refute the statement.

Card 2:

To test his hypothesis about how food coloring would dissipate in cooking oil instead of water, Trenton would need specific equipment, a clear procedure, and to follow safety precautions due to the use of hot liquids. Here's how he can set up the experiment:

Equipment:

1. **3 beakers or clear containers** (for hot, warm, and cold cooking oil)
2. **Cooking oil** (enough to fill each beaker)
3. **Thermometers** (to measure the temperature of the oil in each beaker)
4. **Food coloring** (liquid form, to add drops to the oil)
5. **Stirring rods** (for optional stirring after adding the food coloring)
6. **Hot plate** (for heating the oil)
7. **Ice and water bath** (to cool the oil in one of the beakers)
8. **Digital timer** (to measure the time taken for dissipation)
9. **Safety gloves** (for handling hot beakers and oil)
10. **Safety goggles** (to protect eyes from splashes)
11. **Apron or lab coat** (to protect clothing)

Procedure:

1. **Prepare the oil in the beakers:**
 - Fill each of the three beakers with the same amount of cooking oil.
2. **Heat and cool the oil:**
 - Heat one beaker of oil to a high temperature using a hot plate (not boiling, but hot enough to test dissipation). Use a thermometer to monitor the temperature.
 - Leave the second beaker at room temperature (warm oil).
 - Cool the third beaker of oil by placing it in an ice and water bath until it reaches a cold temperature. Use the thermometer to check.
3. **Add food coloring:**
 - Once the oil in each beaker reaches the desired temperature (hot, warm, and cold), place three drops of food coloring into each beaker.
4. **Observe the dissipation:**
 - Set a timer and observe how the food coloring behaves in each beaker of oil. Does it spread out (dissipate) or stay clumped together?
 - Optionally, gently stir the oil with a stirring rod to observe if the food coloring disperses with movement.
5. **Record observations:**
 - Take note of how quickly or slowly the food coloring dissipates in each beaker. Record the time it takes in each temperature condition.

- Compare the behavior of food coloring in oil versus what you observed in water. You will likely notice that food coloring doesn't mix well with oil due to the difference in polarity between water and oil.

Safety Precautions:

1. **Handling hot oil carefully:**

Cooking oil can become very hot and potentially cause burns. Always use heat-resistant gloves when handling beakers with hot oil. Use a thermometer to ensure the oil isn't overheated, as hot oil can splatter.

2. **Using a hot plate safely:**

Be careful when using the hot plate to heat oil. Never leave the hot plate unattended, and ensure it is turned off and cool before cleaning up.

3. **Eye protection:**

Wear safety goggles to protect your eyes from splashes of oil or food coloring.

4. **Lab safety attire:**

Wear a lab coat or apron to protect your clothes from oil spills, and avoid loose clothing that could knock over beakers or catch on the hot plate.

5. **Proper ventilation:**

If the oil is heated to a high temperature, make sure the lab is well-ventilated to avoid inhaling fumes.

Conclusion:

By following this procedure, Trenton can observe whether food coloring dissipates differently in oil compared to water, taking note of how the temperature of the oil might affect the dispersal process. With proper safety precautions, he can safely carry out his experiment.

Card 3:

Chris could perform an experiment to investigate the relationship between temperature and cricket chirping. Since he noticed that the crickets were chirping at a slightly lower temperature than what he remembered, he could explore whether the temperature in the classroom still fits with the typical behavior of crickets or if other factors might be influencing the chirping.

Equipment:

1. **Thermometer** (to measure the temperature accurately near the crickets)
2. **Crickets** (several crickets to observe chirping behavior)
3. **Digital timer or stopwatch** (to measure the chirping rate per minute)
4. **Thermostat or heating/cooling source** (to adjust the temperature in the cricket's environment)
5. **Notebook or recording device** (to document observations)
6. **Graph paper or spreadsheet software** (to plot the data)

Procedure:

1. **Set up the environment:**

- Place the crickets in an enclosed space, such as a terrarium, where you can control and monitor the temperature.
 - Use a thermometer to accurately measure the temperature of the environment near the crickets.
2. **Record baseline observations:**
 - At the current room temperature (20°C), observe and count how many chirps each cricket makes in a minute. Repeat this process multiple times and calculate the average chirping rate at this temperature.
 3. **Gradually adjust the temperature:**
 - Slowly increase the temperature in the cricket environment by small increments (for example, by 1°C at a time) using the thermostat or another heating source, and repeat the chirp counting process at each new temperature level.
 - Continue adjusting the temperature until you reach or exceed 22°C (the temperature Chris recalled from the book). Record the chirping rate at each temperature level.
 4. **Observe temperature effects:**
 - Additionally, lower the temperature (if possible) to see how the crickets' chirping behavior changes in cooler conditions.
 5. **Record and analyze data:**
 - Plot a graph or table with temperature on the x-axis and the chirping rate (number of chirps per minute) on the y-axis to visualize how chirping frequency correlates with temperature.
 6. **Compare results:**
 - After gathering the data, compare it to the information from Chris's insect book. Is the chirping behavior consistent with the temperature ranges described, or are the crickets chirping differently at 20°C than expected?

Additional Information Chris Needs to Gather:

1. **Cricket species data:**

He should confirm the specific species of crickets in the classroom, as different species may have different chirping patterns at varying temperatures.
2. **Chirping patterns:**

Find out if the insect book specifies the exact rate of chirping for the species in question at different temperatures. Typically, cricket chirping rates increase with temperature.
3. **Humidity and other environmental factors:**

Humidity and other environmental conditions could affect chirping. Chris should check if humidity levels are constant or varying.
4. **Age and health of the crickets:**

The age or health of the crickets could impact their chirping frequency, so Chris might want to consider whether the crickets being used are mature and healthy.

Conclusion:

By conducting this experiment, Chris can verify whether the temperature alone accounts for the crickets' chirping behavior or if other environmental factors might be influencing

their chirping at 20°C. His results will give him a better understanding of how temperature affects crickets and help explain why they might have been chirping at a lower temperature than expected.

Card 4:

Emma can design a straightforward experiment to measure how much of a pencil is used up each day by sharpening. By comparing the lengths of pencils before and after daily use and sharpening, she can determine how much is lost over time. Here's a step-by-step guide on how she could design the experiment, including the necessary tools.

Equipment:

1. **New pencils** (several to test over a few days)
2. **Ruler or measuring tape** (to measure the length of the pencils in millimeters or centimeters)
3. **Pencil sharpener** (standard manual or electric sharpener)
4. **Notebook** (to record measurements and observations)
5. **Digital scale** (optional, to measure the weight of pencils before and after sharpening if Emma wants to track weight loss as well as length loss)
6. **Digital timer** (optional, to measure how long the pencil is used each day)

Procedure:

1. **Prepare the pencils:**
Start by selecting several new pencils of the same type to ensure consistency. Emma can choose a few to test since different students might use them differently.
2. **Measure the initial length:**
Use a ruler or measuring tape to measure the length of each pencil from the eraser end to the tip of the sharpened lead. Record the initial length in a notebook.
3. **Track daily use:**
Give each pencil to different students for daily use. At the end of each day, before sharpening, measure the pencil's length again and record it. This measurement will show how much of the pencil was used before any additional sharpening.
4. **Measure after sharpening:**
After the students sharpen the pencil at the end of the day, measure the pencil's length once again. Record this new length in the notebook.
5. **Repeat for several days:**
Repeat this process for several consecutive days (e.g., a week) to collect data on how much of the pencil is lost daily, both through regular use and from sharpening.
6. **Analyze data:**
At the end of the experiment, calculate the difference in length between each day's initial and final measurements. This will tell Emma how much pencil is lost each day from sharpening. She can calculate an average by adding up the daily losses and dividing by the number of days.
7. **Optional weight measurements:**
If using a digital scale, Emma could weigh each pencil before and after sharpening

to track the amount of material lost. This could provide a secondary measure beyond just length.

Safety and Accuracy Tips:

- **Sharpen carefully:**
Make sure that the same sharpener is used consistently and that pencils are sharpened in a uniform way to avoid unnecessary loss due to over-sharpening.
- **Consistency of usage:**
Try to ensure the pencils are used for similar durations each day to maintain consistent data collection. If Emma wants more control, she could set a specific time limit for how long each pencil is used daily.

Conclusion:

By following this experimental design, Emma can gather data on how much pencil is lost each day due to sharpening. This will give her a clear answer to how quickly pencils are consumed and could help her understand why only short, stubby ones remain after a few days.