

Name: _____ Date: _____

Gizmo Activity: Comparative Investigations

[Note: This activity requires you to use the Summer and Winter Gizmo™. This activity was designed as a follow-up to the Descriptive Investigations Gizmo Activity.]

Learning goals

After completing this activity, you will be able to ...

- Write a hypothesis to explain something about the natural world.
- Identify the independent and dependent variables in an investigation.
- Design and implement a fair test to answer a question.

Vocabulary: comparative investigation, dependent variable, fair test, hypothesis, independent variable, latitude, summer solstice, winter solstice



Warm-up questions (Do these BEFORE using the Gizmo.)

Desiree notices that her shadow seems to be shorter during the summer than it is in the winter. She decides to see if this is really the case. At noon on June 21, she measures her shadow to be 34 centimeters long. At noon on December 21, her shadow is 256 centimeters long.

1. What does the length of Desiree's shadow tell you about the height of the Sun at each date?

2. Why is it important that Desiree measured her shadow at noon on each day? _____

3. Would you call Desiree's activity a scientific investigation? Explain why or why not. _____

Activity A: Comparative investigations

What Desiree did was an example of a **comparative investigation**. A comparative investigation is one in which data is collected from different situations in order to make a comparison. Usually, the purpose of a comparative investigation is to see how one factor affects another.

A comparative investigation usually begins with a question. For example, Desiree's question was, "How does the time of year affect the length of my shadow?" Next, the investigator comes up with a **hypothesis**. A hypothesis is a proposed answer to the question. Desiree's hypothesis might be, "I think my shadow will be longer in the winter and shorter in the summer." The next step is to design an investigation to test the hypothesis.

In a comparative investigation, the investigator is trying to determine how an **independent variable** affects a **dependent variable**. The independent variable is changed by the investigator and the dependent variable is then measured. In Desiree's investigation, the time of year is the independent variable and the shadow length at noon is the dependent variable.

Besides the time of the year, there are other factors that could affect the length of Desiree's shadow. The time of day could affect the shadow length. Shadows are longer in the morning and evening when the Sun is close to the horizon. Desiree could also change her shadow length if she crouched or if she stood on a slope or next to a wall.



To see how the time of year affects the shadow length, Desiree needs to design a **fair test**. A fair test is one in which only one variable is changed. To do this, Desiree makes sure she measures her shadow at the same time each day. She stands on a flat surface and stands up straight. For greater accuracy, Desiree could measure the shadow of a fixed object such as a post or flagpole.



1. Michael wants to know what type of birdseed the birds in his back yard like to eat. He prepares two identical birdfeeders and hangs them from the same branch in his yard. The first feeder contains 500 grams of sunflower seeds. The second feeder contains 500 grams of millet seeds. He measures how long it takes for the birds to empty each feeder.

A. In Michael's investigation, which is the independent variable? (Circle your choice.)

- | | |
|-----------------------|----------------------------------|
| a. Type of birdfeeder | c. Amount of seed |
| b. Type of seed | d. Time it takes to empty feeder |

B. In Michael's investigation, which is the dependent variable?

- | | |
|-----------------------|----------------------------------|
| a. Type of birdfeeder | c. Amount of seed |
| b. Type of seed | d. Time it takes to empty feeder |

C. Was Michael's investigation a fair test? Explain. _____

2. Allison wants to see how temperature affects the growth of plants. She gets two tomato seedlings from a local nursery. She places one seedling on a warm windowsill and places the other seedling in the refrigerator. She gives each seedling the same amount of water.

After two weeks, the seedling on the windowsill has grown to a height of 22 centimeters and has many green leaves. The seedling in the refrigerator has grown to a height of 11 centimeters and has two pale leaves. Allison concludes that plants do not grow well in cold temperatures.

A. Was this a fair test of the effect of temperature on plant growth? _____

Explain why or why not. _____

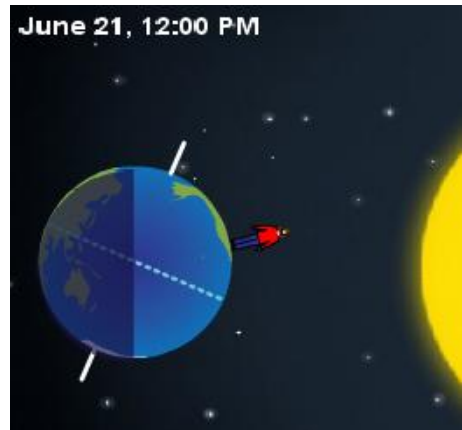
B. Challenge: How could you change the experiment so that it is a fair test? _____

Activity B: Summer and winter

Desiree's comparative investigation showed that the winter Sun is lower in the sky than the summer Sun. Does this have any effect on the temperature?

You can find out using the *Summer and Winter Gizmo*. The Gizmo has two tabs. The **Space** tab shows a view of Earth on June 21 and December 21. An observer stands on Earth on each date. The time for the observer is 12:00 p.m. (noon).

Notice that the North Pole is tilted toward the Sun in June and away from the Sun in December.



In the Northern Hemisphere, June 21 is the longest day of the year and is called the **summer solstice**. December 21 is the shortest day of the year and is called the **winter solstice**. The solstice names are the opposite in the Southern Hemisphere.

The **Earth** tab shows the observer standing on Earth's surface on each date. Next to the observer is a solar panel. The solar panel will help you measure how much sunlight is hitting Earth's surface at a given time. The greater the intensity of sunlight, the higher the temperature an area will experience.

Question: How does the intensity of sunlight compare on June 21 and December 21?

1. Make a hypothesis: For a location on the Northern Hemisphere, how do you think the intensity of sunlight compare on June 21 and December 21?

2. Observe: On the **Space** tab, drag the observer so that her **Current latitude** is 44° N. Check that the **Current axis tilt** is 23.5°. (If it isn't, click **Reset tilt**.) Turn on **Show Sun rays**.

A. Look at the observers on the two dates. On which date will the Sun appear higher in the sky? _____

B. On which date will the observer have a longer shadow? _____

3. Measure: Select the **Earth** tab. In this Gizmo, you can measure the amount of sunlight hitting each solar panel by counting the rays that hit the panel.

A. How many rays hit the panel on June 21? _____

B. How many rays hit the panel on December 21? _____

C. Based on the number of rays hitting each panel, what can you say about the intensity of sunlight on each date? _____

D. Was your hypothesis correct? _____

4. Observe: The Gizmo also lists the day length for each date. How long is each day?

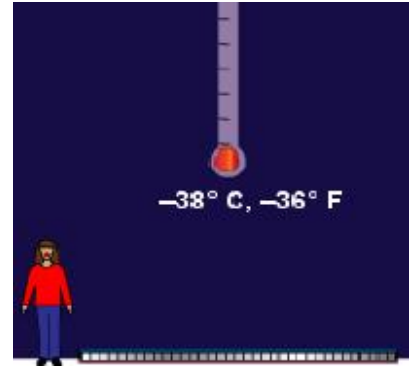
June 21: _____

December 21: _____

5. Draw conclusions: What are *two* reasons that it is colder in December than it is in June for a location in the Northern Hemisphere? _____

Activity C: Latitude

The date is not the only thing that can affect the intensity of sunlight. **Latitude**, or the distance north and south of the equator, can also have a large impact. You can change the latitude of the observer on the **Space** tab by dragging the observer north and south.



Using the *Summer and Winter Gizmo*, design a comparative investigation to determine the relationship between latitude and intensity of sunlight. Be sure to keep other factors, such as axis tilt and date, the same in your investigation.

Use the template below to record your question, hypothesis, procedure, data, and conclusions. Create a table and construct a graph of your data. (Attach extra sheets if necessary.) After you have written your conclusions, answer the follow-up questions.

Question: _____

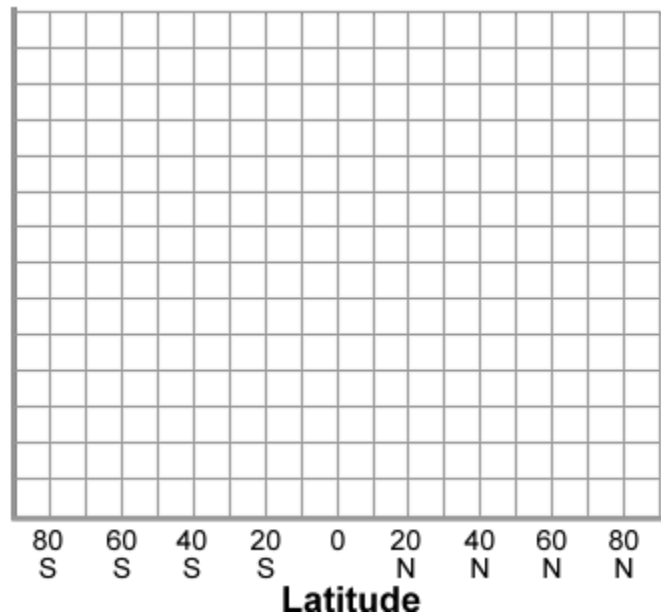
Hypothesis: _____

Procedure: _____

Data table (Note: Label columns 2 and 3)

Date:		
Latitude		

Graph (Note: Label the y-axis)



Conclusions: _____

Follow-up questions

1. Did you investigate June 21, December 21, or both dates? _____

2. For the date you investigated, which latitude(s) experienced the most intense sunlight?

3. For the date you investigated, which latitude(s) experienced the least intense sunlight?

4. In general, why is it colder near the poles than it is near the equator? _____

5. The Gizmo shows the expected temperature at each location and date.
A. Do you think these temperatures would be accurate for a given date and time?

B. What factors that influence temperature are not included in this model? _____

