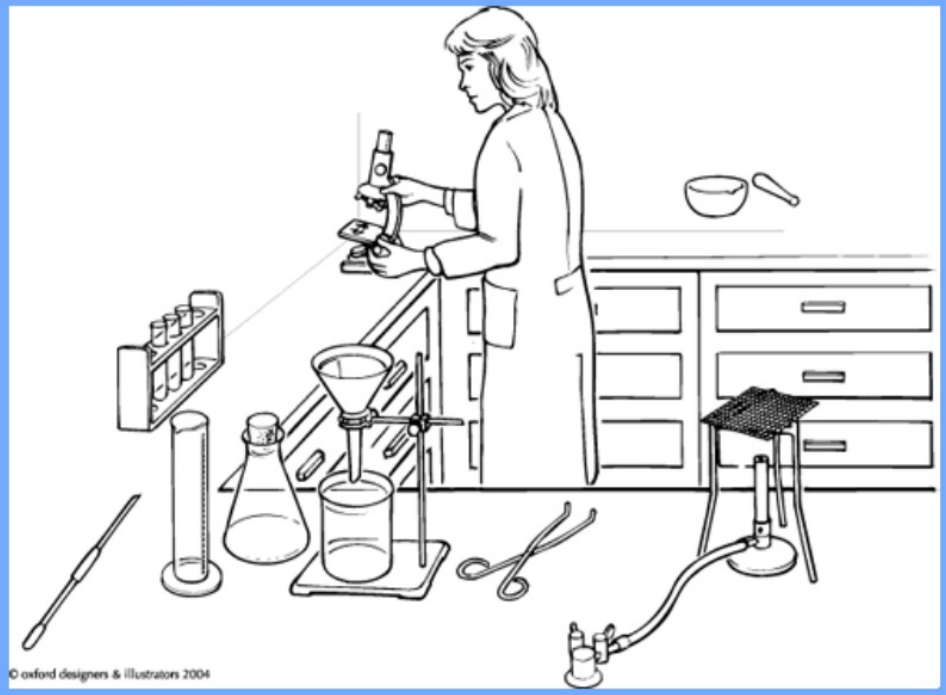
The Scientific Method

Virginia SOL 5.1



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SCIENTIFIC METHOD

Scientists are constantly using their senses to observe the world around us.

The observations they make may cause them to wonder why things happen the way they do. This is the beginning of the scientific method. A scientist asks a question.

For example, you have already observed that plants grow better with water. Do you think the type of water plants receive affects how well they grow?

Notes

SCIENTIFIC METHOD

Which of these can be observed in this picture?

A The moon is circular.

B The moon spins around on its axis.

C The moon is solid rock.

D The moon has little air.

SCIENTIFIC METHOD

Once a scientist has asked a question based on his/her observations, he/she then must come up with a hypothesis. A hypothesis is a statement of what he/she thinks is the answer to the question.

Question: Does the type of water plants receive affect their growth?

Hypothesis: If plants receive plain tap water, they will grow better than plants that receive other types of water.

Notice that the hypothesis is stated as a fact, in an If..., then statement!

SCIENTIFIC METHOD

A hypothesis is NOT a random guess. A scientist uses inference to determine his/her hypothesis. An inference is a tentative explanation based on background knowledge and available data. A scientist uses what he/she has observed and combines that information with what he/she already knows to come up with the hypothesis.

For example, if you wake up in the morning and observe that the sun is shining but the streets, sidewalks, and everything else is wet, you can INFER that it rained earlier.

SCIENTIFIC METHOD

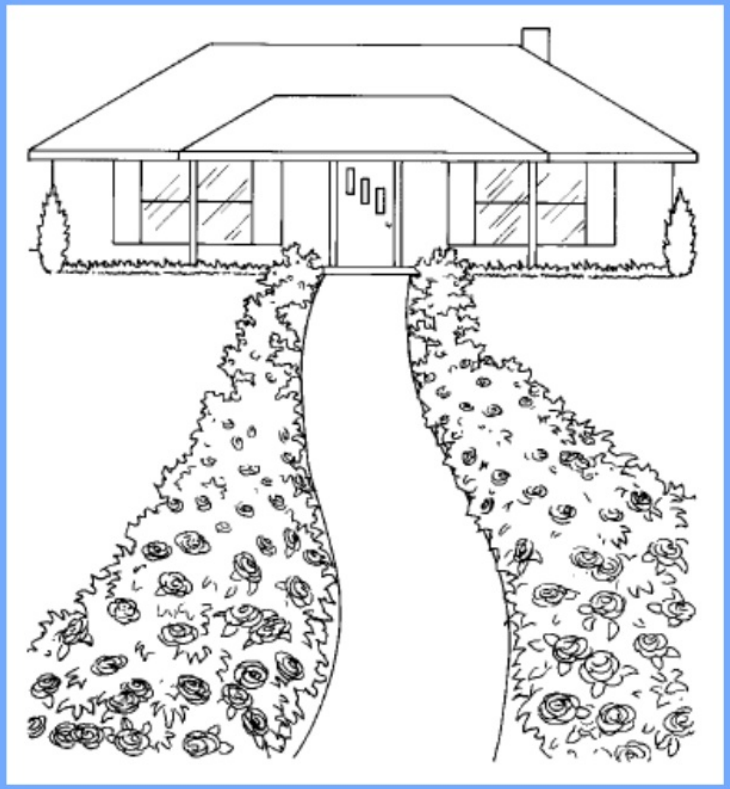
Sandy grows roses along her walkway. The roses close to the street had more blooms than the roses close to the house. Which statement is a hypothesis Sandy could make about her roses?

A There were many blooms on the roses near the house and fewer blooms on the roses closest to the street.

B The roses closest to the street had more blooms because they received more sunlight.

C The roses near the house were taller but had fewer blooms.

D The roses close to the house had fewer blooms and leaves.



SCIENTIFIC METHOD

Once a scientist has stated his/her hypothesis, he/she must prove whether it is right or wrong. Scientists use experiments to prove or disprove a hypothesis.

What type of experiment could we design to prove our hypothesis?

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Notes

SCIENTIFIC METHOD

This could be an experiment to prove our hypothesis.

Materials: 4 young plants of equal size, ruler, tap water, sugar water, salt water, bottled water

Procedure:
1. Measure the size of each plant at the start
2. One plant will receive only tap water, one only sugar water, one only salt water, and one only bottled water.
3. Each day, give each plant the same amount of its type of water and record the size of the plant.
4. Continue the experiment for 2 weeks.

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Notes

SCIENTIFIC METHOD

In our experiment, what is changing for each plant?

This is the independent variable in our experiment. We are trying to see if the independent variable affects something.

What are we measuring in our experiment?
This is the dependent variable. It is what is affected by the independent variable.

Do we need to place each plant in the same place? Can we put some in the sun and others inside? Why? These are the controlled variables (constants). We make sure they are the same for each plant.

Notes Reset

SCIENTIFIC METHOD

A teacher wants to see if money affects student reading speed. She pays half the students $5 for finishing a particular book in a certain amount of time. The other students aren't offered money.

Independent variable:

Dependent variable:

Controlled variable:

Can you think of some problems with this experiment? What is not being controlled?

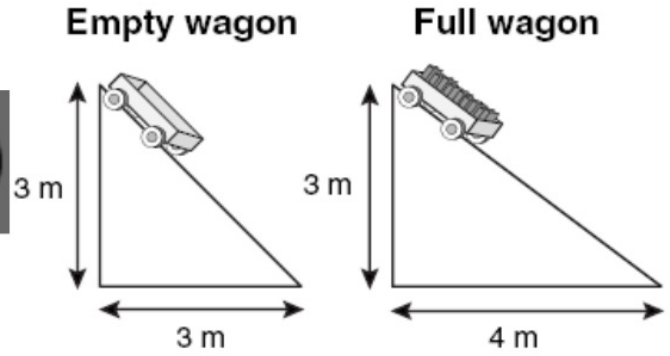
Click on the microscope for a fun activity on variables.

Notes Reset

SCIENTIFIC METHOD

A science class wanted to know if an empty wagon and a wagon full of books would roll down a ramp at the same speed. Which ramps should the students build to perform a fair test?

A



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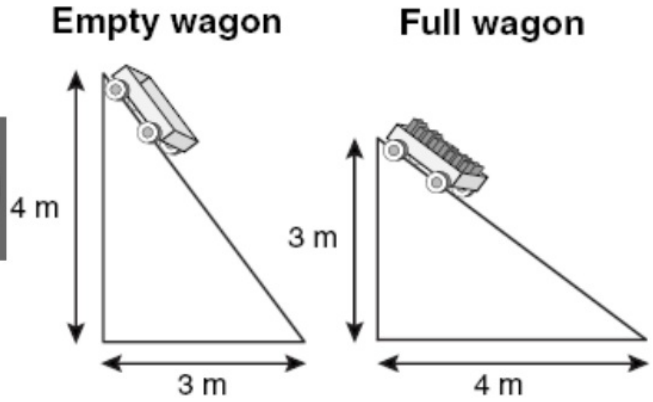

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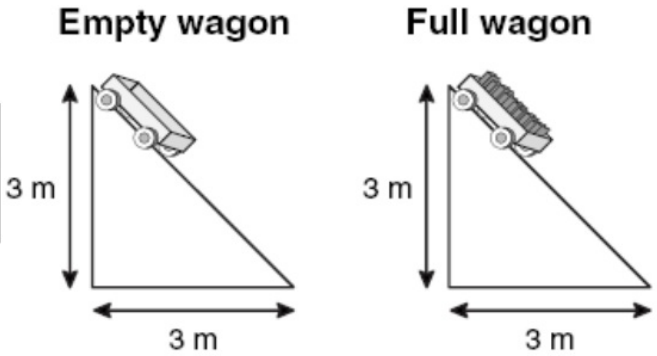

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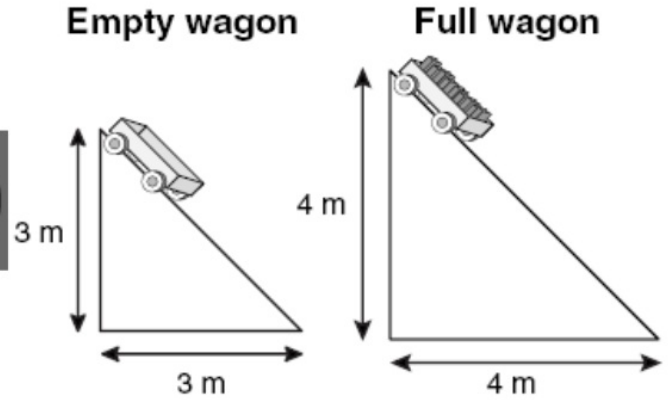
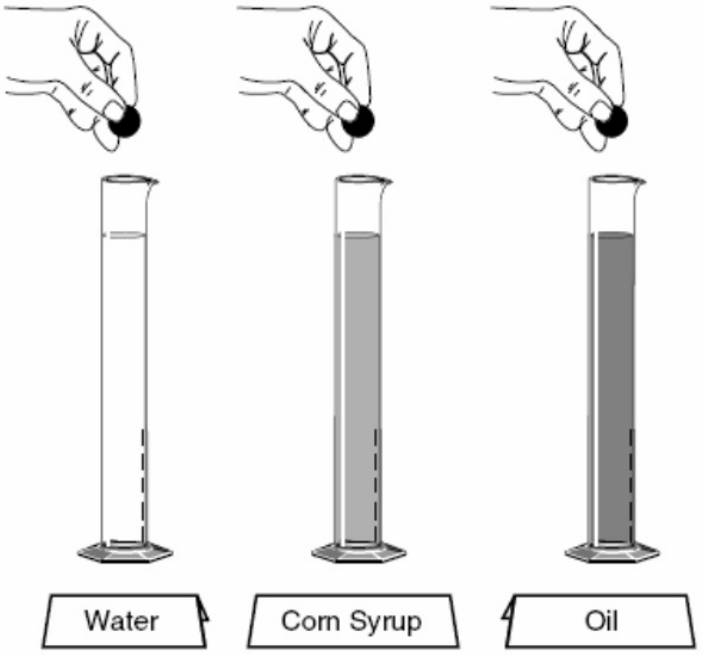


SCIENTIFIC METHOD



A student uses the equipment shown above to study which liquid is the thickest. What information is the most appropriate to record?

A The height of each of the graduated cylinders

B The time it takes for each marble to hit bottom

C The size and mass of each of the marbles

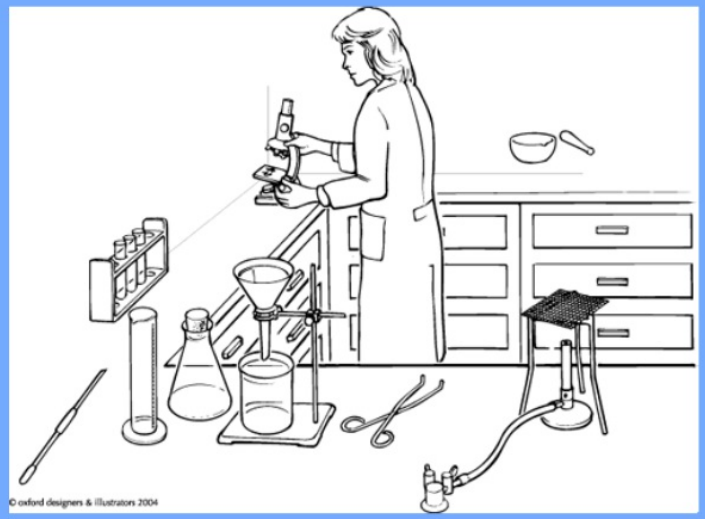
D The volume of each of the liquids in the cylinders

SCIENTIFIC METHOD

After a scientist has conducted an experiment and recorded his/her observations, he/she must then analyze the results. Typically graphs and charts will be created to make this easier.

After analyzing the results, the scientist draws a conclusion based on the results. A conclusion is a summary statement bawsed on the results of an investigation. It must be verifiable.

A scientist must decide if the hypothesis was correct or incorrect.

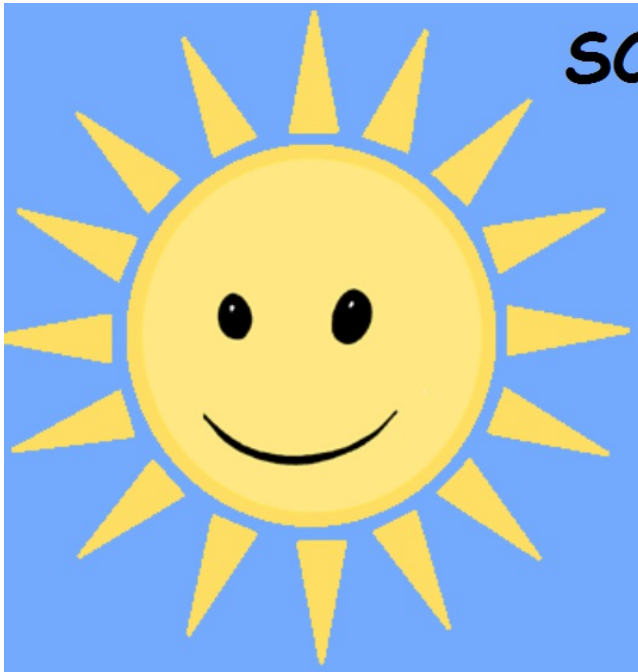


SCIENTIFIC METHOD

Based on the picture above, which of these is a conclusion rather than an observation?

A This animal has hair.
B This animal is standing.
C This animal has four legs.
D This animal is a mammal.

SCIENTIFIC METHOD



Experimental Results

Student	Numbers of Seeds Sprouted
1	25
2	19
3	27
4	5

Some students recorded the number of bean seeds that sprouted in their experimental plots. Each student began with the same number and type of seeds, the same type of soil plot, and the same amount of water and sunlight. Which of the following students *most likely* made an error in the experiment?

A 1
B 2
C 3
D 4

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SCIENTIFIC METHOD

Here is the data for our experiment. We need to analyze it to draw conclusions.

DAY	Plant1 (tap H2O)	Plant2 (sugarH2O)	Plant 3 (saltH2O)	Plant4(bottled H2O)
1	4 inches	4 inches	4 inches	4 inches
2	4 inches	4 inches	4 inches	4 inches
3	4.2 inches	4.1 inches	3.8 inches	4.2 inches
4	4.3 inches	4.3 inches	3.5 inches	4.4 inches
5	4.4 inches	4.5 inches	3.4 inches	4.5 inches
6	4.5 inches	4.9 inches	3.0 inches	4.6 inches
7	4.7 inches	5.1 inches	3.0 inches	4.8 inches
8	5.0 inches	5.2 inches	3.0 inches	4.9 inches
9	5.1 inches	5.4 inches	3.0 inches	5.2 inches
10	5.3 inches	5.7 inches	3.0 inches	5.3 inches
11	5.6 inches	6.0 inches	3.0 inches	5.5 inches
12	5.6 inches	6.1 inches	3.0 inches	5.7 inches
13	5.6 inches	6.1 inches	3.0 inches	5.8 inches
14	5.8 inches	6.5 inches	3.0 inches	5.8 inches

What can we conclude from our experiment?

Notes

SCIENTIFIC METHOD

If each of our plants had different soils, would this have been a valid experiment? Why or why not?

The next step a scientist would take would be to communicate with other scientists about the results of the experiment. A scientist would write up his experiment and publish the report. The report would include purpose, hypothesis, materials, procedure, observations, and conclusions.

Scientists publish their reports so that others can replicate the results and consensus can be reached about the conclusion.

SCIENTIFIC METHOD

Remember, these are the steps of the scientific method:

- Observation
- Question
- Hypothesis
- Experiment
- Analysis
- Conclusion
- Communication

Click on each step to see the definition.

Reset

SCIENTIFIC METHOD

Notes Reset

Match the step in the scientific method with its definition.

Observations	steps to prove or disprove a hypothesis
Question	scientists notice what is happening, results in a question
Hypothesis	report about the results
Experiment	statement of what is believed
Analysis	look at data to determine the results of the experiment
Conclusion	statement of what happened, based on data
Communication	problem that a scientist wants to solve

SCIENTIFIC METHOD

Put the steps of the scientific method in the correct order by dragging them to their correct line.

Hypothesis

Communication

Observation

Conclusion

Experiment

Question

Analysis

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

Notes Reset

SCIENTIFIC METHOD

The scientific method allows scientists to determine cause and effect relationships in nature. The scientific method is a procedure that allows scientists to answer questions about things in nature. Scientists use the scientific method so that their results and conclusions can be verified. Other scientists who follow their steps should be able to duplicate the results.

SCIENTIFIC METHOD

Scientific knowledge is always open to improvement and can never be declared absolutely certain. New questions arise, new theories are proposed, new instruments are invented, and new techniques are developed.

SCIENTIFIC METHOD

A student set up an experiment to test how much bean plants will grow in soil with salt in it. The student grew 50 plants in one group and 50 plants in the other group. The only thing that can be different in the two groups is the amount of —

A soil in each plant pot

B water given to each plant

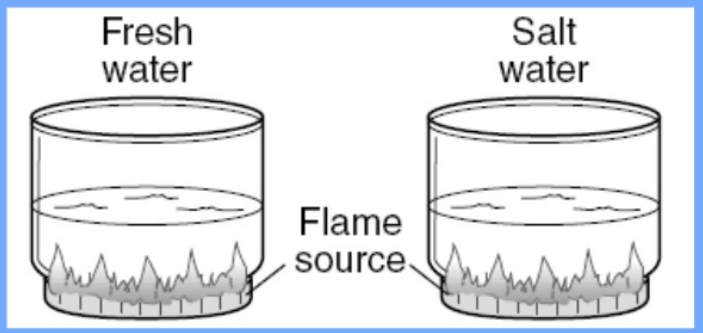
C salt in the soil in each plant pot

D fertilizer given to each plant

SCIENTIFIC METHOD

Which is the *fairest* way to find out if salt water boils faster than fresh water?

A



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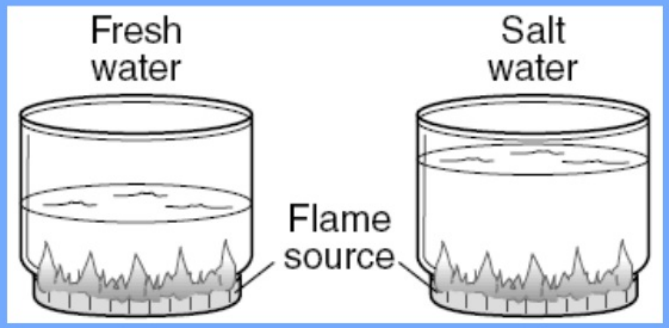

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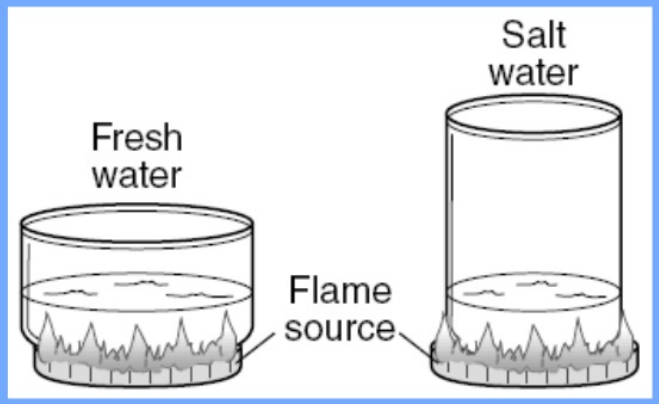

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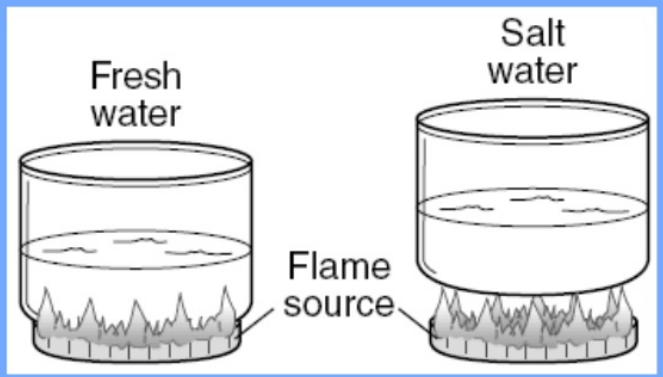


SCIENTIFIC METHOD

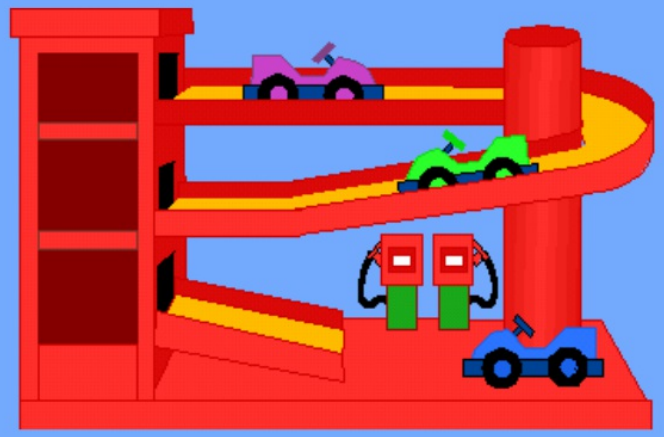
The pictures show how one student tried to see how the heat from a light bulb affected the rate of evaporation of a liquid. What is the only variable being changed in this experiment?

A The size of the container
B The position of the thermometer
C The position of the light bulb
D The amount of water

SCIENTIFIC METHOD

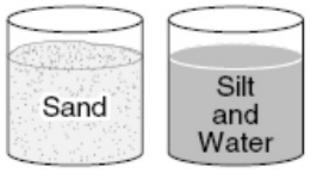
Two students wanted to find out which of their toy race cars would go the farthest. They let each car roll down a ramp and then measured how far the cars rolled. Which of these should be held constant if they want a fair test of their cars?

A The height of the ramp
B The weight of the ramp
C The length of the cars
D The shape of the cars

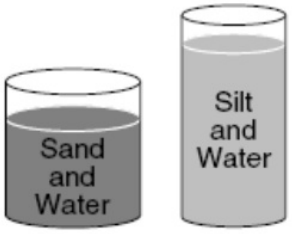


SCIENTIFIC METHOD

Which of these is the fairest way to find out if sand or silt will settle faster when mixed with water?



A



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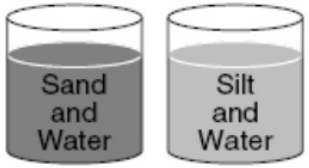
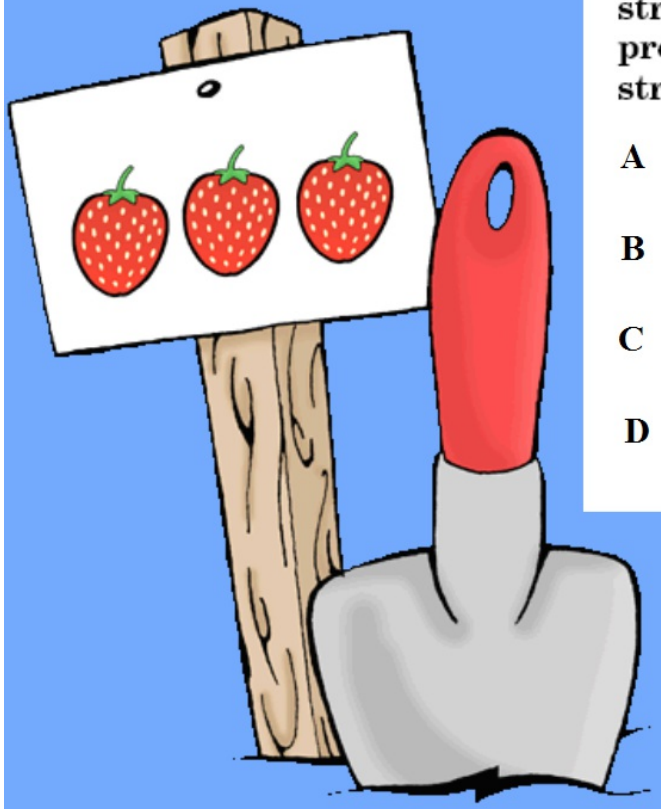


B

D

SCIENTIFIC METHOD



Todd observes that his strawberry plant has grown little green strawberries. Which of these is a prediction Todd might make about his strawberry plant?

A The green berries will ripen into red berries.

B The strawberry plant is growing under an oak tree.

C The strawberry plant doesn't have enough water.

D The green berries are a new type of strawberry.

Source Information:

Questions taken from 2001-2006 Released SOL items. Available at: http://www.pen.k12.va.us/VDOE/Assessment/releasedtests.html