

1. Your students want to grow different bean plants in your windowless classroom. You know a grow light will support the bean plants' growth, and you also know that grow lights can be fitted with different bulbs to provide varying lighting conditions. However, you aren't sure which lighting condition is best for the bean plants your students want to grow: high, medium, or low light. You ask your students to design an investigation to determine which lighting condition is best for growing the bean plants. They decide to measure the average growth of similar bean plants grown in three different lighting conditions (A, B, C) over 10 days.

What are possible dependent (DV) and independent variables (IV) for their investigation?

- a. DV = lighting conditions; IV = number of days
- b. DV = number of days; IV = lighting conditions
- c. DV = plant growth; IV = number of days
- d. DV = lighting conditions; IV = plant growth
- e. **DV = plant growth; IV = lighting conditions**

2. A group of students completed a project which involved making ice cream using soy milk. In the process, the soy milk first had to be heated to boiling. Most of the students cooled their hot soy milk to room temperature before placing it in the freezer. However, Jessy placed her hot soy milk directly in the freezer before it was cooled. Later it was observed that Jessy's soy milk took less time to completely freeze compared to the others! The students were puzzled and wondered, "Do hot liquids freeze faster than cold liquids?"

The table below provides the conditions for an experiment that enables this question the students have to be answered. There are two items missing from the table which are labeled (1) and (2) that you need to think about when you answer the question below.

What do these missing conditions need to be in order for the experiment to answer the students' question about hot or cold liquids freezing first?

	Amount of Milk	Type of Milk	Temperature of Milk before Placing in Freezer
Trial 1	(1)	sugar-free soy milk	30°C
Trial 2	half cup	(2)	70°C

- a. (1) = half cup; (2) = soy milk with sugar in it
- b. **(1) = half cup; (2) = sugar-free soy milk**
- c. (1) = one cup; (2) = soy milk with sugar in it
- d. (1) = one cup; (2) = sugar-free soy milk

3. A student wants to investigate whether a cup placed at the bottom of a ramp will move further when struck by a larger force created by a ball rolling down a higher ramp. The diagram below shows an example experimental setup of a board propped up on a stack of four identical books of the same thickness. A plastic cup is placed at the bottom of the ramp and two balls of different masses (shown as large and small balls below) and additional identical books are available to the student, if needed.



Identify the independent (IV), dependent (DV), and control variables (CV) for the proposed experiment.

- IV = mass of ball
DV = height of ramp
CVs = distance cup moves when struck, thickness of books
 - IVs = height of ramp, mass of ball
DV = thickness of books
CV = distance cup moves when struck
 - IV = distance cup moves when struck
DV = height of ramp
CV mass of ball
 - IV = height of ramp
DV = distance cup moves when struck
CV = mass of ball
4. The student in the previous question does a trial run of the experiment and notices that the cup moves several feet. He has several methods available to him for collecting accurate distance data. Which tool(s) will provide accurate measurement of the distance data?
- Use two 12 inch rulers and continue to place them end to end and add their measurements to determine the total distance the cup moved.
 - Use a tape measure which can be extended up to 12 feet.
 - Each tile block on the classroom floor is a 12 inch by 12 inch square so the student can simply count the number of tiles the cup moved.
 - Both choices a and b.
 - All methods of measurement will yield equally accurate distance data.

5. While building toy cars, a group of students had the idea that the size of the wheels will affect how far the car travels after going down an incline. They hypothesize that cars with larger wheels will travel further. They came up with three experimental designs as shown below to test their hypothesis.

a.

Wheel Size	Distance Traveled (cm)
Small	
Medium	
Large	

b.

Push Down Ramp	Distance Car with Large Wheels Traveled (cm)
Small Push	
Medium Push	
Large Push	

c.

Ramp Height (cm)	Distance Car with Large Wheels Traveled (cm)
10	
20	
30	

Which table will provide the best data to test the students' hypothesis?

- a. **Data Table A**
- b. Data Table B
- c. Data Table C
- d. None of the above

6. On the right is a drawing of three strings hanging from a bar. The three strings have metal weights attached to their ends.

String 1 and String 3 are the same length. String 2 is shorter.

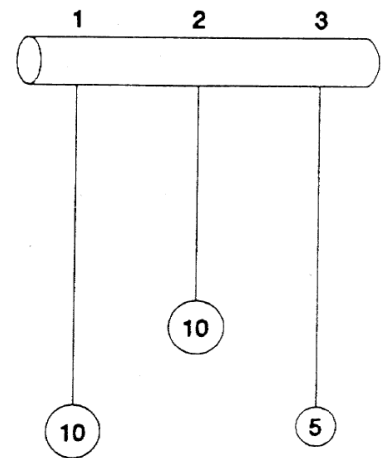
- A 10-unit weight is attached to the end of String 1.
- A 10-unit weight is also attached to the end of String 2.
- A 5-unit weight is attached to the end of String 3.

The strings (and attached weights) can be swung back and forth and the time it takes to make a swing can be timed.

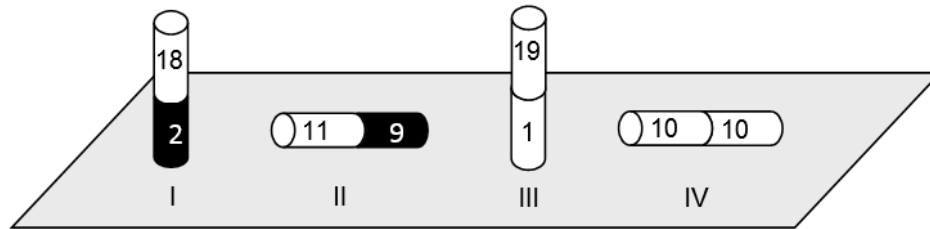
Suppose you want to find out whether the length of the string has an effect on the time it takes to swing back and forth.

Which strings would you use to find out?

- a. only one string
- b. all three strings
- c. strings 2 and 3
- d. strings 1 and 3
- e. **strings 1 and 2**



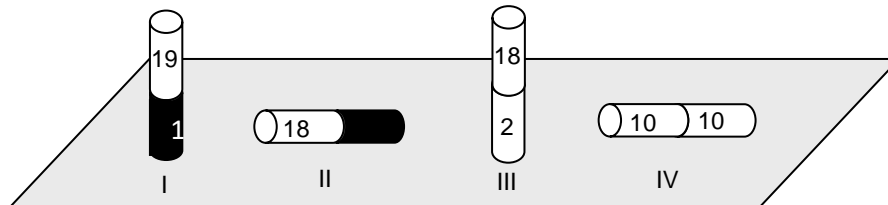
7. In each of four glass tubes, there are twenty fruit flies. The tubes are sealed shut. Tubes I and II are partially covered with black paper; Tubes III and IV are not covered. The tubes are placed on a clear glass table with tubes I and III standing up on their ends and tubes II and IV lying flat as shown. For five minutes they are exposed to red light that is everywhere around each tube. At the end of these five minutes, the number of flies in the uncovered part of each tube is counted as shown below. Note that a total of 20 fruit flies are still in each tube.



Red light is everywhere around each tube. Table is clear glass.

This experiment shows that flies respond to (respond to means move towards or away from):

- red light but not gravity
 - gravity but not red light**
 - both red light and gravity
 - neither red light nor gravity
 - cannot be determined
8. In a second experiment, blue light and a different kind of fly are used. The results are shown in the drawing.



Blue light is everywhere around each tube. Table is clear glass.

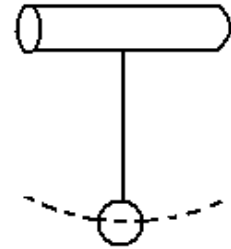
In order to show whether or not these flies respond to blue light, which of the following is needed?

- results in tube I or tube II
- results in both tubes I and II
- results in both tubes I and III
- results in both tubes II and IV**
- results in all four tubes

9. As shown below, a string hangs from a bar and has a small ball attached to its end. The string (and the attached ball) can be made to swing back and forth, and the number of complete swings during a certain time interval can be counted. A student wants to know whether or not the number of swings in 10 seconds is affected by the length of the string, the mass of the ball, and/or the angle the string is pulled away from the vertical at the time of release.

The student carried out several experiments to investigate which factors affected the number of swings in 10 seconds. The conditions and results are shown in the table below.

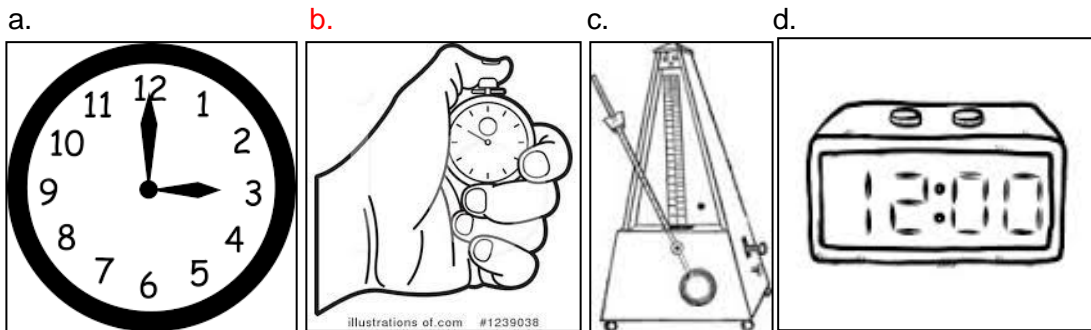
		Trial 1	Trial 2	Trial 3
Variables	length of string	10cm	10cm	40cm
	mass of ball	20g	30g	30g
	angle at release	15°	30°	15°
Number of swings in 10 seconds		16	16	8



Ignoring all other variables, which variable or variables do you think can be tested using the information shown in the table above? You may choose more than one answer on your scantron sheet.

- a. the length of the string
- b. the mass of the ball
- c. the angle at release
- d. none of the variables can be tested using the information in the table

10. If the student in the previous question wanted to measure the time for one swing, which of the following, pictured below, is the best tool to use?



11. In the Spring of last year, five packets of cucumber seeds were donated to a fifth grade classroom. The students noticed that each packet included an expiration date. Each packet had a date printed on it to saying that “*For best results, plant seeds by*” the date indicated. One of the seed packets indicated that the date had passed six years ago, while the other seeds’ date was still two years in the future. The students wondered if the older seeds would still grow. Two groups of students conducted an experiment to determine if the age of the seeds affected their germination rate. After conducting the experiment, each group came to the same conclusion: *older cucumber seeds germinate at a lower rate than newer seeds.*

Consider each group’s data table below.

Group 1:

Seed Expiration Date	# of seeds germinated of 20 seeds per tray	Germination Rate
Expired	10	50%
Not Expired	12	60%

Group 2:

Seed Expiration Date	Tray	# of seeds germinated of 20 seeds per tray	Germination Rate	Average Seed Germination rate
Expired	1	11	55%	50%
	2	10	50%	
	3	9	45%	
	4	10	50%	
Not Expired	5	12	60%	60%
	6	13	65%	
	7	11	55%	
	8	12	60%	

Which group has better evidence supporting the claim that older cucumber seeds germinate at a lower rate than newer cucumber seeds?

- a. Group 1
- b. Group 2
- c. Both groups have equally strong evidence
- d. Neither group has strong evidence

12. Joe grows peas on his farm to sell at the market, but over the years he has never been able to increase his production. This year, compared to previous years, Joe observed that the average temperature during the growing season was cooler and that it rained a lot more. Joe would like to produce and sell more pounds of peas and decides to take a scientific approach. He wonders whether this season’s cooler temperatures and higher rainfall are ideal for producing more pounds of peas. Joe decides to test his hypothesis by conducting an experiment indoors where he will grow a few small beds of peas over the winter.

Which tools will Joe need to collect data to test his hypothesis?

- a. meter stick and weight scale
- b. meter stick, soil moisture sensor, and weight scale
- c. soil moisture sensor and thermometer

- d. soil moisture sensor, thermometer, and weight scale
- e. meter stick, soil moisture sensor and thermometer

13. An agricultural researcher wants to determine how effective one fertilizer is compared to another. The researcher originally plants soybeans on two plots of land located 3 miles apart.

Land Plot 1	Open field, Brand X fertilizer is applied
Land Plot 2	Surrounded by a forest, Brand Y fertilizer is applied

At the end of the experiment, the researcher finds that more soybeans were produced on Plot 2 than Plot 1. What, if anything, could the researcher do to improve this experiment?

- a. The researcher does not need to do anything to improve the experiment. Her results were conclusive that Fertilizer Brand Y is more effective at producing soybeans.
- b. The researcher should repeat the experiment. However, this time she should apply each fertilizer to opposite halves of both Plot 1 and Plot 2 and compare production on each half.
- c. The researcher should repeat the experiment. However, this time she should apply Fertilizer Brand Y to Plot 1 and Brand X to Plot 2 and compare the results to her original finding.
- d. There is nothing the researcher can do to improve this experiment. No conclusion can be drawn.

14. Tom, Jerry and Dan are good friends and go fishing together most weekends. They often use the same type of fishing tools and have similar skills in fishing (that is, they typically catch about the same number of fish as one another every time). On their last fishing trip, they used a variety of fishing rods and fishhooks, and chose between two different locations to fish (see the conditions given in the table below).

		Tom	Jerry	Dan
Variables	Fishing rods	long	long	Short
	Fishhooks	thick	thin	thin
	Locations	Point A	Point A	Point B

Ignoring other possible influences and using the conditions as listed in the table, which of the following variable(s) can be tested for possible impact on the number of fish caught? Select ALL that apply by filling in the relevant bubbles on your scantron sheet.

- a. Length of the fishing rod
- b. Thickness of the fishhooks
- c. Location of fishing
- d. None of the above

15. Two groups of students investigate whether adding crushed eggshells to soil will affect its pH level. They divide a bag of soil into 8 smaller samples and measure the pH of each sample to be 6.1. Both groups then add differing amounts of crushed eggshells to their soil samples and retest the pH levels as shown in the table below.

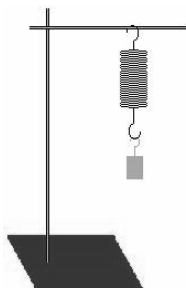
Amount of Eggshells Added	pH Level	
	Group A	Group B
Soil with no added eggshells	6.1	6.1
Soil with 1 pinch of crushed eggshells	6.1	6.3
Soil with 2 pinches of crushed eggshells	6.1	6.5
Soil with 3 pinches of crushed eggshells	6.3	6.7

The students look at the data table and realize their results are inconsistent between the two groups. They feel that a different conclusion could be drawn depending on which group's data was considered. The students decide to repeat the experiment. Before they do so, however, they have to decide what to do differently.

Which option is most likely to result in data that is more accurate than the data they have already collected?

- They should use larger soil samples.
- They should add water to the mixture of soil and eggshells.
- They should add 0, 1, 2, and 3 grams of crushed eggshell to the samples instead of using pinches.**
- They should test three more samples that have 4, 5, and 6 pinches of crushed eggshells added.

16. A group of students investigate the relationship between the amount of mass hung on a spring and how much the spring stretches. They collect the data in the table below.



Mass (g)	Amount of Stretch (cm)
0	0.00
50	0.20
100	0.40
150	0.60
200	0.80

Assuming that the spring can handle larger masses without being damaged, use the data in the table to predict how much the spring will stretch if a 350 g mass is hung on the spring.

- 1.00 cm
- 1.20 cm
- 1.40 cm**
- 1.60 cm
- There is not enough information provided to make this prediction.

17. Two students conduct an experiment to investigate how temperature affects the amount of three different solids that can be dissolved in 1000 ml of water at temperatures between 40 °C and 100 °C. The students collect data as shown in the table below.

Solid	Amount dissolved in 1000 mL water at 40 °C (g)	Amount dissolved in 1000 mL water at 60 °C (g)	Amount dissolved in 1000 mL water at 80 °C (g)	Amount dissolved in 1000 mL water at 100 °C (g)
Salt (Sodium)	365	375	380	390
Sugar (Sucrose)	2410	2880	3630	4870
Slaked Lime (Calcium hydroxide)	1.4	1.2	0.9	0.6

Suppose the temperature of the water was only 20 °C. Predict how this would affect how much of each solid would be dissolved in 1000 ml of water at this new temperature when compared to the higher temperatures.

- Smaller amounts of all three solids would be dissolved at this lower temperature.
 - Larger amounts of all three solids would be dissolved at this lower temperature.
 - Smaller amounts of salt and sugar, but a larger amount of calcium hydroxide would be dissolved at this lower temperature.
 - Larger amounts of salt and sugar, but a smaller amount of calcium hydroxide would be dissolved at this lower temperature.
 - There is not enough information provided to make this prediction.
-

18. A group of fifth grade students investigated local weather conditions during the month of May. Before they collected any data, they made two hypotheses:

Hypothesis 1: *The amount of cloud cover impacts the air temperature.*

Hypothesis 2: *The amount of cloud cover impacts how strong the winds are that day.*

The class then collected data each day during the month of May including the date and time, outdoor temperature, amount of cloud cover, wind speed, wind direction, and presence of rain.

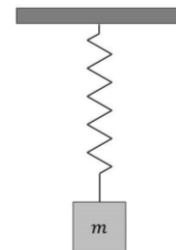
Which of the data the students collected is necessary to test their two hypotheses?

- amount of cloud cover, outdoor temperature, and wind speed
- outdoor temperature, wind direction, and wind speed
- amount of cloud cover, outdoor temperature, and presence of rain
- outdoor temperature, presence of rain, and wind speed

Use the scenario below for the next two questions:

An object suspended from a spring can be made to bob up and down. During science class, multiple groups of students investigated whether certain variables affected the number of times the object bobbed up and down in 10 seconds. The table below displays data collected by Sally's lab group using the conditions as shown.

Variable	Scenario A	Scenario B	Scenario C
Initial unstretched spring length	12 inches	27 inches	12 inches
Distance object is pulled when released	3 inches	6 inches	3 inches
Object mass	50 g	72 g	72 g
# of bobs that occur in 10 seconds	54	30	45



19. At the end of the investigation, other lab groups claimed that the **object's mass impacts the number of bobs that occur in 10 seconds**. Did Sally's lab group take appropriate measurements and produce data that supports this claim?
- Yes, by comparing Scenarios A and B, Sally's group can make the same claim as other groups.
 - Yes, by comparing Scenarios A and C, Sally's group can make the same claim as other groups.
 - Yes, by comparing Scenarios B and C, Sally's group can make the same claim as other groups.
 - Yes, by comparing all three scenarios, Sally's group can make the same claim as other groups.
 - None of the scenarios Sally's group tested can be used to support the claim of the other groups.
20. At the end of the investigation, other lab groups made a second claim that the **initial unstretched spring length impacts the number of bobs in 10 seconds**. Sally's group realizes that they did not collect appropriate data to support this second claim. What conditions for an added test would help Sally's group collect appropriate data to support or refute this second claim?

a.

Scenario D
12 inches
6 inches
50 g

b.

Scenario D
12 inches
6 inches
72 g

c.

Scenario D
27 inches
6 inches
50 g

d.

Scenario D
39 inches
6 inches
50 g

- e. None of the above

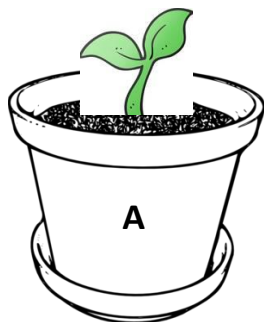
21. A group of students drop a ball from 4 different heights and record the amount of time it takes the ball to fall through each distance. Their data table is shown below.

Trial	?	Time of Drop (s)
A	2	0.63
B	4	0.89
C	6	1.10
D	8	1.26

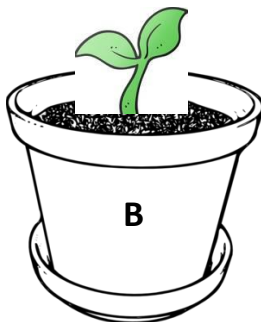
Accurate and detailed labelling is important in recording scientific data. Which of the following is the best label for the second column?

- a. Speed (m/s)
- b. Height
- c. Distance of Drop (m)
- d. Speed
- e. Mass (g)

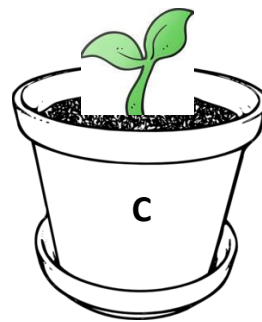
22. A group of students wish to investigate whether *the amount of water added each week affects plant growth*. They obtained three identical seedlings of the same height, all of which were planted in identical pots. They placed the pots in similar growing conditions which includes growing the plants indoors under grow lights. Every Monday the students plan to add a different amount of water to each pot as indicated below each picture.



20 mL of water
added each week



40 mL of water
added each week



60 mL of water
added each week

Which information should the students record in their lab notebooks to investigate whether the amount of water added each week affects plant growth? Choose one.

- a. volume of water added each week, flower production
- b. volume of water added each week, color of stems
- c. volume of water added each week, height of plants
- d. height of plants, color of leaves
- e. height of plants, temperature of the soil