

REAL Science Challenge

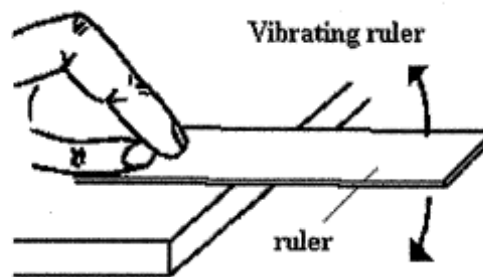
Relevant, Extracurricular, Applied, Learning

- Please print your name, student number, and grade on the ScanTron sheet.
- The challenge has 30 questions based on 4 passages. All information needed to answer the questions are provided in the passages provided. Refer to them when necessary.
- Time limit: 45 minutes

Experiment #1

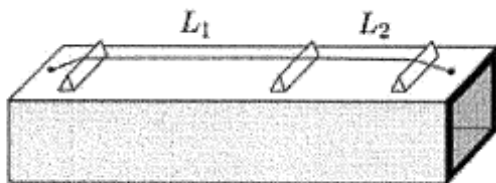
Sally and George perform an experiment. A ruler is attached to a table with a pen taped to the end free to vibrate. The ruler is struck and it vibrates up and down against a piece of paper. The pen draws a wave pattern on the paper. The students count the number of crests in the wave pattern, while the time is recorded. They then calculate the vibrating frequency. Here is their data:

Time (s)	2.0	2.0	2.0	2.0
Length over the edge of the table (cm)	80	60	40	20
Number of crests counted	8	12	16	32
Frequency (Hz)	4.0	6.0	8.0	16



Experiment #2

Pythagoras is of course famous for finding the relationship between the three sides of a right triangle, but he also figured out the relationship between musical notes and the length of the vibrating string, the basis of which we still use today in our western musical scales. An octave is divided into eight notes. When a note is an octave higher than another, there are eight notes between, the string is half the length, and the frequency is twice. A perfect fourth is four notes above another, and the frequency is $4/3$ times higher. A perfect fifth is five notes higher and the frequency is $3/2$ higher. Pictured below is a wooden sound box with a taut (tight) metal string attached to each end. A wooden slider is able to move between the two ends changing the length of each string, thus changing the note(s) produced. L_1 is able to produce a sound independently of L_2 or they can produce a sound at the same time.



$$L_1 = 1/2, L_2 = 1/2 : \text{unison};$$

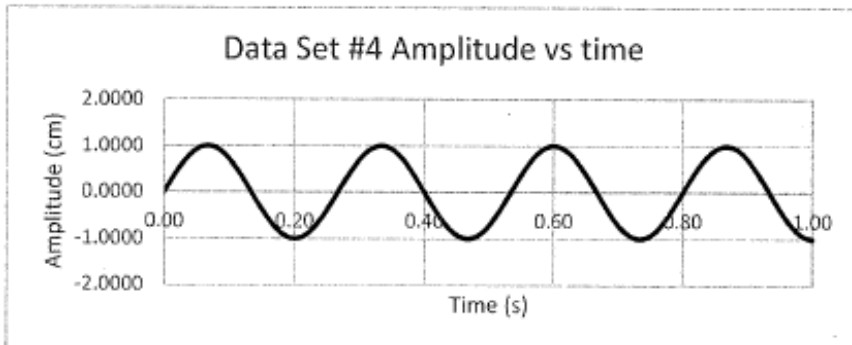
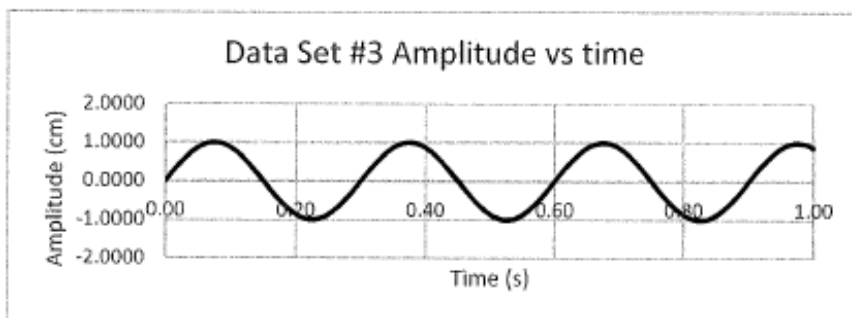
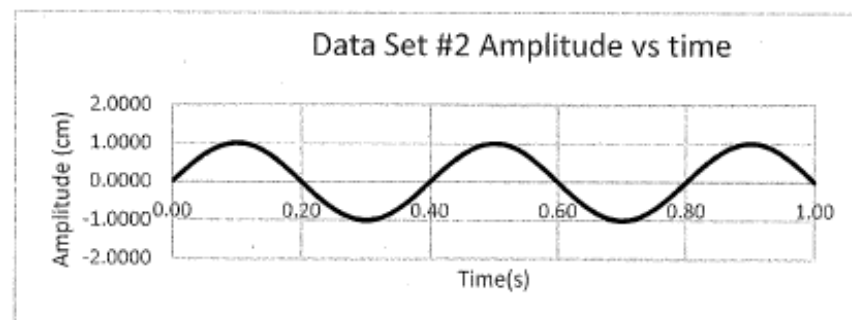
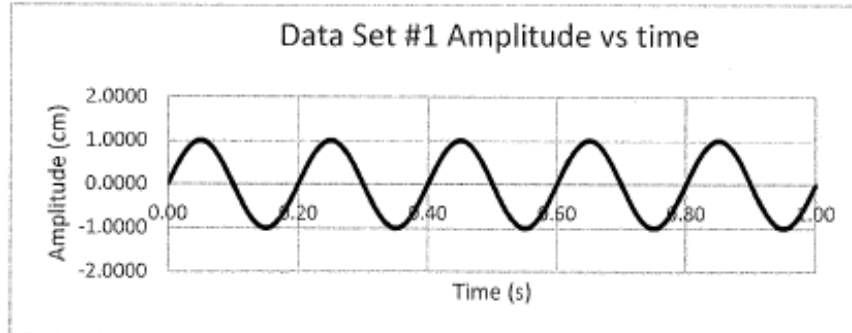
$$L_1 = 1/3, L_2 = 2/3 : \text{octave};$$

$$L_1 = 3/5, L_2 = 2/5 : \text{perfect fifth};$$

$$L_1 = 4/7, L_2 = 3/7 : \text{perfect fourth}$$

Experiment #3

Four electronic waves are generated by a machine and the wave pattern is recorded on the electroscop. Pictured below are the data of amplitude vs time graphs. Examine the data carefully.



1. In experiment #1, which is the independent variable and which is the dependent variable?

	Independent variable	Dependent variable
a)	Vibrating frequency of ruler	Length of ruler
b)	Length of pen	Vibrating frequency
c)	Width of ruler	Sound produced
d)	Length of ruler over edge of table	Amplitude
e)	Length of ruler over edge of table	Vibrating frequency of ruler

2. What is a good hypothesis for experiment #1?

- a) If the length of the ruler increases, then the frequency decreases
- b) If the length of the ruler increases, then the frequency of vibration increases
- c) If the frequency of vibration increases, then the length of the ruler is greater
- d) If the length of the ruler increases, then more of the ruler is over the edge of the table
- e) If the frequency of the vibration increases, then the pen draws more waves

3. In experiment #2, where is the wooden slider so that each side L_1 and L_2 produce the same note?

- a) Closer to the right side
- b) Closer to the left side
- c) As far to the right side as possible
- d) As far to the left side as possible
- e) In the middle

4. In experiment #3, how do you know data set #1 has the highest frequency?

- a) There are more peaks in one second than the other data sets
- b) There are fewer peaks in one second than the other data sets
- c) Data set #1 has the smallest amplitude
- d) Data set #2 has only three peaks in one second

5. Using experiments #2 and #3, compare data set #1 and data set #2

- a) Data set #2 is one octave above data set #1
- b) Data set #1 is a perfect fifth above data set #2
- c) Data set #1 is a perfect fourth above data set #2
- d) Data set #1 is one octave above data set #2

6. In experiment #2, if the taut metal string is 30cm long, where do you place the wooden slider to produce L_2 an octave higher than L_1 .

- a) 18 cm from the right side
- b) 10 cm from the left side
- c) 10 cm from the right side
- d) 15 cm from the right side

7. Using experiments #2 and #3, compare data set #2 with data set #4.

- a) Data set #2 is a perfect fifth above data set #4
- b) Data set #4 is a perfect fourth above data set #2
- c) Data set #4 is a perfect fifth above data set #2
- d) Data set #4 is one octave above data set #2

8. Using experiment #1, if the length of the ruler hanging over the edge of the table is 70cm, estimate what you think the frequency vibration would be?
- 5 Hz
 - 7 Hz
 - 9 Hz
 - 11 Hz
 - 3 Hz
9. Using experiment #1, if the first length of the ruler hanging over the edge of the table is 80 cm, how do you produce a sound that is perfect fifth higher?
- Decrease the length hanging over the edge by a factor of 2
 - Decrease the length hanging over the edge by a factor of $\frac{3}{2}$
 - Increase the length hanging over the edge by a factor of 2
 - Increase the length hanging over the edge by a factor of $\frac{3}{2}$
10. Suppose Sally and George now move on to experimenting with the sound box in experiment #2 to find a relationship between different notes of a musical scale. Which **two** of the following pieces of equipment must they use?
- Ruler
 - Timing device
 - Thermometer
 - Test tube
 - Triple beam balance
11. Suppose Edith and Archie now begin experimenting with the equipment used by Sally and George in experiment #1. They want to find out the relationship between the colour of the ruler and the frequency of vibration. What do you think they will find out?
- Blue rulers vibrate at a higher frequency than red rulers
 - Red rulers vibrate at vibrate at a higher frequency than blue rulers
 - Of all the colours, yellow rulers have the lowest frequency of vibration.
 - There is no relationship between the colour of the ruler and its frequency of vibration
12. Suppose Edith and Archie now begin experimenting with the equipment used by Sally and George in experiment #1. They want to find out the relationship between the colour of the ruler and the frequency of vibration. Here are their results. What can you assume about their results?

Red rulers	Vibrate at the lowest frequency
Yellow rulers	Vibrate somewhere in between the highest and lowest frequency recorded
Green rulers	Vibrate somewhere in between the highest and lowest frequency recorded
Blue rulers	Vibrate at the highest frequency

- Edith and Archie have performed a valid and sound experiment
- Edith and Archie need to take more data to find the difference between yellow rulers and green rulers
- Edith and Archie have not accounted for the possibility of other factors in their data, such as mass and length of the ruler
- Edith and Archie have not accounted for the possibility of other factors in their data, such as air temperature and air pressure

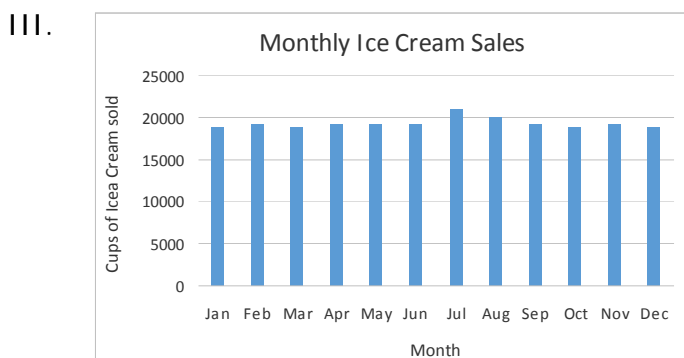
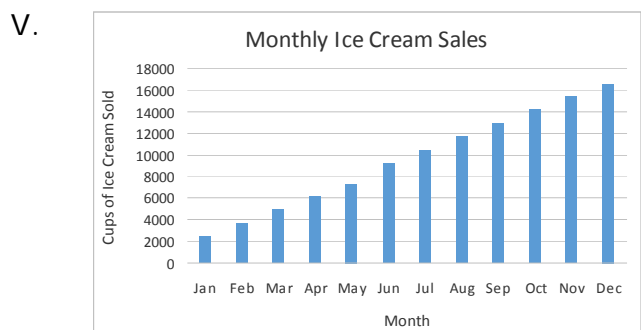
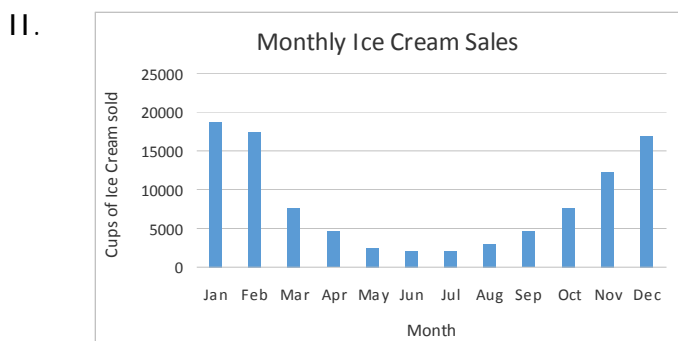
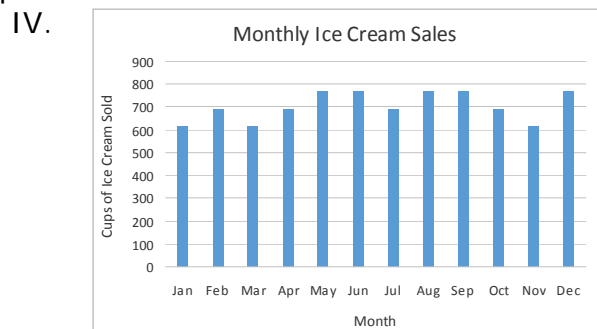
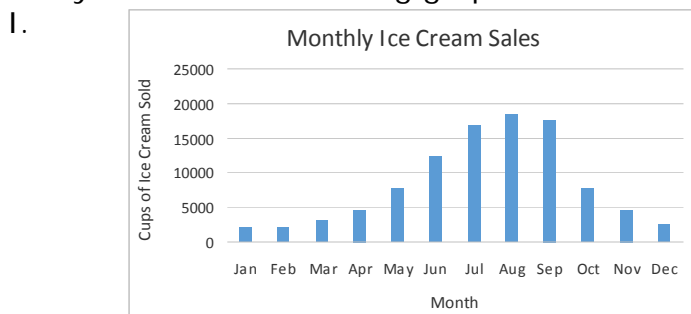
13. In experiment #3, what is the amplitude of data set #1?
- 1.0 cm
 - 0.2 s
 - 0.05 s
 - 1.0 s
 - 0.25 s
14. A complete wave is defined as when the wave completes one full cycle of up and down. In experiment #3 data set #1, there are five complete waves in the 1.0 second of time. How many complete waves are there in data set #2?
- 2
 - 2.5
 - 3
 - 4
 - 5
15. In experiment #2, if the taut metal string is 30 cm long, where do you place the wooden slider to produce L_2 , a perfect fourth higher than L_1 ?
- 1/4 from the left side
 - $4/7 \times 30$ cm from the left side
 - 15 cm from the left side
 - $4/7 \times 30$ cm from the right side
16. In experiment #2, if the taut metal string is 30 cm long, where approximately do you place the wooden slider to produce L_1 a single note higher than L_2 ?
- Just slightly to the right of centre
 - Just slightly to the left of centre
 - As far to the left as possible
 - As far to the right as possible
17. Assume the data in experiment #3 is produced by a ruler hanging over the edge of a table, which data set is produced by the shortest ruler?
- Data set #4
 - Data set #3
 - Data set #2
 - Data set #1
18. You can produce all eight notes of a musical scale using one sound box as in experiment #2.
- True
 - False
19. Which **three** experiments would produce results similar to the data in experiment #3?
- Heating water in a beaker. You measure temperature vs time.
 - A pendulum swing. You change the length of the string.
 - A spring bouncing up and down. You change the spring tightness.
 - Mixing water and vinegar. You observe the mixing of the different colour liquids.
 - Plant growth. You measure the amount of plant growth through a 24 hour cycle of daylight and night.

20. In experiment #3, which data set has the largest amplitude?
- Data set #1
 - Data set #2
 - Data set #3
 - Data set #4
 - They all have the same amplitude

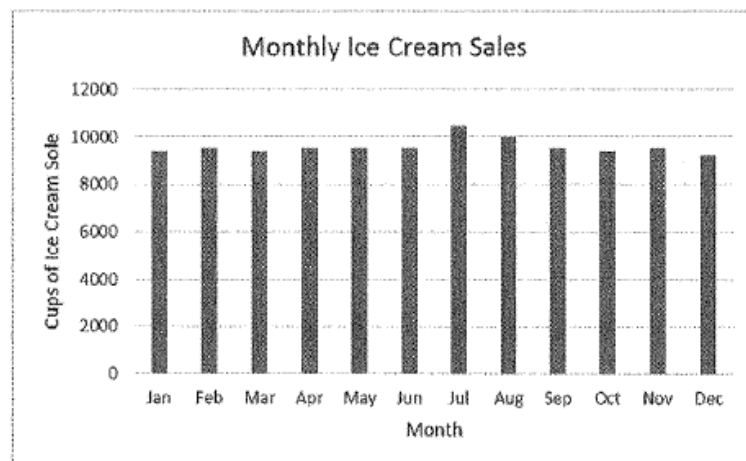
Experiment #4

Bob and George both love ice cream and they decide to open up an ice cream franchise. In a franchise, stores of the same franchise sell the exact same product at each location using the exact same ingredients and recipes. McDonald's Restaurants is an example of a franchise. Bob and George decide to open up 2 ice cream shops as part of this franchise: Bob's shop will be located in temperate Vancouver, BC, and George's shop will be located in tropical West Palm Beach, Florida.

The following hypothetical graphs display the cups of ice cream sold per month over the course of a year. Use the following graphs for the next 4 questions.



21. Which of the above graphs would best represent the sales for Bob's ice cream store?
- Graph I
 - Graph II
 - Graph III
 - Graph IV
 - Graph V
22. Which of the above graphs would best represent the sales for George's ice cream shop?
- Graph I
 - Graph II
 - Graph III
 - Graph IV
 - Graph V
23. If monthly ice cream sales recorded for Bob's store looked like Graph 5, what could be concluded?
- Customers enjoy eating ice cream in winter more than any other month
 - Bob's ice cream recipe has been getting better and better throughout the year, thereby attracting more customers
 - Bob's marketing plan, which was initiated at the beginning of the year and involved word-of-mouth endorsements and paid ads on social media, has gradually helped get Bob more attention.
 - As temperatures drop, more and more customer enjoy eating ice cream.
 - Most of Bob's customers are students who typically eat more ice cream as a means to cope with increased stress.
24. A new ice cream shop called The Ice Cream Emporium has opened down the street from George's ice cream shop. This ice cream shop has had a negative effect on George's business. Assume George's monthly sales prior to the Emporium moving in looks like the following:



Also assuming the Emporium is the only thing affecting ice creams sales at George's shop. Then, which of the above graphs would best represent the sales figures for George's ice cream shop after the Emporium has moved in?

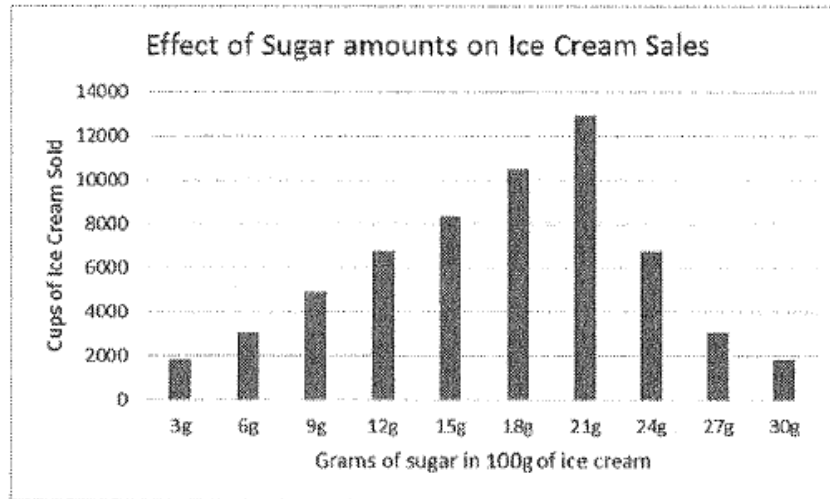
- Graph I
- Graph II
- Graph III
- Graph IV
- Graph V

25. At the end of the year, Bob and George compare their monthly sales and graphs. It turns out their graphs and sales were identical. What is the conclusion that can be drawn from this observation?
- Ice cream sales are not affected by geographical location
 - Ice cream is more popular in Vancouver than in West Palm Beach.
 - Bob is spending more on advertisement than George
 - West Palm Beach had lowered ice cream sales due to more extreme weather as a result of climate change.
 - Bob's use of local ingredients has attracted more customers to his shop than George's shop.



26. George wants to bring his ice cream shop to another city. But, he wants a city that would provide the same conditions as his current city. Which city would be the best choice?
Note: West Palm Beach, Florida and Vancouver, BC are both indicated by flags 1 and 2 respectively on the map above.
- New York, NY (Flag 3)
 - Las Vegas, Nevada (Flag 4)
 - Seattle, Washington (Flag 5)
 - New Orleans, Louisiana (Flag 6)
 - Albuquerque, New Mexico (Flag 7)
27. Which locations would you expect to have the same sales as Vancouver?
- Seattle and New York
 - Las Vegas and Albuquerque
 - Seattle and Las Vegas
 - Louisiana and Albuquerque
 - Louisiana and New York

The following graph shows the number of ice cream sales as it relates to the amount of sugar in the ice cream recipe. Use the graph in the following 2 questions.



28. What amount of sugar produces the most the ice cream sales?
- 6 g
 - 15 g
 - 21 g
 - 24 g
 - 30 g
29. 5900 cups of ice cream was reportedly sold. What amount of sugar may have been used in the recipe?
- 9 g
 - 12 g
 - 18 g
 - 25 g
 - 30 g
30. Both Bob and George use social media to advertise their ice cream shops. What could be one hypothesis they could test?
- Ad revenue at Facebook has increased compared to the year before. More businesses are using social media advertisement and the ice cream shop should too.
 - If social media advertising can bring more customers to the ice cream shop, then the ice cream shop should use social media.
 - If the ice cream shop spends money advertising in print newspapers, then the ice cream shop will sell more ice cream.
 - If the ice cream shop shares more pictures on Instagram, then more customers will come to our shop.
 - Getting a picture or message "shared" or "re-tweeted" on social media can bring a lot of attention to the ice cream shop.