ACT SCIENCE PRACTICE PAPER 6
SET 1

Directions: Each passage is followed by several questions. After reading a passage, choose the best answer to each question and fill in the corresponding oval on your answer document. You may refer to the passages as often as necessary.

You are NOT permitted to use a calculator on this test.

Two ways to measure the quality of soil are bulk density and the soil organic matter test, SOM (a measure of the active organic content). High-quality soil provides structure to plants and moves water and nutrients, so plants grow in larger quantities, leading to higher crop yields at harvest.

Bulk density is measured as the dry weight of a sample of soil divided by the volume of the sample. A bulk density measure above 1.33 g/cm^3 negatively affects soil quality. Figure 1 shows the bulk density levels for 5 different years at Fields A and B.

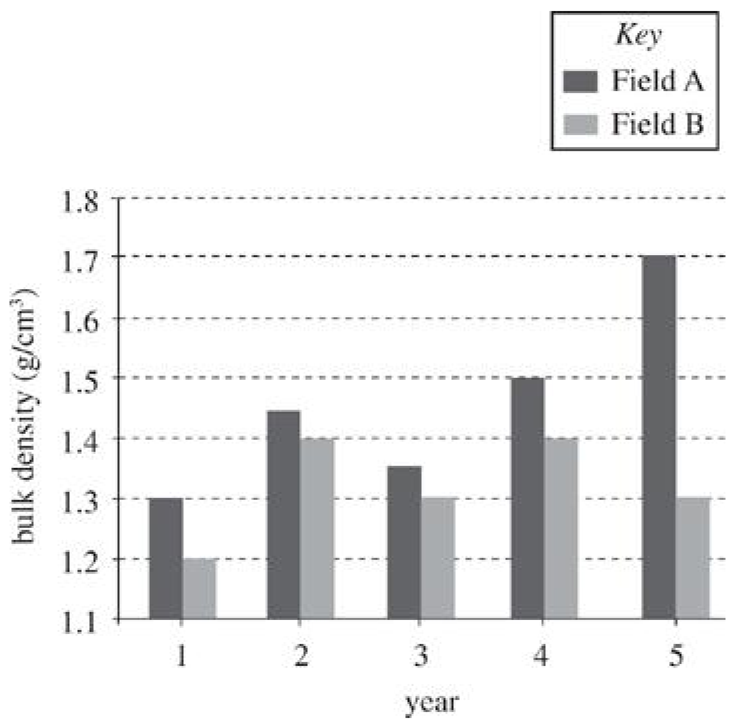


Figure 1

Table 1 shows how soil quality varies with SOM. Table 2 shows the average SOM at the end of each of the 5 years.

Table 1	
SOM	Soil quality rating

<?0.25	poor
0.25 to 0.50	fair
0.51 to 0.75	good
>?0.75	excellent

Table 2

	Average SOM

	0.8 9
	0.2 8

Figure 2 shows the total crop yield at each field at the end of the 5 years.

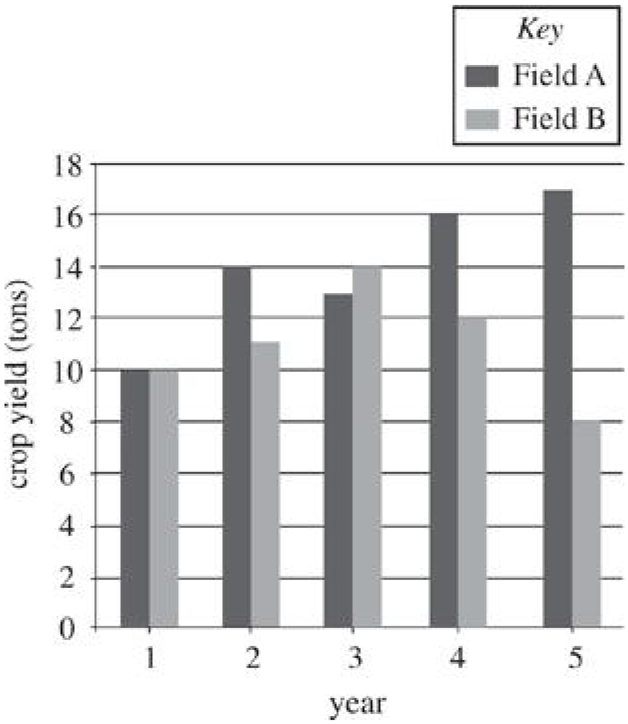


Figure 2

1. Which set of data best supports the claim that Field A has *lower* soil quality than Field B?

A. Figure 1

B. Figure 2

C. Table 1

D. Table 2

2. If 8 tons or fewer in crop yields were considered a failed harvest, in which year and in which field would there have been a failed harvest?

F. Field A in Year 1

G. Field A in Year 3

H. Field B in Year 4

J. Field B in Year 5

3. Suppose a new crop rotation for Field B included legumes and other deep-rooted and high-residue crops. The SOM of this field will most likely change in which of the following ways? The SOM will:

A. decrease, because soil quality is likely to increase.

B. decrease, because soil quality is likely to decrease.

C. increase, because soil quality is likely to increase.

D. increase, because soil quality is likely to decrease.

4. Based on Figures 1 and 2, consider the average bulk density and the average crop yields for Fields A and B over the study period. Which site had the lower average crop yield, and which site had the higher average bulk density?

<u>Lower crop yield</u> <u>Higher bulk density</u>

F. Field A Field A

G. Field B Field B

H. Field A Field B

J. Field B Field A

5. As soil quality improves, the number of earthworms increases. Students hypothesized that more earthworms would be found in Field B. Are the data presented in

Table 2 consistent with this hypothesis?

A. Yes; based on SOM, Field B had a soil quality rating of fair and Field A had a soil quality rating of poor.

B. Yes; based on SOM, Field B had a soil quality rating of excellent and Field A had a soil quality rating of fair.

C. No; based on SOM, Field B had a soil quality rating of poor and Field A had a soil quality rating of fair.

D. No; based on SOM, Field B had a soil quality rating of fair and Field A had a soil quality rating of excellent.

Ferric oxide (Fe_2O_3) is more commonly known as rust. This is produced in a reaction between iron, a

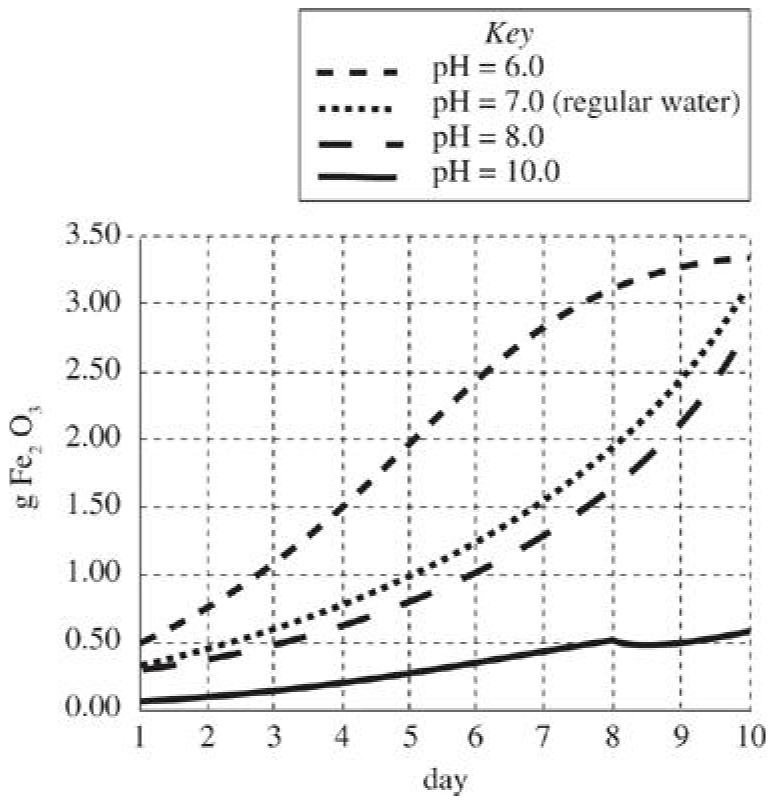
common metal, and water, H_2O.

$$2Fe + 3\,H_2O \longrightarrow Fe_2O_3 + 3H_2$$

Table 1 shows the amount of Fe_2O_3 produced over time from 15 g Fe submerged in different liquids: 100 mL distilled water, a salt solution made from dissolving 20 g of salt in 100 mL of distilled water, and a sugar solution made from dissolving 20 g of sugar in 100 mL of distilled water.

Table 1				
Solution	g Fe_2O_3 produced			
	Day 2	Day 4	Day 6	Day 8
Distilled water	0.34	0.40	0.59	0.72
Salt solution	0.56	0.81	1.23	1.84
Sugar solution	0.00	0.05	0.11	0.19

The distilled water trial was repeated four times, but for each trial, a total volume of 100 mL of water was buffered to different pH levels.



6. Based on

Table 1, if the amount of Fe_2O_3 produced on Day 9 had been measured for the salt solution, it would most likely have been:

F. less than 0.56 g.

G. between 0.59 g and 0.72 g.

H. between 1.23 g and 1.84 g.

J. greater than 1.84 g.

7. In the experiments shown in

Table 1 and

Figure 1, by measuring the rate at which Fe_2O_3 was formed every day, the experimenters could also measure the rate at which:

A. H_2O was produced.

B. H_2 was produced.

C. Fe was produced.

D. FeO was produced.

8. Consider the amount of Fe_2O_3 produced by the salt solution on Day 2. Based on

Table 1 and

Figure 1, the water buffered to pH = 10.0 produced approximately the same amount of Fe_2O_3 on which of the following days?

F. Day 1

G. Day 3

H. Day 6

J. Day 10

9. According to

Table 1, what was the amount of Fe_2O_3 produced by the sugar solution from the time the amount was measured on Day 6 until the time the amount was measured on Day 8?

A. 0.08 g

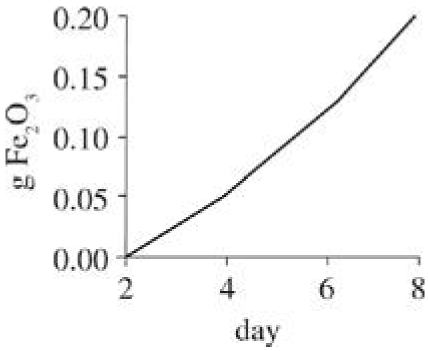
B. 0.11 g

C. 0.19 g

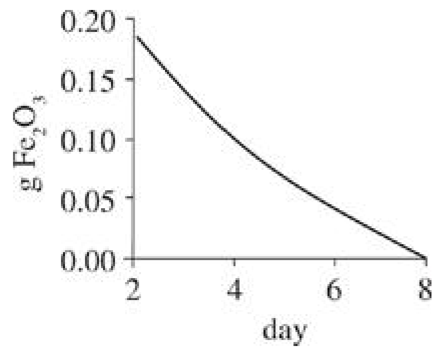
D. 0.30 g

10. Based on

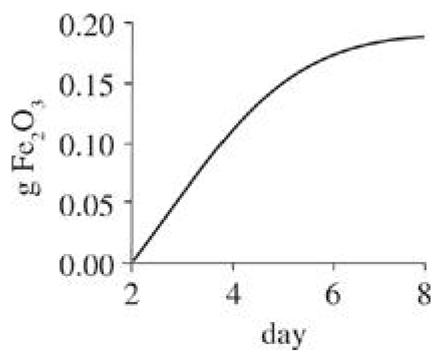
Table 1, which graph best shows how the amount of Fe_2O_3 produced by the sugar solution changes over time?



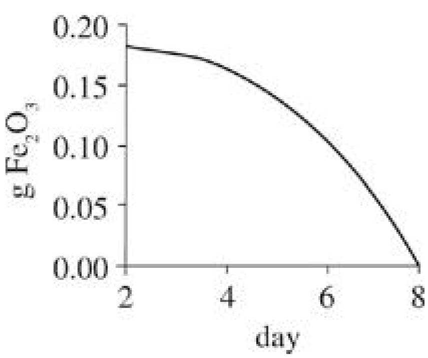
F.



G.



H.



J.

SET 2

Some physics students conducted experiments to study forces and springs. They used several identical springs attached to the bottom of a level platform, shown below in Figure 1.

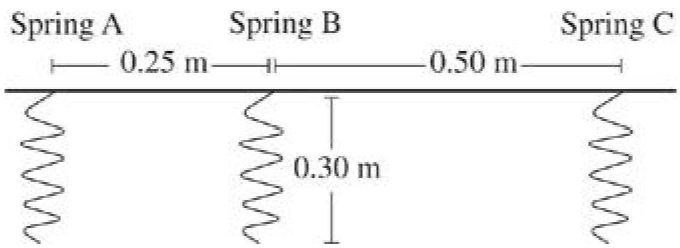


Figure 1

The length of each spring was 0.30 m when there were no weights attached. The springs had identical spring constants. When weights were attached, the length of the springs increased as the force of the weights stretched the springs downward. The length the springs stretched was proportional to the force of the weight.

Experiment 1

The students attached different weights to two springs at once. When the springs stopped oscillating and came to a rest, the students measured their length. In Trial 1, a 10.0 N weight was attached to Spring A and Spring B, which were attached 0.25 m apart on the board. In Trial 2, a 15.0 N weight was attached to Spring A and Spring B. In Trial 3, a 20.0 N weight was attached to Spring A and Spring B. The effects of the weights on Springs A and B for the three trials are shown below in Figure 2.

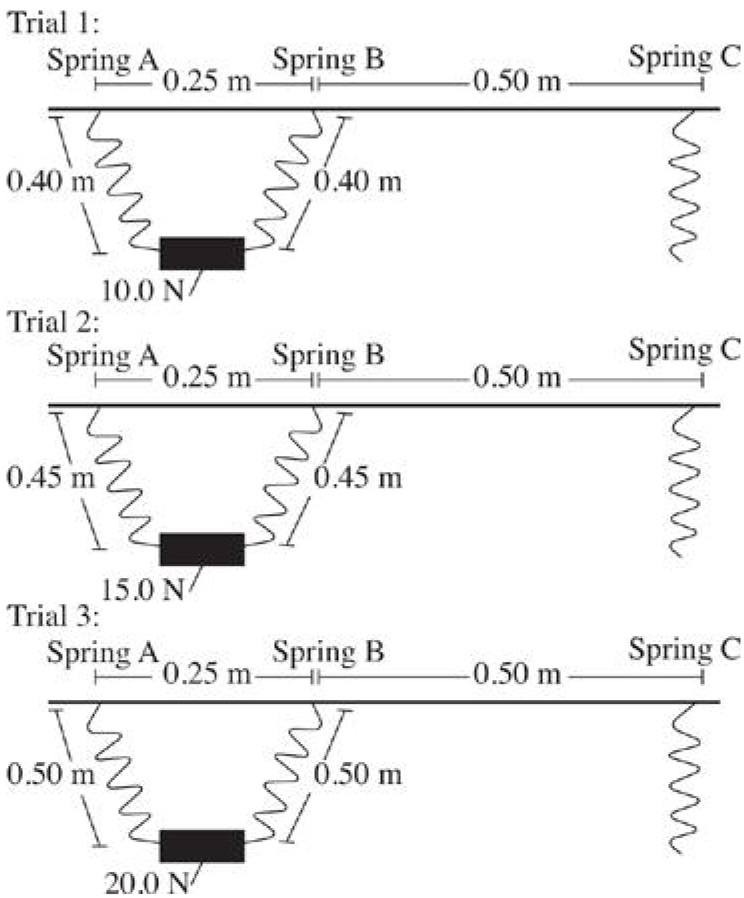


Figure 2

Experiment 2

The students attached a 0.25 m board with a high friction surface to Spring B and Spring C (see Figure 3). The students then placed a 5.0 N weight at different locations along the board. Because of the high friction surface, the weights stayed in place when the board was at an angle.

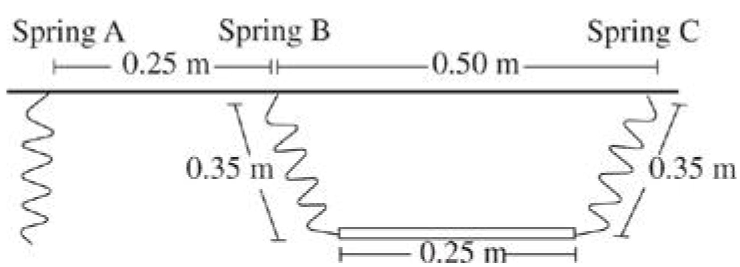


Figure 3

In each of these 3 trials, a 5.0 N weight was placed at various distances along the board from the attachment with Spring B (see Figure 4). In Trial 4, the weight was placed so its center was 0.075 m along the board from the attachment with Spring B. In Trial 5, the weight was placed so its center was 0.125 m along the board from the attachment with Spring B. In Trial 6, the weight was placed so its center was

0.200 m along the board from the attachment with Spring B. The effects of the weight position on the lengths of Springs B and C for the 3 trials are also shown in Figure 4.

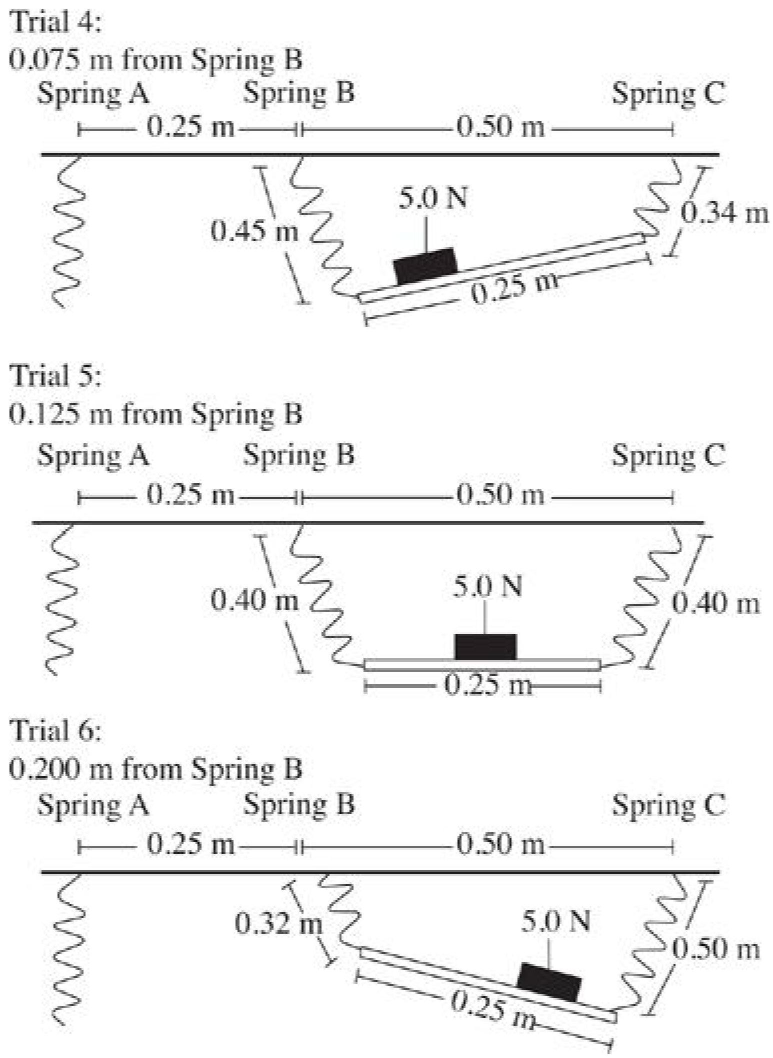
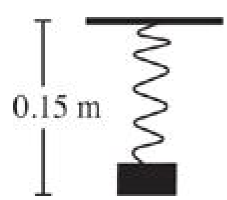
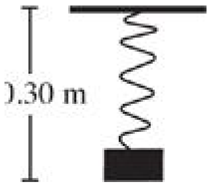
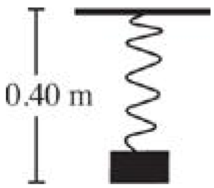


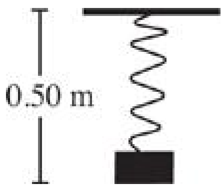
Figure 4

1. In a new study, suppose the students had placed a 10.0 N weight on Spring A only. Which of the following drawings most likely represents the results of this experiment?

A. 

B. 

C. 

D. 

2. In Experiment 2, as the distance between the 5.0 N weight and the attachment of the board to Spring B increased, the force exerted on Spring B:

F. increased only.

G. decreased only.

H. increased, then decreased.

J. decreased, then increased.

3. Which of the following statements is most likely the reason that the students used identical springs in Trials 1-3?

A. To ensure that the springs stretched similarly when a weight was attached.

B. To ensure that the springs did not share the weight evenly.

C. To compensate for the effects of oscillation on the results of the experiment.

D. To compensate for the weight of the board exerted on each of the springs.

4. Based on the results of Trials 1 and 5, the weight of the board used in Experiment 2 was:

F. 0 N.

G. 2.5 N.

H. 5.0 N.

J. 10.0 N.

5. In which of the following trials in Experiment 2, if any, was the force exerted by the weight and the board equally distributed between Springs B and C?

A. Trial 4

B. Trial 5

C. Trial 6

D. None of the trials

6. Assume that when a spring is stretched from its normal length, it stores the energy to return to its normal state as potential energy. Assume also that the greater the force of the weight stretching the spring, the more the spring will stretch. Was the potential energy stored by Spring C higher in Trial 5 or Trial 6?

F. In Trial 5, because the force of the weight on Spring C was greater in Trial 5.

G. In Trial 5, because the force of the weight on Spring C was less in Trial 5.

H. In Trial 6, because the force of the weight on Spring C was greater in Trial 6.

J. In Trial 6, because the force of the weight on Spring C was less in Trial 6.

Sodium chloride, or salt, is used to de-ice roads and sidewalks during the winter because it lowers the freezing point of water. Water with sodium chloride freezes at a lower temperature than water alone, so putting sodium chloride on icy sidewalks and roads can cause the ice to melt. Sodium chloride is highly effective as a de-icer and is given a de-icer proof of 100. Distilled water is ineffective as a de-icer and is given a de-icer proof of 0.

Different proportions of sodium chloride and distilled water were combined to create mixtures with de-icer proofs between 0 and 100.

Table 1

De-icer proof	Volume of distilled water	Volume of sodium chloride
100	0 mL	50 mL
80	10 mL	40 mL
60	20 mL	30 mL
40	30 mL	20 mL
20	40 mL	10 mL
0	50 mL	0 mL

Experiment 1

A 125-g cube of ice, frozen from distilled water, was submerged in 500-mL of each de-icing mixture listed in Table 1. After 300 seconds, the portion of the cube that had not been melted was removed and weighed. The de-icing rate was calculated by determining the weight of ice melted per second. By doing this, it was possible to determine de-icer proof for a solution based on the rate at which ice was melted.

Experiment 2

The addition of magnesium chloride to a de-icer changes its de-icer proof. Different amounts of magnesium chloride were added to 500-mL samples of sodium chloride. Each de-icing mixture was tested under the same conditions as Experiment 1 and the measured de-icing rate was used to calculate the de-icer proof. The results are shown in Figure 1.

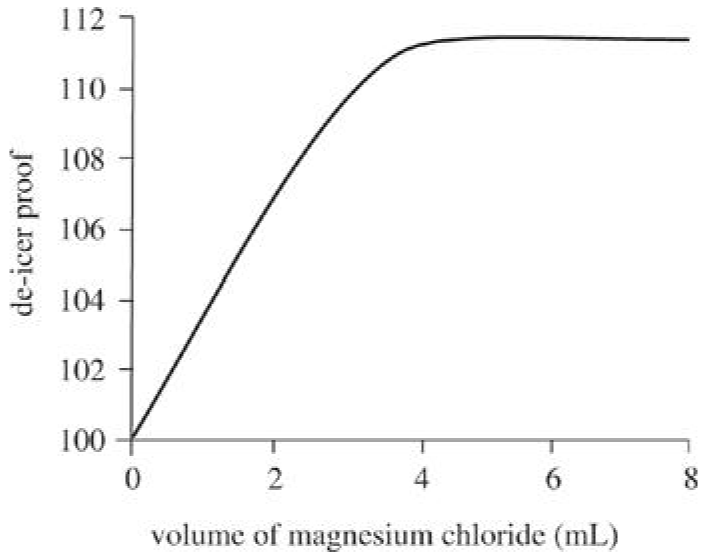


Figure 1

Experiment 3

The temperature rating (TR) is the minimum de-icer proof of a de-icing solution for a de-icer to have any effect on ice. 125-g cubes of ice were submerged in 500-mL samples of De-icers A and B and the samples were then placed in freezers at different temperatures. Table 2 shows the de-icer proof determined for each de-icer at each freezer temperature and the known TR for that temperature.

Table 2

Freezer temperature	TR	Proof of:	
		De-icer A	De-icer B
–10°C	24.1	90.3	70.1
–25°C	36.9	78.9	64.9
–50°C	49.7	68.8	59.7
–75°C	52.3	56.6	51.7

7. Suppose a trial had been performed in Experiment 3 with a freezer temperature of -30°C. At this temperature, which of the following sets of proofs would most likely have been determined for De-icer A and De-icer B? <u>De-icer A</u> <u>De-icer B</u>

A. 68.8 59.7

B. 70.1 70.5

C. 75.5 61.8

D. 78.9 64.9

8. Based on

Table 1, if 1 mL distilled water were added to 4 mL sodium chloride, the proof of this mixture would be:

F. 4

G. 8

H. 40

J. 80

9. Based on Experiment 3, as temperature decreases, the minimum proof for a de-icer to be effective:

A. increases only.

B. decreases only.

C. increases, then decreases.

D. decreases, then increases.

10. Which of the following expressions is equal to the proof for each de-icer mixture listed in

Table 1?

F. $\frac{\text{volume of sodium chloride}}{\text{volume of water}} \times 100$

G. $\frac{\text{volume of water}}{\text{volume of sodium chloride}} \times 100$

H. $\frac{\text{volume of sodium chloride}}{(\text{volume of water + volume of sodium chloride})} \times 100$

J. $\frac{\text{volume of water}}{(\text{volume of water + volume of sodium chloride})} \times 100$

11. Based on

Table 1 and Experiment 2, if 6 mL magnesium chloride were added to a mixture of 10 mL distilled water and 40 mL sodium chloride, the proof of the resulting de-icer would most likely be:

A. less than 60.

B. between 60 and 80.

C. between 80 and 112.

D. greater than 112.

12. Which of the 2 de-icers from Experiment 3 would be better to use to melt ice if the temperature were between -10°C and -75°C?

F. De-icer A, because its proof was lower than the TR at each temperature tested.

G. De-icer A, because its proof was higher than the TR at each temperature tested.

H. De-icer B, because its proof was lower than the TR at each temperature tested.

J. De-icer B, because its proof was higher than the TR at each temperature tested.

SET 3

Comets originate from regions of our solar system that are very far from the sun. The comets are formed from debris thrown from objects in the solar system: they have a nucleus of ice surrounded by dust and frozen gases. When comets are pulled into the earth's atmosphere by gravitational forces and become visible, they are called meteors. Meteors become visible about 50 to 85 km above the surface of Earth as air friction causes them to glow. Most meteors vaporize completely before they come within 50 km of the surface of Earth.

The Small Comet debate centers on whether dark spots and streaks seen in images of the Earth's atmosphere are due to random technological noise or a constant rain of comets composed of ice. Recently, images were taken by two instruments, UVA and VIS, which are located in a satellite orbiting in Earth's magnetosphere. UVA and VIS take pictures of the aurora borealis phenomenon, which occurs in the magnetosphere. The UVA and VIS technologies provide images of energy, which cannot be seen by the human eye.

The pictures taken by VIS and UVA both show dark spots and streaks. Scientists debate whether these spots and streaks are due to a natural incident, such as small comets entering the atmosphere, or random technological noise. The layers of Earth's atmosphere are shown in Figure 1.

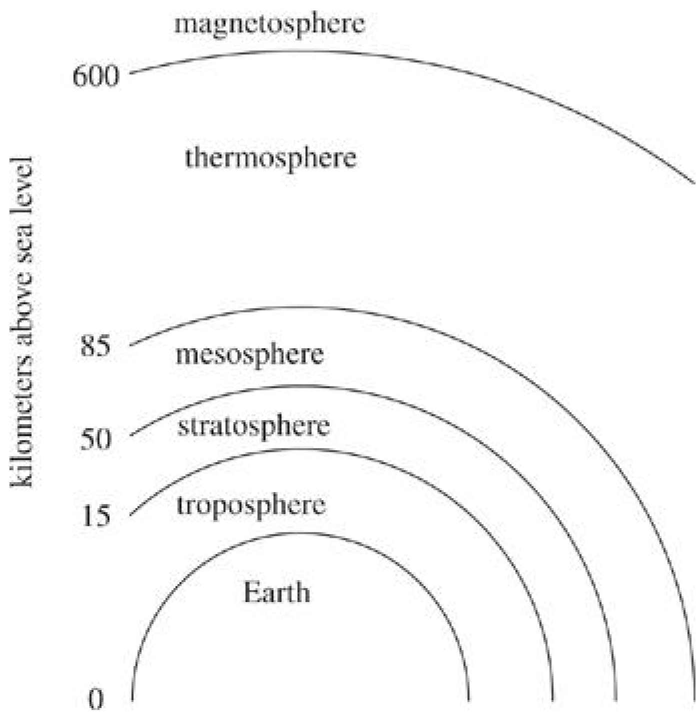


Figure 1

Two scientists debate whether there is a constant rain of comets burning up in Earth's magnetosphere.

Scientist 1

Small comets are pulled into Earth's atmosphere by gravitational effects and burn up in the magnetosphere. They are about 20 to 30 feet in diameter and burn up in the magnetosphere because they are much smaller than the comets that become meteors. Comets with larger radii will burn up in portions of the atmosphere much closer to Earth. About 30,000 small comets enter the Earth's magnetosphere every day. The dark spots and streaks on UVA and VIS images occur when the small comets begin to boil in the magnetosphere, releasing krypton and argon and creating gaseous H_2O, which interacts with hydroxyl, OH^-, radicals. Images taken by these instruments at different points in time show the same frequency of dark spots and streaks and give conclusive evidence in favor of the Small Comet theory. If the spots and streaks were due to random technological noise, then the frequency of their appearance would fluctuate.

Scientist 2

The dark spots and streaks in the UVA and VIS images are due to technological noise, not small comets. If the Small Comet Theory were true, and 20 small comets bombarded Earth's atmosphere per minute, there would be a visible bright object at least twice every five minutes. This is because, as objects enter the Earth's mesosphere, they burn up, creating large clouds of ice particles. As the ice particles vaporize, they have a brightness in the sky approximately equal to that of Venus. Because comets rarely enter Earth's atmosphere, such bright flashes are rare occurrences, far less than two times every five minutes, so the Small Comet theory cannot be correct. Further, since comets originate from regions of space beyond the orbit of the farthest

planet, they contain argon and krypton. If the Small Comet theory were true and Earth were bombarded by 30,000 comets per day, there would be 500 times as much krypton in the atmosphere as there actually is.

1. According to Scientist 2, which of the following planets in our solar system is most likely the closest to the region of space where comets originate?

A. Jupiter

B. Venus

C. Neptune

D. Saturn

2. Based on Scientist 1's viewpoint, a comet that burns up in the thermosphere would have a diameter of:

F. 5-10 ft.

G. 10-20 ft.

H. 20-30 ft.

J. greater than 30 ft.

3. Which of the following generalizations about small comets is most consistent with Scientist 1's viewpoint?

A. No small comet ever becomes a meteor.

B. Some small comets become meteors.

C. Small comets become meteors twice every five minutes.

D. All small comets become meteors.

4. During the *Perseids*, an annual meteor shower, more than 1 object burning up in the atmosphere is visible per minute. According to the information provided, Scientist 2 would classify the Perseids as:

F. typical comet frequency in the magnetosphere.

G. unusual comet frequency in the magnetosphere.

H. typical meteor frequency in the mesosphere.

J. unusual meteor frequency in the mesosphere.

5. Given the information about Earth's atmosphere and Scientist 1's viewpoint, which of the following altitudes would most likely NOT be an altitude at which small comets burn up?

A. 750 km

B. 700 km

C. 650 km

D. 550 km

6. Suppose a study of the dark holes and streaks in the UVA and VIS images revealed krypton levels in the atmosphere 500 times greater than normal levels. How would the findings of this study most likely affect the scientists' viewpoints, if at all?

F. It would strengthen Scientist 1's viewpoint only.

G. It would strengthen Scientist 2's viewpoint only.

H. It would weaken both Scientists' viewpoints.

J. It would have no effect on either Scientist's viewpoint.

7. Scientist 1 would most likely suggest enhanced imaging technology that can take pictures of objects in the atmosphere be used to look at what region of the atmosphere to search for small comets?

A. The region between 15 km above sea level and 50 km above sea level.

B. The region between 50 km above sea level and 85 km above sea level.

C. The region between 85 km above sea level and 600 km above sea level.

D. The region between above 600 km above sea level.

A cotton fiber is composed of one very long cell with two cell walls. During a 2-week period of cell life called elongation, cotton fibers grow 3 to 6 cm. The level of hydrogen peroxide in cotton fiber cells during elongation is very high. Scientists wanted to study whether the level of hydrogen peroxide affected the length of the cotton fiber.

The amount of hydrogen peroxide is controlled by an enzyme called superoxide dismutase (SOD). This enzyme turns superoxide into hydrogen peroxide. Four identical lines of cotton fiber plants were created. Each line was able to express only one of three types of superoxide dismutase. The gene for SOD1 was incorporated into L1, the gene for SOD2 was incorporated into L2, and the gene for SOD3 was incorporated into L3.

Experiment

Five cotton plants of each line were grown in nutrient solution until cotton fibers completed the elongation period. The average length of cotton fibers and the average concentration of hydrogen peroxide were determined. This information is shown in Table 1.

Table 1			
Line	At the end of elongation period:		
	Average elongation period length (days)	Average amount of hydrogen peroxide (μmol/mg)	Average cotton fiber length (cm)
L1	8	2.1	3.6
L2	4	0.2	1.4
L3	20	5.6	5.9
L4	12	2.3	4.5

Next, because the scientists had determined the average elongation period, they measured the amount of hydrogen peroxide and the length of the cotton fibers halfway through their elongation period. This information is shown in Table 2.

Table 2			
Line	At the midpoint of elongation period:		
	Day of elongation period	Average amount of hydrogen peroxide (μmol/mg)	Average cotton fiber length (cm)
L1	4	4.1	2.7
L2	2	5.3	1.0
L3	10	12.4	2.0
L4	6	8.7	3.2

Finally, the scientists measured the amount of hydrogen peroxide and the length of cotton fibers on the first day of the elongation period. This information is shown in Table 3.

Table 3			
Line	On the first day of elongation period:		
	Day of elongation period	Average amount of hydrogen peroxide (μmol/mg)	Average cotton fiber length (cm)
L1	1	1.2	0.2
L2	1	6.0	0.5
L3	1	5.7	0.1
L4	1	1.9	0.2

8. For L2, as the elongation period moved from the first day to the end, the amount of hydrogen peroxide:

F. increased only

G. decreased only

H. increased, then decreased

J. decreased, then increased

9. Which of the following is a dependent variable in the experiment?

A. The point in time during the elongation period

B. The type of superoxide dismutase the plant could express

C. The length of the cotton fiber

D. The type of cotton plant

10. A cotton fiber is one very long cell with two cell walls. A cotton fiber is a special kind of what type of cell?

F. Prokaryotic

G. Animal

H. Plant

J. Bacterial

11. One plant had an average cotton fiber length of 0.5 cm, and the average amount of hydrogen peroxide in its fibers was 5.9 μmol/mg. Which of the following most likely describes this plant?

A. It was from L1 and at the end of its elongation period.

B. It was from L1 and at the midpoint of its elongation period.

C. It was from L2 and at the beginning of its elongation period.

D. It was from L2 and at the end of its elongation period.

12. The scientists used one of the four lines of cotton plants as a control. Which line was most likely the control?

F. L1

G. L2

H. L3

J. L4

13. Suppose the data for all the plants were plotted on a graph with the time of the elongation period on the *x*-axis and the average length of the cotton fiber on the *y*-axis. Suppose also that the best-fit line for these data was determined. Which of the following would most likely characterize the slope of this line?

A. The line would have a positive slope.

B. The line would have a negative slope.

C. The line would have a slope equal to zero.

D. The line would have no slope, because the line would be vertical.