

SCIENCE FULL-LENGTH PRACTICE TESTS 1

SCIENCE TEST*40 Minutes–40 Questions*

Directions: There are six passages in this test. 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.

Passage I

As people age, they experience changes in their bone mineral density (the amount of bone mineral in bone tissue) and serum CTX levels (the amount of a particular marker for bone turnover in the blood). A study examined how treatment time for four different daily supplements affected the average bone mineral density and average serum CTX levels of patients. Table 1 shows how the average bone mineral density for patients treated with each supplement changed over time. Table 2 shows how the serum CTX levels of patients treated with each supplement changed over time. (Note: All of the patients were of the same gender and age at 0 months.)

| Table 1 | | | | |
|---------------------|---|-----------|-----------|-----------|
| Brand of supplement | Average bone mineral density (in mg/cm^3 *) for patients treated with supplement daily for: | | | |
| | 0 months | 18 months | 36 months | 54 months |
| Bonegenic | 130 | 120 | 117 | 116 |
| Calcitrenix | 128 | 125 | 121 | 118 |

| | | | | |
|--|-----|-----|-----|-----|
| Strength+ | 131 | 122 | 118 | 115 |
| Vitagrow | 127 | 123 | 116 | 113 |
| *milligrams per cubic centimeter of bone | | | | |

| Table 2 | | | | |
|------------------------------------|---|-----------|-----------|-----------|
| Brand of supplement | Average serum CTX (in pg/mL*) for patients treated with supplement daily for: | | | |
| | 0 months | 18 months | 36 months | 54 months |
| Bonegenic | 531 | 327 | 304 | 315 |
| Calcitrenix | 416 | 375 | 341 | 307 |
| Strength+ | 507 | 389 | 363 | 371 |
| Vitagrow | 327 | 299 | 293 | 289 |
| *picograms per milliliter of serum | | | | |

1. Suppose that a doctor wants to prescribe the supplement that will help patients maintain as much of their initial bone density as possible when taken daily for 3 years. Based on Table 1, which of the 4 supplements tested would best meet the doctor's preferred specifications?

- A.** Bonegenic
- B.** Calcitrenix
- C.** Strength+
- D.** Vitagrow

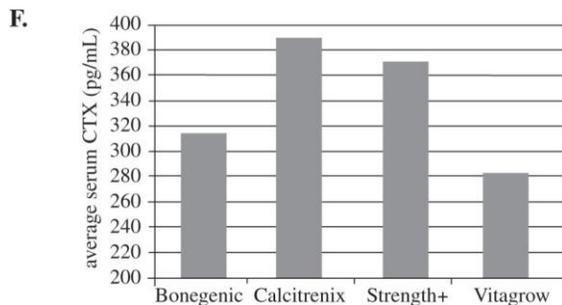
2. According to Table 2, in the study, was the initial average serum CTX of patients given the Strength+ supplement equal to 510 pg/mL, greater than 510 pg/mL, or less than 510 pg/mL ?

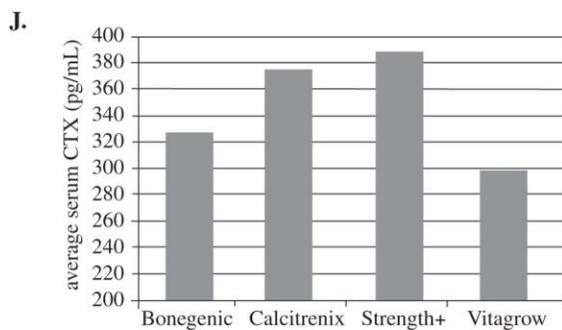
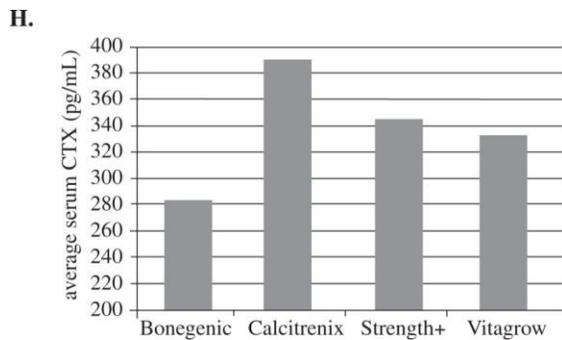
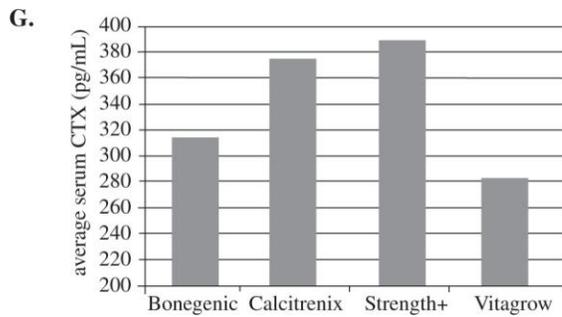
- F. Equal
- G. Greater
- H. Less
- J. Cannot be determined from the given information

3. A scientist predicted that as the time of treatment with a supplement increased from 0 months through 54 months, the average serum CTX produced by patients would always decrease. According to Table 2, this prediction was consistent with the data for which of the 4 supplements?

- A. Calcitrenix only
- B. Calcitrenix and Vitagrow only
- C. Strength+ and Vitagrow only
- D. Bonegenic, Calcitrenix, Strength+, and Vitagrow

4. Based on Table 2, which of the following graphs best shows the average serum CTX for patients given the 4 supplements at a treatment time of 18 months?





5. Based on Table 1, patients of which of the 4 supplements showed the least change in average bone mineral density between 18 months and 36 months of treatment?

- A.** Bonegenic
- B.** Calcitrenix
- C.** Strength+
- D.** Vitagrow

6. Consider the statement “Among the 4 supplements tested, the supplement whose patients initially had the lowest average bone mineral density was also the supplement whose patients had the

greatest average serum CTX at a treatment time of 54 months.” Do the data in Tables 1 and 2 support this statement?

F. Yes; that supplement was Strength+.

G. Yes; that supplement was Vitagrow.

H. No; on average, Vitagrow patients initially had the lowest average bone mineral density, but Strength+ patients had the greatest average serum CTX at 54 months.

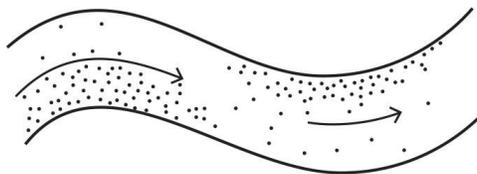
J. No; on average, Strength+ patients initially had the lowest average bone mineral density, but Vitagrow patients had the greatest average serum CTX at 54 months.

Passage II

Riverbed sediment deposition occurs when silt, sand, and gravel traveling in a river settle down and accumulate on the river bottom. Sediment accumulation patterns differ between *straight-channel rivers* and *meandering rivers* (see Figure 1).



straight-channel river
(sediment accumulation is relatively consistent along the riverbed)



meandering river
(sediment accumulation is concentrated more heavily along the inner curves)

Figure 1

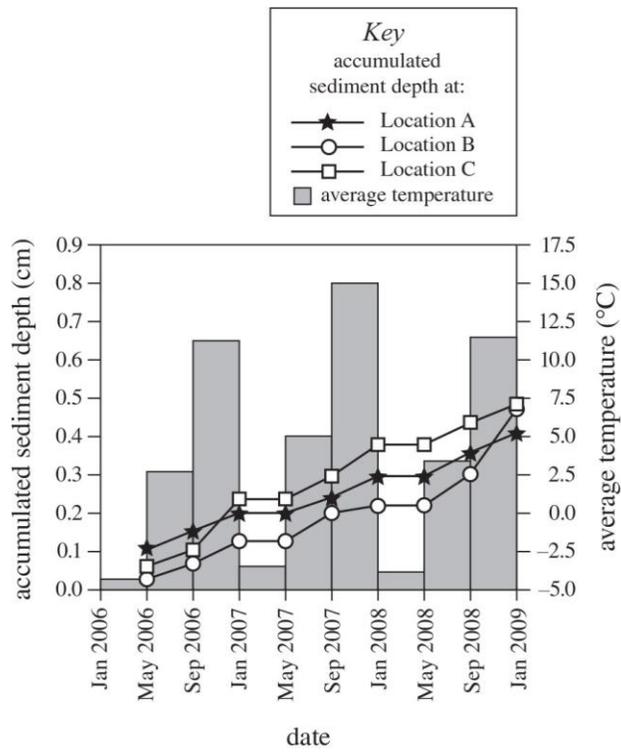


Figure 2

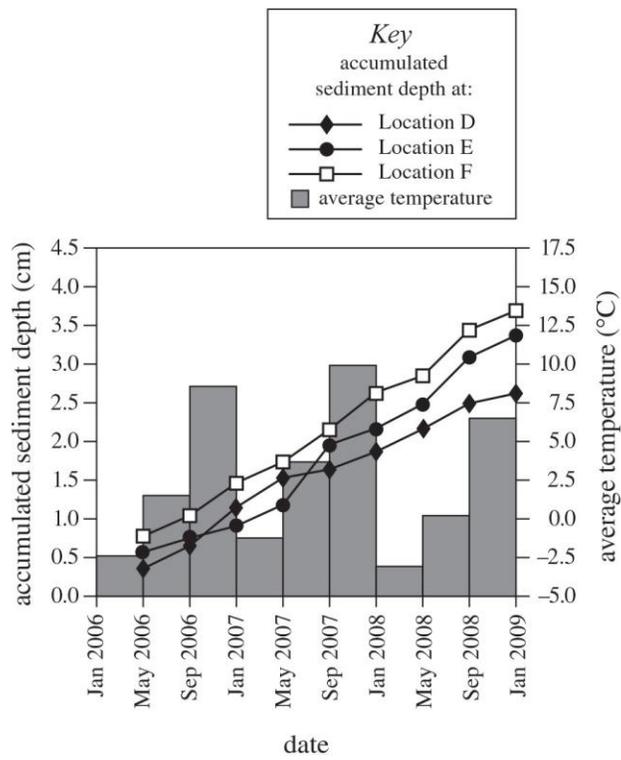
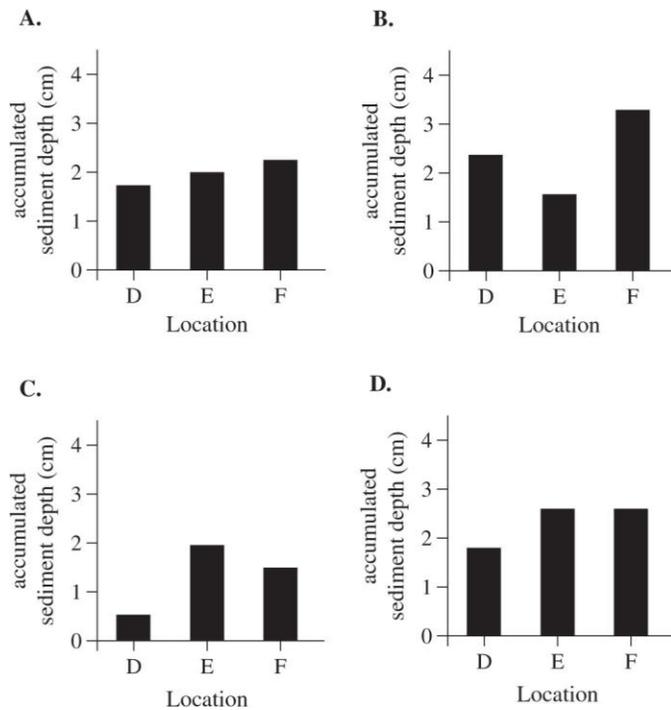


Figure 3

Researchers studied sediment accumulation in six locations along snowmelt-fed rivers: three locations were on a straight-channel river (Locations A–C) and three locations were on a meandering river (Locations D–F). The researchers measured the sediment depth along the center of the riverbed at each location every four months from January of 2006 to January of 2009 and used the values to calculate the accumulation of sediment throughout the study. Figures 2 and 3 show the results for Locations A–C and D–F, respectively. The average temperatures in the region over each 4-month interval are also shown in both figures.

- 7.** According to Figure 3, the increase in accumulated sediment depth at Location D was the least between which of the following months?
- A.** September 2006 and January 2007
 - B.** May 2007 and September 2007
 - C.** September 2007 and January 2008
 - D.** January 2008 and May 2008
- 8.** Which of the following best explains why researchers recorded temperature data along with accumulated sediment data?
- F.** When temperatures are high, snowmelt may prevent any sediment from reaching the river.
 - G.** When temperatures are low, lack of snowmelt may limit the amount of sediment that flows into the river.
 - H.** When temperatures are high, snowmelt may limit the amount of sediment that flows into the river.
 - J.** When temperatures are low, lack of snowmelt may increase the amount of sediment that flows into the river.
- 9.** According to Figure 3, which of the following graphs best shows the total accumulated sediment depth at Locations D–F by September 2007 ?



10. In Figure 2, consider the 4-month intervals during which there was no additional sediment accumulation at any of Locations A–C. The average temperature at each location during these time intervals was:

- F.** less than -4°C .
- G.** between -4°C and -2°C .
- H.** between -2°C and 0°C .
- J.** greater than 0°C .

11. Suppose the researchers had also measured, every four months, the accumulated sediment depth near the riverbank on the inner curve at Location E since January of 2006. Based on Figures 1 and 3, in September 2007, would they more likely have recorded an accumulated sediment depth of less than 2 cm or greater than 2 cm ?

- A.** Less than 2 cm, because sediment concentrated more heavily along the center than on the inner curves.
- B.** Less than 2 cm, because sediment concentrated more heavily along the inner curves than in the center.

- C. Greater than 2 cm, because sediment concentrated more heavily along the center than on the inner curves.
- D. Greater than 2 cm, because sediment concentrated more heavily along the inner curves than in the center.

12. According to Figures 2 and 3, over the study period, was the accumulated sediment depth in the straight-channel river greater than or less than the total sediment accumulation in the meandering river?

- F. Greater; sediment accumulated as much as 2.8 cm in the straight-channel river, whereas sediment accumulated as much as 0.3 cm in the meandering river.
- G. Greater; sediment accumulated as much as 3.7 cm in the straight-channel river, whereas sediment accumulated as much as 0.5 cm in the meandering river.
- H. Less; sediment accumulated as much as 0.5 cm in the straight-channel river, whereas sediment accumulated as much as 3.7 cm in the meandering river.
- J. Less; sediment accumulated as much as 0.3 cm in the straight-channel river, whereas sediment accumulated as much as 2.8 cm in the meandering river.

Passage III

Three experiments were performed to examine the flammability of acacia trees.

Experiment 1

Researchers collected 100 branches of similar shape and mass from 100 live acacia trees grown in a particular preserve. Each branch, with all of its attached foliage, was weighed and the *average sample initial mass* (SIM) was recorded. The branches were then placed in a storage room at a constant temperature and 25% humidity. After 5 days, 10 branches were removed from storage and placed in a glass burn chamber filled with dry air where they were ignited and allowed to burn for exactly 10 minutes. After

burning, the remaining sample and all accumulated ash were removed and weighed. The *average sample final mass* (SFM) was calculated. This process was repeated 6 additional times at different storage intervals with 10 branches each time. The *percentage of mass burned* (PMB) for each group was calculated with the following equation:

$$\text{PMB} = \frac{\text{SIM} - \text{SFM}}{\text{SIM}} \times 100$$

The results for all groups are shown in Table 1.

| Table 1 | |
|---------------------|------|
| Storage time (days) | PMB |
| 5 | 64.3 |
| 10 | 68.5 |
| 15 | 71.2 |
| 20 | 73.1 |
| 30 | 75.6 |
| 40 | 76.4 |
| 50 | 78.9 |

Experiment 2

The procedure used in Experiment 1 was repeated except that the dry air in the burn chamber was compressed to three different pressures (see Table 2).

| Table 2 | | | |
|---------------------|-----------------------------------|------|------|
| Storage time (days) | PMB at air pressure (in psi*) of: | | |
| | 20 | 40 | 80 |
| 5 | 67.6 | 68.2 | 72.1 |
| 10 | 70.3 | 71.4 | 75.9 |
| 15 | 72.8 | 74.5 | 78.2 |

| | | | |
|--|------|------|------|
| 20 | 75.7 | 76.7 | 80.3 |
| 30 | 77.2 | 79.6 | 83.5 |
| 40 | 79.5 | 81.8 | 84.7 |
| 50 | 82.9 | 84.4 | 89.6 |
| *pounds of force per square inch of area | | | |

Experiment 3

The procedure used in Experiment 1 was repeated at four different humidity levels during storage (see Table 3).

| Storage time (days) | PMB at humidity (%) of: | | | |
|------------------------|-------------------------|------|------|------|
| | 10% | 15% | 20% | 35% |
| 5 | 73.3 | 70.5 | 66.2 | 61.7 |
| 10 | 76.2 | 73.6 | 70.5 | 63.4 |
| 15 | 81.4 | 77.1 | 72.3 | 66.6 |
| 20 | 84.6 | 79.2 | 75.8 | 68.5 |
| 30 | 88.1 | 82.4 | 77.7 | 69.9 |
| 40 | 93.3 | 86.7 | 80.4 | 71.1 |
| 50 | 95.8 | 90.3 | 82.2 | 73.9 |

13. Based on the results of Experiment 3, storing acacia branches at a constant temperature at what humidity and for what length of time resulted in the least amount of mass burned?

- A. humidity: 10%, storage time: 5 days
- B. humidity: 10%, storage time: 20 days
- C. humidity: 35%, storage time: 5 days
- D. humidity: 35%, storage time: 20 days

14. If an air pressure of 60 psi had been tested in Experiment 2, the PMB at 20 days would most likely have been:

- F.** less than 76.7.
- G.** between 76.7 and 80.3.
- H.** between 80.3 and 83.5.
- J.** greater than 83.5.

15. Suppose the procedure of Experiment 1 is repeated at humidity of 30%. Based on the results of Experiments 1 and 3, a storage time of 10 days will most likely result in a PMB that is:

- A.** less than 63.4.
- B.** between 63.4 and 68.5.
- C.** between 68.5 and 70.5.
- D.** greater than 70.5.

16. Consider the branches in Experiment 1 that were stored for 30 days. If the accumulated ashes had *not* been collected from the burn chamber before the remaining sample was weighed, would their PMB more likely have been less than or greater than the PMB shown in Table 1 for a storage time of 30 days?

- F.** Less, because the SFM would have been less.
- G.** Less, because the SFM would have been greater.
- H.** Greater, because the SFM would have been less.
- J.** Greater, because the SFM would have been greater.

17. At the conclusion of Experiment 1, how many branches had *not* been burned in the burn chamber?

- A. 20
- B. 30
- C. 50
- D. 60

18. Examine the results of Experiments 1 and 2. Compared to the PMB of acacia burned in ordinary dry air, the PMB at any given storage time for acacia burned in compressed air was:

- F. always greater.
- G. always the same.
- H. always less.
- J. at times less and at times greater, depending on the air pressure.

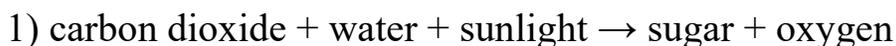
19. Consider the SFM of any group of stored acacia branches in Experiment 1. Also consider the SIM of the group of acacia branches before storage. Was the SFM equal to, greater than, or less than the SIM ?

- A. Equal
- B. Greater
- C. Less
- D. Cannot be determined from the given information

Phenol red is a water-soluble dye that can be used to approximate the pH of an aqueous solution. A phenol red solution can be yellow, orange, or dark pink depending on the solution's pH. Table 1 shows the pH ranges that apply to each solution color in a phenol red solution.

| Solution color | pH |
|----------------|-----------|
| yellow | < 6.6 |
| orange | 6.6 - 8.1 |
| dark pink | > 8.1 |

Since an acid is produced when carbon dioxide dissolves in an aqueous solution, changes in the carbon dioxide concentration of a solution can be observed by monitoring pH changes. In an aquatic ecosystem, the concentration is affected by photosynthesis, which consumes carbon dioxide, and cellular respiration, which produces carbon dioxide. Photosynthesis and cellular respiration are demonstrated by equations 1 and 2, respectively.



A student conducted 3 experiments to determine the effect of the inclusion of aquatic plants and animals on the pH of aqueous solutions.

Experiment 1

The student prepared a solution of phenol red and water. The color of the solution was orange. The student added 20 mL of the phenol red solution to each of 2 glass vials. She also added a piece of *cabomba* (an aquatic plant) in both glass vials, capped the vials, and then incubated them at 20°C for 48 hr. During the 48 hr incubation, one of the vials was exposed to constant light while the other was kept in a dark room. After the incubation period, the color of the solution was noted (see Table 2).

| Table 2 | | | |
|---------|----------------|------------------|-------------------|
| Vial | Organism added | Exposed to light | Color after 48 hr |
| 1 | cabomba | yes | orange |
| 2 | cabomba | no | yellow |

Experiment 2

The student repeated the same process from Experiment 1 except that a goldfish was placed in each vial instead of a piece of cabomba (see Table 3).

| Table 3 | | | |
|---------|----------------|------------------|-------------------|
| Vial | Organism added | Exposed to light | Color after 48 hr |
| 3 | goldfish | yes | yellow |
| 4 | goldfish | no | yellow |

Experiment 3

The procedure for Experiment 1 was repeated except that the student used 4 vials, 2 of which contained both a piece of cabomba and a goldfish and 2 of which contained neither. Two of the vials were exposed to light and two were kept in the dark room (see Table 4).

| Table 4 | | | | |
|---------|------------------|-------------------|------------------|-------------------|
| Vial | Cabomba included | Goldfish included | Exposed to light | Color after 48 hr |
| 5 | yes | yes | yes | orange |
| 6 | yes | yes | no | yellow |
| 7 | no | no | yes | orange |
| 8 | no | no | no | orange |

20. Suppose that the student wanted to conduct additional trials in Experiment 2 with a different type of animal species but did not have any remaining phenol red. Which of the following pieces of equipment could the student use to detect changes in the concentration of carbon dioxide in the solutions in the additional vials?

- F.** Thermometer
- G.** Digital scale
- H.** pH sensor
- J.** Light microscope

21. The pH of the solution in Vial 2 after the 48-hr incubation period was closest to which of the following values?

- A.** 6.0
- B.** 7.5
- C.** 8.5
- D.** 10.0

22. The experimental set-up for Experiment 2 differed from Experiment 1 in which of the following ways? In Experiment 2:

- F.** each vial contained a primary producer, whereas in Experiment 1 each vial contained an omnivore.
- G.** each vial contained an omnivore, whereas in Experiment 1 each vial contained a primary producer.
- H.** both vials were exposed to light, whereas in Experiment 1 both vials were kept in a dark room.
- J.** both vials were kept in a dark room, whereas in Experiment 1 both vials were exposed to light.

23. The student predicted that over the 48-hr incubation period, exposure to light in the absence of photosynthesis and cellular respiration would cause the phenol red to discolor and turn yellow. Are the results of Experiment 3 consistent with her prediction?

- A.** No; after 48 hrs of incubation, the solution in Vial 6 was orange.
- B.** No; after 48 hrs of incubation, the solution in Vial 7 was orange.
- C.** Yes; after 48 hrs of incubation, the solution in Vial 6 was yellow.
- D.** Yes; after 48 hrs of incubation, the solution in Vial 7 was yellow.

24. At the conclusion of the 48-hr incubation, why was the color of the phenol red solution in Vial 1 different from the color of the phenol red solution in Vial 2? The presence of light in Vial 1 was necessary for the cabomba to undergo:

- F.** cellular respiration, which caused it to consume more carbon dioxide than the cabomba in Vial 2.
- G.** cellular respiration, which caused it to consume less carbon dioxide than the cabomba in Vial 2.
- H.** photosynthesis, which caused it to consume more carbon dioxide than the cabomba in Vial 2.
- J.** photosynthesis, which caused it to consume less carbon dioxide than the cabomba in Vial 2.

25. After the 48-hr incubation period, another student removed the cabomba from Vial 1 and added 1 mL of an unknown solution. The student observed that the color of the phenol red solution changed to yellow. Is the unknown solution more likely acidic or basic?

- A. Basic, because the addition of the unknown solution led to an increase in the pH of the phenol red solution.
 - B. Basic, because the addition of the unknown solution led to a decrease in the pH of the phenol red solution.
 - C. Acidic, because the addition of the unknown solution led to an increase in the pH of the phenol red solution.
 - D. Acidic, because the addition of the unknown solution led to a decrease in the pH of the phenol red solution.
- 26.** Suppose that at the end of the incubation period in Experiment 3, the student added a tadpole to Vial 7. If Vial 7 had then been incubated for an additional 48 hrs with exposure to light, the color of the phenol red solution would most likely have been:
- F. yellow, because the tadpole would produce carbon dioxide while undergoing cellular respiration.
 - G. yellow, because the tadpole would consume carbon dioxide while undergoing photosynthesis.
 - H. dark pink, because the tadpole would produce carbon dioxide while undergoing cellular respiration.
 - J. dark pink, because the tadpole would consume carbon dioxide while undergoing photosynthesis.

Passage V

An object at rest will stay at rest when the forces acting on it are balanced such that the *net force* is zero. In each trial of 2 experiments on forces, a helium balloon was at rest with balanced forces, as shown in Figure 1.

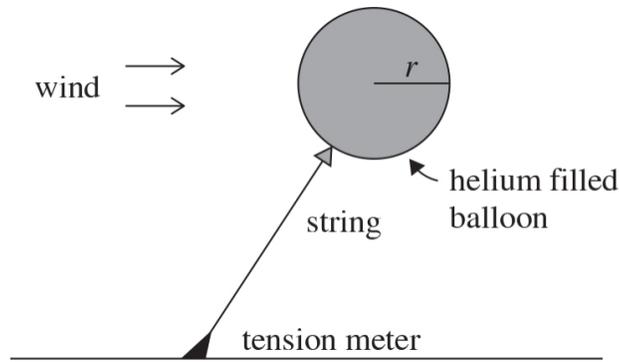


Figure 1

A spherical balloon with radius r is filled with helium and tied to a string tethered to the floor of a lab. A horizontal wind with constant speed V was generated. Once the string was stretched taut and returned to rest, a tension meter was used to measure the tension in the string. The *buoyant force* (upward force due to the low density of helium) was calculated. The forces acting on the balloon while it was at rest are shown in Figure 2.

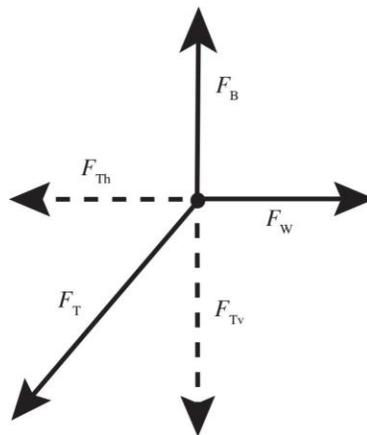


Figure 2

The buoyant force, F_B , was purely vertical, while the wind force, F_W , was purely horizontal. The tension force of the string, F_T , had both a horizontal component, F_{Th} , and a vertical component, F_{Tv} .

Experiment 1

In Trials 1–5, r was varied and V was 2.0 m/s. The values for r , in meters, for each trial are shown in Table 1 along with the values of F_B , F_W , F_{Th} , and F_{Tv} , in newtons (N).

| Table 1 | | | | | |
|---------|---------|-----------|-----------|--------------|--------------|
| Trial | r (m) | F_B (N) | F_W (N) | F_{Th} (N) | F_{Tv} (N) |
| 1 | 0.3 | 1.22 | 0.28 | -0.28 | -1.22 |
| 2 | 0.4 | 2.89 | 0.49 | -0.49 | -2.89 |
| 3 | 0.5 | 5.64 | 0.77 | -0.77 | -5.64 |
| 4 | 0.6 | 9.75 | 1.11 | -1.11 | -9.75 |
| 5 | 0.7 | 15.48 | 1.51 | -1.51 | -15.48 |

Experiment 2

In Trials 6–10, r was 0.5 m and V was varied. The values for V , in meters per second, for each trial are shown in Table 2 along with the values of F_B , F_W , F_{Th} , and F_{Tv} , in newtons (N).

| Table 2 | | | | | |
|---------|-----------|-----------|-----------|--------------|--------------|
| Trial | V (m/s) | F_B (N) | F_W (N) | F_{Th} (N) | F_{Tv} (N) |
| 6 | 3.0 | 5.64 | 1.73 | -1.73 | -5.64 |
| 7 | 4.0 | 5.64 | 3.08 | -3.08 | -5.64 |
| 8 | 5.0 | 5.64 | 4.81 | -4.81 | -5.64 |
| 9 | 6.0 | 5.64 | 6.92 | -6.92 | -5.64 |
| 10 | 7.0 | 5.64 | 9.42 | -9.42 | -5.64 |

27. Based on the results of Experiment 2, as V increased, the wind force:

- A. increased only.
- B. decreased only.
- C. increased, then decreased.
- D. remained constant.

28. According to the results of Experiments 1 and 2, which of the following calculations would always result in zero?

F. $F_B - F_{Tv}$

G. $F_B - F_W$

H. $F_B + F_{Tv}$

J. $F_B + F_W$

29. Suppose that the method used to determine the wind force was only valid for wind forces greater than 0.4 N (meaning this method was unreliable to calculate forces less than 0.4 N). Based on the results of the experiments, was this method appropriate to use in all of these trials?

A. No, because the value of F_W exceeded 0.4 N in all trials.

B. No, because the value of F_W did not exceed 0.4 N in one of the trials.

C. Yes, because the value of F_W exceeded 0.4 N in all trials.

D. Yes, because the value of F_W did not exceed 0.4 in one of the trials.

30. According to the results of Experiment 2, approximately what speed should the horizontal wind be in order for the value of F_{Th} to be equal to F_{Tv} ?

F. 3.5 m/s

G. 4.5 m/s

H. 5.5 m/s

J. 6.5 m/s

31. Suppose that in Experiment 1 a trial had been performed in which F_W was 1.65 N. The radius of the balloon in this trial would most likely have been:

- A. less than 0.6 m.
- B. between 0.6 m and 0.7 m.
- C. between 0.7 m and 0.8 m.
- D. greater than 0.8 m.

32. Which of the following statements about r or V indicates the main difference between the 2 experiments? In Experiment 1:

- F. r was held constant, while in Experiment 2, r was a dependent variable.
- G. r was held constant, while in Experiment 2, r was an independent variable.
- H. V was held constant, while in Experiment 2, V was a dependent variable.
- J. V was held constant, while in Experiment 2, V was an independent variable.

33. A vector quantity, such as force, can be expressed as $V = [V_x, V_y]$ where V_x is the horizontal component of the vector and V_y is the vertical component of the vector. For example, the force (in N) on the string in Trial 5 can be expressed as $V = [-1.51, -15.48]$. Which of the following gives the force (in N) of the *wind* during Trial 5 ?

- A. [1.51, 15.48]
- B. [1.51, 0.00]
- C. [-1.51, 15.48]
- D. [-1.51, 0.00]

Passage VI

In the year 79 BCE, Mt. Vesuvius erupted in a giant plume of ash. Records indicate that volcanic lightning was observed in the ash cloud following the eruption, with some branches of lightning extending up to 15 km above the volcanic vent. Two scientists debate whether *fractoemission* or *ice charging* generated the initial charges that lead to the lightning strikes during the Mt. Vesuvius eruption in 79 BCE.

Scientist 1

In the build-up to a volcanic eruption, as heated magma rises towards the vent on the surface, the decrease in pressure causes volatiles such as carbon dioxide and nitrogen in the magma to form bubbles. In silicate-rich magma, like that found at Mt. Vesuvius in 79 BCE, the bubbles expand faster than the magma can accommodate and the magma is forcibly fractured. When the magma is fractured, electrically charged ash particles are created in a process called *fractoemission*. Once the charged particles are expelled during the eruption, the positively charged particles travel faster and higher in the ash cloud than the negatively charged particles, causing a separation of charges. Within minutes, lightning bolts are generated to resolve the difference in charges. These lightning bolts always occur less than a kilometer downwind from the vent since they happen in the first few minutes after the eruption.

Volcanic lightning leads to the creation of Br radicals in the ash plume immediately surrounding the lightning strike. When the lightning is caused by *fractoemission* charging, evidence of locally high concentrations of these radicals can be found in the ash near the volcanic vent. The sediment found within a kilometer of Mt. Vesuvius contains evidence of high concentrations of Br radicals in the ash from 79 BCE.

Scientist 2

In violent volcanic eruptions, such as the Mt. Vesuvius eruption in 79 BCE, a large number of neutral ash particles are ejected in dense ash plumes at high speeds. These ash plumes have a high water vapor content, and even though the particles are ejected at temperatures of approximately 1,000°C, the water vapor eventually freezes once the particles rise above the freeze line (the altitude at which temperatures are low enough to freeze water droplets). The ice particles in the ash plume then collide with other ash particles and these collisions cause the particles to become charged in a process known as *ice charging*. As the charged particles move downwind, positively charged and negatively charged molecules travel at different speeds. Several minutes to hours after the initial eruption, the separation of charges eventually leads to lightning strikes slightly downwind from the vent and high in the ash plume.

When volcanic lightning occurs in the densely packed core of the ash cloud immediately following the eruption, as occurs with fractoemission charging, round crystals called lightning-induced volcanic spherules (LIVS) are produced. No spherules were found in the sediment from 79 BCE on Mt. Vesuvius, so the lightning observed must have been due to ice charging.

34. Both scientists discuss how the particles in the ash plume of the volcanic eruption initially gained a charge. The process described by each scientist is an example of:

F. combustion.

G. ionization.

H. weathering.

J. condensation.

35. A prominent researcher asserted that, on the day Mt. Vesuvius erupted in 79 BCE, based on the estimated temperature and wind patterns, the velocity of the ash particles would not have been sufficient enough for the ash plume to have crossed the freeze line prior to the observed

volcanic lightning strikes. This information is *inconsistent* with the viewpoint(s) of which of the scientists, if either?

A. Neither scientist

B. Scientist 1 only

C. Scientist 2 only

D. Both Scientist 1 and Scientist 2

36. Consider Scientist 1's and Scientist 2's claims about the generation of the charges in the ash particles that led to the volcanic lightning seen in the Mt. Vesuvius eruption of 79 BCE. According to Scientist 1, were the charges generated prior to the eruption or after the eruption; and according to Scientist 2, were the charges generated prior to the eruption or after the eruption?

F. Scientist 1: prior to the eruption, Scientist 2: after the eruption

G. Scientist 1: prior to the eruption, Scientist 2: prior to the eruption

H. Scientist 1: after the eruption Scientist 2: after the eruption

J. Scientist 1: after the eruption, Scientist 2: prior to the eruption

37. Research has shown that particles charged through fractoemission will be discharged before they can reach an altitude of more than 10 km above a volcanic vent. Does this information support or weaken the viewpoint of Scientist 1 ?

A. It weakens Scientist 1's viewpoint because at least a couple of the lightning branches extended 15 km above the volcano vent.

B. It weakens Scientist 1's viewpoint because all of the lightning branches extended 15 km above the volcano vent.

C. It supports Scientist 1's viewpoint because some of the lightning branches extended more than 10 km above the volcano vent.

D. It supports Scientist 1's viewpoint because all of the lightning branches extended more than 10 km above the volcano vent.

- 38.** The discovery of which of the following, if made today, would provide the most support for Scientist 1's viewpoint?
- F. The formation of ice particles in the ash plume of a volcanic eruption
 - G. Lightning damage on trees 5 km downwind of Mt. Vesuvius
 - H. 2,100-year-old silicate-rich lava on Mt. Vesuvius
 - J. 2,100-year-old sediment with no LIVS on Mt. Vesuvius
- 39.** Suppose that a volcanic lightning strike did occur in the densely packed core of the ash plume near the volcanic vent during the eruption of Mt. Vesuvius in 79 BCE. Would Scientist 1 agree that Br radicals might have been present in the Mt. Vesuvius ash in 79 BCE, and would Scientist 2 agree that LIVS might have been present in the Mt. Vesuvius ash in 79 BCE ?
- A. Scientist 1: no, Scientist 2: no
 - B. Scientist 1: no, Scientist 2: yes
 - C. Scientist 1: yes, Scientist 2: no
 - D. Scientist 1: yes, Scientist 2:
yes
- 40.** Based on Scientist 1's discussion, did the charging process that occurred during the fracture of magma have the effect of increasing the mass of the particles that became positively charged or decreasing the mass of the particles that became positively charged?
- F. Increasing the mass, because the particles lost an electron.
 - G. Increasing the mass, because the particles gained a proton.
 - H. Decreasing the mass, because the particles lost an electron.
 - J. Decreasing the mass, because the particles gained a proton.

END OF TEST.

STOP! DO NOT TURN THE PAGE UNTIL TOLD TO DO SO

Answers and Explanations

SCIENCE PRACTICE TEST 1 EXPLANATIONS

Passage I

1. B

The question asks which supplement best meets the criteria that it will *maintain as much of (patients') initial bone density as possible* if it is taken for 3 years. Use Table 1 and compare the bone density between 0 months and 36 months for each supplement, as these are the *initial* value and the value at *3 years*. For Bonegenic, the bone density goes from 130 in month 0 to 117 in month 36 for a decrease in bone density of 13 mg/cm^3 over three years. For Calcitrenix, the value goes from 128 to 121 for a decrease of 7 mg/cm^3 . For Strength+, the value goes from 131 to 118 for a decrease of 13 mg/cm^3 . For Vitagrow, the values go from 127 to 116 for a decrease of 11 mg/cm^3 . The smallest decrease occurred when patients took Calcitrenix. The correct answer is (B).

2. H

The question asks for a comparison of the *initial average serum CTX of patients given the Strength+ supplement* in relation to 510 pg/mL . Use Table 2 and look up the initial average serum CTX for Strength+ patients. At the *initial* time of 0 months, the average serum CTX is 507 pg/mL , which is less than 510 pg/mL . The correct answer is (H).

3. B

The question asks which supplement(s) are consistent with the prediction given. The prediction is that as the time of treatment with a supplement increased, the average serum CTX would always decrease. Use Table 2 and check to see which supplements showed a

decrease across time from 0 months to 54 months. For Bonegenic, the average serum CTX decreases each time from 0 months to 18 months to 36 months, but then it increases from 36 months to 54 months. Eliminate (D) because it includes Bonegenic. For Calcitrenix, the average serum CTX decreases at every time interval. Eliminate (C) because it does not include Calcitrenix. No remaining answers include Strength+, so check Vitagrow next to determine if (A) or (B) is the correct answer. For Vitagrow, the average serum CTX decreases at every time interval. Eliminate (A) because it does not include Vitagrow. The correct answer is (B).

4. **J**

The question asks for the graph that best shows *the average serum CTX* across supplements at 18 months. Use Table 2 to find the values of average serum CTX for each supplement. At 18 months, Strength+ has the highest average serum CTX at 389 pg/mL. Eliminate (F) and (H) since these graphs do not show Strength+ as having the highest average serum. Compare the graphs for (G) and (J). The graphs show different values for Vitagrow. Check Table 2 for the average serum CTX at 18 months for Vitagrow; the average serum CTX is 299 pg/mL, which is shown on the graph for (J). The correct answer is (J).

5. **A**

The question asks for the supplement that showed *the least change in average bone mineral density* from 18 months to 36 months of treatment. Use Table 1 to compare the values of bone mineral density between 18 months and 36 months for each supplement. For Bonegenic, the bone density goes from 120 in month 18 to 117 in month 36 for a difference of 3 mg/cm³. For Calcitrenix, the bone density goes from 122 in month 18 to 121 in month 36 for a difference of 4 mg/cm³. For Strength+, the bone density goes from 122 in month

18 to 118 in month 36 for a difference of 4 mg/cm^3 . For Vitagrow, the bone density goes from 123 in month 18 to 116 in month 36 for a difference of 7 mg/cm^3 . Bonegenic has the least change in bone density. The correct answer is (A).

6. **H**

The question asks if the data in Tables 1 and 2 support the statement that patients with *the lowest average bone mineral density* initially took the same supplement as the patients who *had the greatest average serum CTX* at 54 months. Use Table 1 to find the supplement given to patients with the lowest average bone mineral density initially. At 0 months, patients given Vitagrow had the lowest average bone mineral density at 127 mg/cm^3 . Next, use Table 2 to see if patients given Vitagrow had the greatest average serum CTX at 54 months. At 54 months, patients given Vitagrow had the lowest average serum, so the results do not support the statement. Eliminate (F) and (G) because they indicate that the statement is supported. Compare (H) and (J). Choice (J) incorrectly states that Strength+ patients initially had the lowest average bone mineral density. Eliminate (J). The correct answer is (H).

Passage II

7. **B**

The question asks for the range of months when the increase in accumulated sediment depth was the least at Location D. The accumulated sediment depth at Location D is shown in Figure 3. Look at Figure 3 and find the line showing the sediment depth for Location D. The smallest increase will be the line that is most horizontal. Out of the four answer choices, the line between May 2007 and September 2007 is the most horizontal. Eliminate (A), (C), and (D) since these

time periods show a greater, rather than smaller, increase in accumulated sediment depth. The correct answer is (B).

8. **G**

The question asks why the researchers recorded average temperature. Read the answer choices for key terms and use POE. The answer choices all mention snowmelt. In the description of the study, it says the researchers studied *snowmelt-fed rivers*. Increased snowmelt would increase the sediment in the rivers, as sediment will be carried with the snowmelt into the river. Eliminate (F) and (H) because snowmelt would increase sediment rather than prevent or limit it. Eliminate (J) because lack of snowmelt would not increase sediment flow into rivers. The correct answer is (G).

9. **A**

The question asks for a graph that shows the accumulated sediment depth for Locations D–F in September 2007. The accumulated sediment depths for Locations D–F are shown in Figure 3. In September 2007, Location F had the highest accumulated sediment depth. Eliminate (C) because it shows Location E as having the highest accumulated sediment depth. Eliminate (D) because it shows Location E and Location F as having the same accumulated sediment depth. Based on Figure 3, Location D had the lowest accumulated sediment depth in September 2007. Eliminate (B) because it shows Location D as having a higher accumulated sediment depth than Location E. The correct answer is (A).

10. **G**

The questions asks for the temperature when there was no additional sediment accumulation at Locations A–C. The data for Locations A–C are shown in Figure 2. Use Figure 2 to find the times when the

sediment accumulation did not increase, which will be the time periods when the line is horizontal. The sediment accumulation did not increase between January 2007 to May 2007 and between January 2008 to May 2008. In both of these time periods, the temperature, indicated by the bars, is less than -2.5°C . Eliminate (H) and (J). Both time periods are roughly halfway between -2.5°C and -5.0°C , which is greater than -4.0°C . The correct answer is (G).

11. **D**

The question asks whether the measured sediment at an inner curve of the river at Location E would be greater or less than 2 cm in September 2007. The data for Location E is shown in Figure 3. Based on Figure 3, the accumulated sediment depth at Location E in September 2007 was 2 cm. Based on Figure 1, for a meandering river such as Location E, the accumulation of sediment is greater along the inner curves of the river. Eliminate (A) and (B) because the accumulated sediment depth would be greater than 2 cm, not less. Eliminate (C) because it incorrectly states that the sediment concentration is greater in the center than along the inner curves. The correct answer is (D).

12. **H**

The question asks if the accumulated sediment depth in the straight-channel river was greater or less than the accumulated sediment depth in the meandering river. The passage states that Locations A–C *were on a straight-channel river* and Locations D–F *were on a meandering river*. Compare the accumulated sediment depth in Figure 2 (straight-channel river) to the accumulated sediment depth in Figure 3 (meandering river). In Figure 2, the accumulated sediment depth ranges from less than 0.1 cm to 0.5 cm. In Figure 3, the accumulated sediment depth ranges from less than 0.5 cm to about 3.5 cm. At each time interval, the accumulated sediment depth is less in the straight-

channel river. Eliminate (F) and (G) because they incorrectly state that the sediment depth is greater in the straight-channel river. Eliminate (J) because it incorrectly states that the highest values for accumulated sediment depth for the straight-channel river is 0.3 cm and the meandering river is 2.8 cm. The correct answer is (H).

Passage III

13. C

The question asks for the humidity and storage time that resulted in the least amount of mass burned in Experiment 3. The results for Experiment 3 are shown in Table 3. The data shows PMB, which is described in the passage as *percentage of mass burned*. Look for the smallest PMB on Table 3. Note the trends. The PMB increases as the storage time increases, so 5 days will have a smaller PMB. Eliminate (B) and (D). PMB decreases as humidity increases, so 35% has a smaller PMB than 10% humidity. The correct answer is (C).

14. G

The question asks what the PMB would be for a storage time of 20 days and an air pressure of 60 psi in Experiment 2. Look for the data for the PMB at a storage time of 20 days in Table 2. The PMB is listed for air pressures of 20 psi, 40 psi, and 80 psi. The PMB values increase with higher air pressures. Thus, the PMB at an air pressure of 60 psi will fall between the values for 40 and 80 psi. At a storage time of 20 days, the PMB is 76.7% at 40 psi and 80.3% at 80 psi. The correct answer is (G).

15. B

The question asks what the PMB would be with a storage time of 10 days and a humidity of 30% based on Experiments 1 and 3. Since humidity is not mentioned in Table 1, read the description of

Experiment 1 to find the humidity percentage. The humidity for Experiment 1 was 25%. Based on Table 1, at 25% humidity and 10 days of storage time, the PMB was 68.5%. Based on Table 3, at 35% humidity and 10 days of storage time, the PMB was 63.4%. Therefore, the PMB at 30% humidity and 10 days of storage time would be between 63.4% and 68.5%. The correct answer is (B).

16. **H**

The question asks how the PMB would have changed if the accumulated ashes had *not* been collected from the burn chamber before the remaining sample was weighed. Read the description of Experiment 1 to learn more about the accumulated ashes. The passage says that the *remaining sample and all accumulated ash were removed and weighed* to find the *average sample final mass* (SFM). If the accumulated ashes were not collected, the SFM would have been less. Eliminate (G) and (J) because they indicate the SFM would have been greater. Based on the equation
$$\text{PMB} = \frac{\text{SIM} - \text{SFM}}{\text{SIM}} \times 100$$
, a smaller SFM would result in a greater PMB. The correct answer is (H).

17. **B**

The question asks how many branches were *not* burned at the conclusion of Experiment 1. Read the description of Experiment 1 to

find out how many branches were burned. The passage says that *researchers collected 100 branches*. Later it states that *10 branches* were burned and that the *process was repeated 6 additional times*. Therefore, the total number of branches burned was 70. Since the researchers started with 100 branches, 30 branches were not burned. The correct answer is (B).

18. F

The question asks how the PMB of acacia burned in ordinary dry air compared to the PMB of acacia burned in compressed air. These words do not appear in the tables, so skim the surrounding text to find the word *compressed*. This word appears in the description of Experiment 2, which was similar to Experiment 1 except that the *dry air...was compressed*. Compare the results of Table 1 to the results of Table 2 for each storage time. For the acacia stored in dry air for 5 days, the PMB is 64.3% and for the acacia stored in compressed air (20 psi) for 5 days, the PMB is 67.6%. The PMB in compressed air is greater. Eliminate (G) and (H) because these indicate that the PMB in compressed air is always the same as or always less than that of dry air. Compare the remaining data points in Table 1 to the data points with the same storage time for 20 psi in Table 2. For each storage time, the PMB in compressed air is greater. The correct answer is (F).

19. C

The question asks how the SFM compared to the SIM in Experiment

1. Based on the description of Experiment 1, the average sample

initial mass (SIM) and the average sample final mass (SFM) are used

to calculate PMB using the equation
$$\text{PMB} = \frac{\text{SIM} - \text{SFM}}{\text{SIM}} \times 100$$
. Use POE

to find the relationship. If the SFM and the SIM were equal, the equation would equal 0. Since none of the values on Table 1 are 0, the SFM and SIM were not equal; eliminate (A). If the SFM were greater than the SIM, the equation would result in a negative number. Since none of the values on Table 1 are negative, the SFM was not greater than the SIM; eliminate (B). If the SFM were less than the SIM, the equation would result in a positive number. Since all the values on Table 1 are positive, the SFM was always less than the SIM. The correct answer is (C).

Passage IV

20. H

The question asks which of the devices listed could detect changes in the concentrations of carbon dioxide. Look for information about changes in carbon dioxide concentration. The passage says that *changes in the carbon dioxide concentration of a solution can be observed by monitoring pH changes*. A pH sensor would detect these changes whereas the other instruments listed would not. The correct answer is (H).

21. A

The question asks for the approximate pH of the phenol red solution in Vial 2 after 48 hours. Table 2 shows that the color of the solution in

Vial 2 after 48 hours is yellow. Refer to Table 1 for the relationship between solution color and pH. According to Table 1, a yellow solution has a pH of less than 6.6. Eliminate (B), (C), and (D) because all of these pH values are greater than 6.6. The correct answer is (A).

22. **G**

The question asks how the set-up for Experiment 2 differed from the setup for Experiment 1. Look at Table 3 for the data for Experiment 2. According to Table 3, Vial 3 was exposed to light but Vial 4 was not. Eliminate (H) since it states that both vials in Experiment 2 were exposed to light, and eliminate (J) because it says that both of the vials were kept in the dark. The remaining answer choices use the term *primary producers*, which is an organism that produces sugars through photosynthesis. Eliminate (F) because the only organisms in Experiment 2 were goldfish, which are not primary producers. The correct answer is (G).

23. **B**

The question asks whether Experiment 3 is consistent with the student's prediction that phenol red solution would turn yellow after 48 hours when exposed to light in the absence of cellular respiration and photosynthesis. Use POE. According to Table 4, after 48 hours, the solution in Vial 6 was yellow. Eliminate (A) since it states that the solution in Vial 6 was orange. The solution in Vial 7 was orange in Table 4. Eliminate (D). Table 4 also shows that Vial 7 was exposed to light, while Vial 6 was not. Since the question is about a solution that is exposed to light, eliminate (C). The correct answer is (B).

24. **H**

The question asks why the color of the phenol red solution in Vial 1 differed from the color of the solution in Vial 2 after 48 hours. Refer

to the passage and look for key terms in the answer choices. Equations 1 and 2 show the reactions of photosynthesis and cellular respiration, respectively. According to the equations, photosynthesis requires sunlight as a reactant, while cellular respiration does not, so eliminate (F) and (G) because they state that sunlight is necessary for cellular respiration. The passage states that photosynthesis consumes carbon dioxide. Eliminate (J), which states that photosynthesis would cause the cabomba in Vial 1 to consume less, rather than more, carbon dioxide than the cabomba in Vial 2. The correct answer is (H).

25. **D**

The question asks whether an unknown solution that causes the phenol red solution in Vial 1 to turn yellow is likely to be acidic or basic. Table 2 shows that the solution in Vial 1 was orange after the 48-hour incubation period. Refer to Table 1 for the relationship between solution color and pH. According to Figure 1, orange solutions have a pH between 6.6 and 8.1 and yellow solutions have a pH below 6.6. This means that the pH of the solution decreased as it changed color from orange to yellow. Eliminate (A) and (C), which state that the pH of the solution increased rather than decreased. To choose between the remaining choices, you need some outside knowledge. Acidic solutions have a pH less than 7.0, while basic solutions have a pH greater than 7.0. Eliminate (B) since addition of a basic solution would cause the pH to increase rather than decrease. The correct answer is (D).

26. **F**

The question asks for the color of the solution in Vial 7 after 48 hours with exposure to light if the vial had contained a tadpole. According to Table 4, Vial 7 contained neither a cabomba nor a goldfish, was not exposed to light, and remained orange after the 48-hour incubation period. A tadpole is an animal, so find the vial that was also exposed

to light and contained an animal. Vial 3 was exposed to light and contained a goldfish. The solution in Vial 3 turned yellow after the 48-hour incubation period. Eliminate (H) and (J) since they both indicate that the solution would turn dark pink. Eliminate (G) since it incorrectly claims that the tadpole would undergo photosynthesis. The correct answer is (F).

Passage V

27. A

The question asks how the wind force varies as V is increased, based on the results of Experiment 2. The results of Experiment 2 are shown in Table 2. Use Table 2 and look for the relationship between the values of V and the wind force, F_w . For each trial in Table 2, the value for V increases, from 3.0 m/s in Trial 6 to 7.0 m/s in Trial 10. For F_w , the value is 1.73 N for Trial 6 and increases in every trial, ending with a maximum F_w of 9.42 N in Trial 10. The correct answer is (A).

28. H

The question asks which calculation would always result in zero, based on Experiments 1 and 2. The information for all variables in the answer choices is in Table 1, so choose any trial and plug in the values to calculate each answer. Start with (F). For (F), refer to Trial 1 in Table 1. When the value of -1.22 N for F_{T_V} is subtracted from the value of 1.22 N for F_B , the result is $1.22 - (-1.22)$, which does not equal zero. Eliminate (F). For (G), when the value of 0.28 N for F_w is subtracted from the value of 1.22 N for F_B , the result does not equal zero. Eliminate (G). For (H), when the value of -1.22 N for F_{T_V} is added to the value of 1.22 N for F_B , the result is $1.22 + (-1.22)$ which equals zero. Keep (H). For (J), when the value of -0.28 N for F_w is

added to the value of 1.22 N for F_B , the result does not equal zero. Eliminate (J). The correct answer is (H).

29. **B**

The question asks whether a specific method of determining wind force would be an appropriate method to use in all the trials, given that the method *was only valid for wind forces greater than 0.4 N*. Begin by examining Table 1 and looking at the wind force F_w values for Trials 1 through 5. Trial 1 had a wind force value of 0.28 N, which is less than the 0.4 N stated in the question. Eliminate (A) and (C), which both state that *the value of F_w exceeded 0.4 N in all trials*. Since the method is unreliable to calculate forces less than 0.4 N, the method would be inappropriate for Trial 1. Eliminate (D) since it indicates that the method would be appropriate to use in Trials 1–10. The correct answer is (B).

30. **H**

The question asks at which horizontal wind speed the value of F_{Th} would be equal to F_{Tv} in Experiment 2. The results of Experiment 2 are shown in Table 2. Examine the columns for F_{Th} and F_{Tv} in Table 2. The value of F_{Tv} remains constant at -5.64 N. For the value of F_{Th} to equal the value of F_{Tv} , F_{Th} would also have to equal -5.64 N. The value -5.64 N is between -4.81 N in Trial 8 and -6.92 N in Trial 9. The wind speed is likely between the values of the wind speed for these two trials. In Trial 8, $V = 5.0$ m/s, and in Trial 9, $V = 6.0$ m/s. The only value between 5.0 m/s and 6.0 m/s is 5.5 m/s in (H). The correct answer is (H).

31. **C**

The question asks for the radius of the balloon in Experiment 1 corresponding to an experimental value, F_w , of 1.65 N. The results of Experiment 1 are shown in Table 1. Determine the relationship between the radius, r , and F_w . As seen in Table 1, as r increases, F_w also increases. The greatest value of F_w is 1.51 N, which is when $r = 0.7$ m. Since there is a direct relationship between r and F_w and 1.65 N is greater than 1.51 N, the radius will be larger than 0.7 m. Eliminate (A) and (B), which both indicate a radius less than 0.7 m. To choose between (C) and (D), look at the values of F_w to estimate the rate of increase. As seen in Table 1, the value of F_w increases by at least 0.2 N for every 0.1 m increase in the radius, r . Eliminate (D) since a radius greater than 0.8 meters would result in a value of F_w greater than $1.51 \text{ N} + 0.2 \text{ N} = 1.71 \text{ N}$. The correct answer is (C).

32. **J**

The question asks for the statements about r or V that best indicates the main difference between the experiments. The first part of the answers refers to Experiment 1, so look at r and V in Experiment 1. In this experiment, the passage states that r was varied, and V was constant at 2.0 m/s. Eliminate (F) and (G), as they both incorrectly state that r was held constant rather than varied. Next examine Experiment 2. You need some outside knowledge here: an *independent variable* is also known as a manipulated variable because it is a variable whose value is manipulated by the experimenter. In Experiment 2, the value of V was manipulated by the scientists, so V is an independent variable. Eliminate (H). The correct answer is (J).

33. **B**

The question asks for the vector notation of the force of the *wind*, in N, during Trial 5. The question states that the notation lists the horizontal component first followed by the vertical component. Since

the question asks about wind force, look at F_w . The value for $F_w = 1.51$ N in Trial 5. The passage states that *the wind force, F_w , was purely horizontal*. This means that the value of the vertical component, V_y , must be zero. Eliminate (A) and (C) since they both have a non-zero vertical component (V_y). Eliminate (D), as it shows a negative V_x component of the vector. The correct answer is (B).

Passage VI

34. G

The question asks which term accurately represents the process by which the charged particles were formed, according to both scientists. According to Scientist 1, *electrically charged ash particles are created in a process called fractoemission*, and according to Scientist 2, *collisions cause the particles to become charged in a process known as ice charging*. Eliminate (F) because neither explanation mentions combustion or burning. *Ionization* means the process of uncharged particles becoming charged, which is consistent with both explanations. There is no mention of weathering or condensation, so eliminate (H) and (J). The correct answer is (G).

35. C

The question asks which scientist's viewpoint, if either, is *inconsistent* with the assertion that the ash particles would not have crossed the freeze line before the lightning strikes. Scientist 2 states *the particles rise above the freeze line prior to lightning strikes slightly downwind from the vent and high in the ash plume*, which is inconsistent with the new information. Eliminate (A) and (B) because they do not include Scientist 2. Scientist 1 never mentions the freeze line. Eliminate (D). The correct answer is (C).

36. F

The question asks whether the charged particles were generated prior to or after the eruption, according to each scientist. Work one hypothesis at a time and use POE. According to Scientist 1, *when the magma is fractured, electrically charged ash particles are created, then charged particles are expelled during the eruption*. Therefore, Scientist 1 believes the particles are charged prior to the eruption. Eliminate (H) and (J). According to Scientist 2, *neutral ash particles are ejected in dense ash plumes at high speeds and then after the plume has crossed the freeze line, collisions cause the particles to become charged in a process known as ice charging*. Eliminate (G). The correct answer is (F).

37. **A**

The question asks whether Scientist 1's theory is strengthened or weakened by the new evidence that previously charged particles are discharged before they can reach an altitude of more than 10 km. Refer to the passage and look for data about altitude. According to the passage, *volcanic lightning was observed in the ash cloud following the eruption, with some branches of lightning extending up to 15 km above the volcanic vent*. There is no evidence that every one of the lightning branches was above a certain altitude. Eliminate (B) since it states that *all lightning* extended 15 km above the vent. Eliminate (D) since it states that *all lightning* extended *more than 10 km* above the vent. Scientist 1 claims that *lightning bolts are generated to resolve the difference in charges* of ash particles. However, if these particles are discharged before they reach 10 km, Scientist 1 would not expect the observed *lightning extending up to 15 km above the volcanic vent* during a volcanic eruption. Eliminate (C). The correct answer is (A).

38. **H**

The question asks which new evidence would most support Scientist 1's explanation. Refer to the passage and look for key terms in the

answer choices. Choice (F) mentions the formation of ice particles. However, it is Scientist 2 who explains volcanic lightning as dependent on the formation of ice, while Scientist 1 never mentions ice particles. Eliminate (F) as it refers to the wrong hypothesis. Similarly, LIVS are only mentioned by Scientist 2, who states that the absence of LIVS means *the lightning observed must have been due to ice charging*. Eliminate (J) as it supports the wrong scientist's viewpoint. Scientist 1 claims that *lightning bolts always occur less than a kilometer downwind from the vent*. Eliminate (G) because evidence of lightning damage 5 km downwind of Mt. Vesuvius's vent would weaken Scientist 1's hypothesis. Choice (H) mentions *2,100-year-old silicate-rich lava on Mt. Vesuvius*. Scientist 1 states that fractures in *silicate-rich magma, like that found at Mt. Vesuvius in 79 BCE* caused the fractoemission charging. The correct answer is (H).

39. **D**

The question asks whether Scientist 1 would agree that Br radicals might have been present in the Mt. Vesuvius ash and whether Scientist 2 would agree that LIVS might have been present given the occurrence of lightning strikes in the core of the ash plume of Mt. Vesuvius in 79 BCE. Work one hypothesis at a time and use POE. According to the passage, Scientist 1 states that *volcanic lightning leads to the creation of Br radicals in the ash plume immediately surrounding the lightning strike, and sediment found within a kilometer of Mt. Vesuvius contains evidence of high concentrations of Br radicals in the ash from 79 BCE*. This supports the presence of Br radicals, so eliminate (A) and (B). Scientist 2 claims that *when volcanic lightning occurs in the densely packed core of the ash cloud immediately following the eruption, as occurs with fractoemission charging, round crystals called lightning-induced volcanic spherules (LIVS) are produced*, so eliminate (C), which says that Scientist 2

would not agree that LIVS might have been present in the ash when lightning did occur under these conditions. The correct answer is (D).

40. **H**

The question asks if the positively charged particles discussed by Scientist 1 would increase or decrease in mass as a result of becoming charged. A bit of outside knowledge could help, but is not really needed to answer the question. An atom, which is neutrally charged, becomes positively charged if it loses an electron. Without knowing that, use the information in the passages and POE. Scientist 1 says that *the positively charged particles travel faster and higher in the ash cloud*, indicating that they are lighter than the negatively charged particles. This implies that they have decreased in mass, so eliminate (F) and (G), which both indicate an increase in mass. According to (J), the particles gained a proton. But since protons have mass, this would involve an increase rather than a decrease in mass; eliminate (J). The correct answer is (H).