Chapter 6
Science Reading Passages

Passage I

Scarlet larkspur, a type of wildflower found in the western United States, usually blooms in early summer. The number of flower blooms varies from year to year due to several factors, including precipitation and the presence of certain smoke-derived organic compounds (such as butenolides). Before conducting a study, four scientists discuss their theories about how precipitation and forest fires affect the prevalence of scarlet larkspur.

Scientist 1

Scarlet larkspur grows best in habitats where forest fires are common. The compounds in the smoke of a forest fire spur germination of scarlet larkspur seeds. As a result, the number of scarlet larkspur blooms will be greater on hillsides that experienced a fire in the previous summer than on hillsides that did not. Precipitation does not affect the growth of scarlet larkspur.

Scientist 2

Scarlet larkspur grows best in habitats with dry soil. Drought conditions prevent competition by inhibiting the germination of seeds from competing wildflower species. As a result of decreased competition, scarlet larkspur will produce more blooms on hillsides that have experienced below average rainfall during the spring. Forest fires do not affect the growth of scarlet larkspur.

Scientist 3

Scarlet larkspur is a versatile plant capable of flourishing under a variety of conditions. The level of competition faced by scarlet larkspur is similar at all precipitation levels, and the smoke from forest fires does not affect seed germination rates. Therefore, neither precipitation nor recent forest fires will affect the number of scarlet larkspur blooms found on a hillside.

Scientist 4

Scarlet larkspur grows well in habitats with dry soil, and it also grows well in habitats that have experienced a recent forest fire. Dry soil limits competition from other wildflower species, and compounds in smoke spur the germination of scarlet larkspur seeds. The greatest number of scarlet larkspur blooms will be found on hillsides that have experienced below average spring rainfall and a forest fire in the previous summer.

Study

The scientists selected a variety of hillsides throughout the western United States and categorized them into four groups based on their spring precipitation totals and the presence or absence of a forest fire the *previous* summer. None of the locations experienced forest fires in the fall, winter, or spring. The scientists calculated the average number of scarlet larkspur blooms per 100 m^2 at the beginning of the summer under each set of conditions. The results are shown in Table 1.

Below average rainfall?	Blooms without forest fire	Blooms with forest fire
Yes	593	984
No	456	768

Table 1

1. A researcher found that releasing a synthetic butenolide aerosol into a nursery increased the number of scarlet larkspur seeds that germinated. This finding is consistent with the theories of which of the scientists?

A. Scientist 1 only
B. Scientists 1 and 4 only
C. Scientist 3 only
D. Scientists 3 and 4 only

2. Based on Scientist 4's hypothesis, a scarlet larkspur seed would be *least* likely to bloom into a scarlet larkspur flower on a hillside with:

F. a recent forest fire and plentiful spring rain.
G. a recent forest fire and minimal spring rain.
H. no recent fires and plentiful spring rain.
J. no recent fires and minimal spring rain.

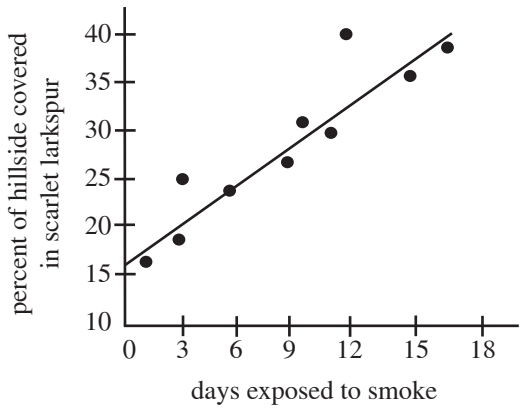
3. Compare the average number of scarlet larkspur blooms for the hillsides without a recent forest fire and below average rainfall to the average number of blooms on the hillsides without a recent forest fire and average or above average rainfall. Are the results of the study consistent with the theory of Scientist 2 ?

A. Yes; there were more scarlet larkspur blooms on the hillsides that experienced below average rainfall.
B. Yes; there were fewer scarlet larkspur blooms on the hillsides that experienced below average rainfall.
C. No; there were more scarlet larkspur blooms on the hillsides that experienced below average rainfall.
D. No; there were fewer scarlet larkspur blooms on the hillsides that experienced below average rainfall.

4. Prior to conducting the study, which scientist would most likely have predicted that the average number of scarlet larkspur blooms per 100 m^2 would be approximately the same for all of the hillsides studied?

F. Scientist 1
G. Scientist 2
H. Scientist 3
J. Scientist 4

5. In another study, a researcher selected 10 hillsides that were exposed to forest fire smoke over the course of a year. The researcher then recorded the total number of days that each hillside was exposed to smoke and estimated the percentage of the hillside that was covered in scarlet larkspur blooms the following summer. The results are shown in the figure below.



The results shown in the figure above are consistent with the theory or theories of which of the scientists?

A. Scientist 1 only
B. Scientist 2 only
C. Scientists 2 and 4 only
D. Scientists 1 and 4 only

6. The results of the study shown in Table 1 are most consistent with the theory of which scientist?

F. Scientist 1
G. Scientist 2
H. Scientist 3
J. Scientist 4

7. All of the following questions can be directly answered by the results of the study shown in Table 1 EXCEPT:

A. Can scarlet larkspur seeds germinate without the presence a forest fire within the past 12 months?
B. Does a decrease in precipitation decrease the competition that the scarlet larkspur faces from other flowering species?
C. Do summer forest fires coincide with an increase in the number of scarlet larkspur blooms the following summer?
D. Does the average number of scarlet larkspur blooms per 100 m^2 differ between hillsides with below average spring rainfall and hillsides with average or above average spring rainfall?

Passage II

Phytoplankton are a natural part of aquatic ecosystems, but a *harmful algal bloom* (HAB) occurs when a phytoplankton species grows out of control, endangering water quality, wildlife, and human health. Two graduate students present their theories about the development of HABs.

Student 1

Heavy rains can lead to a significant increase in agricultural runoff, sending large amounts of nitrogen and phosphorous into a lake. In a healthy lake, the majority of both of these nutrients are trapped in an unusable form in the sediment. The growth of phytoplankton is curbed by the lack of available nitrogen. However, a lake experiencing an HAB has approximately 90% of its nitrogen in useable form (70% from agricultural runoff and another 20% from microbial activity).

Due to the excess nitrogen, the algae grows until it overwhelms much of the other plant life. While the runoff initially increases dissolved oxygen levels, the decomposition of these dead plants eventually leads to decreasing dissolved oxygen levels. Once the oxygen drops below a critical threshold, dead zones will sometimes form that extend from the surface to depths of almost 30 m. Algal blooms spread rapidly, but they also quickly consume the excess nitrogen. After the nitrogen levels return to normal, the HAB will dissipate within a couple of weeks.

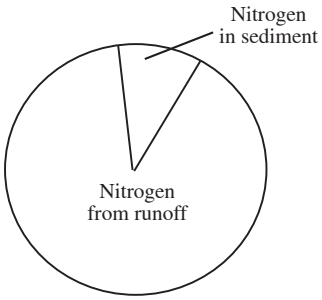
Student 2

Nutrients such as nitrogen and phosphorous are concentrated in the sediment at the bottom of lakes. When dissolved oxygen levels drop due to decreased water movement (such as during droughts or periods of decreased wind activity), a series of biochemical processes causes phosphorous to be released into the water. During an HAB, up to 60% of the phosphorous in the lake is in readily available form in the water instead of in the sediment. The prevalence of phosphorous fuels the growth of phytoplankton.

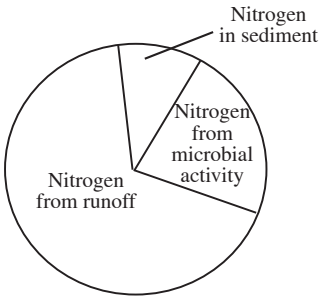
HABs form on or near the surface, but they release toxic gases that kill so much aquatic life that dead zones can extend up to 90 m below the surface. The decomposing organic matter further decreases the oxygen levels, spurring the release of even more nutrients. Once an HAB begins, it tends to worsen over time. Without human intervention, an HAB is likely to spread until it consumes an entire lake.

1. Which of the following pie charts is most consistent with Student 1's description of the distribution of nitrogen in a lake experiencing an HAB?

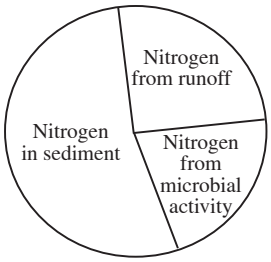
A.



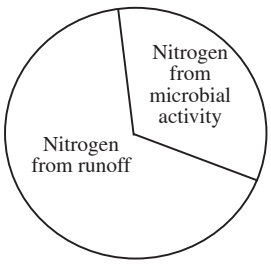
B.



C.



D.



2. Which of the students, if either, state(s) that decreasing dissolved oxygen levels leads to the release of nutrients from the sediments?

F. Neither Student 1 nor Student 2
G. Student 1 only
H. Student 2 only
J. Both Student 1 and Student 2

3. *Ephemeroptera* (mayfly larvae) and *Tubificidae* (sludge worms) are indicator species used to identify changes in certain water quality characteristics. *Ephemeroptera* usually outnumber *Tubificidae* when dissolved oxygen levels are sufficient, but they cannot survive when oxygen levels drop below normal range. In contrast, *Tubificidae* flourish in low dissolved oxygen environments. Based on the passage, which of the two indicator species would each student expect to be more prevalent in a lake at the start of an HAB?

	Student 1	Student 2
A.	*Ephemeroptera*	*Tubificidae*
B.	*Ephemeroptera*	*Ephemeroptera*
C.	*Tubificidae*	*Ephemeroptera*
D.	*Tubificidae*	*Tubificidae*

4. A study reveals that the majority of harmful algal blooms in a region occur annually in the beginning of summer and usually clear up by mid-fall without any intervention. The results of this study would better support the theory of which student?

F. Student 1; Student 1 claims that HABs clear up naturally after the bloom consumes the excess nitrogen.
G. Student 1; Student 1 claims that HABs usually require human intervention to dissipate.
H. Student 2; Student 2 claims that HABs clear up naturally after the bloom consumes the excess nitrogen.
J. Student 2; Student 2 claims that HABs usually require human intervention to dissipate.

5. The *photic zone* of a lake is the upper layer of water in which enough sunlight permeates to permit photosynthesis. The photic zone of a particular lake extends from the surface to a depth of approximately 50 m. Which of the students, if either, would most likely believe that the dead zone created by an HAB could extend *below* the photic zone of this lake?

A. Neither Student 1 nor Student 2
B. Student 1 only
C. Student 2 only
D. Both Student 1 and Student 2

6. A third student claims that lake sediment contains phosphorous in a form that is not readily available to aquatic life. Which of the students, if either, would likely agree with this claim?

F. Neither Student 1 nor Student 2
G. Student 1 only
H. Student 2 only
J. Both Student 1 and Student 2

7. A *limiting factor* is a naturally occurring element, the relative scarcity of which limits the growth of certain plants or animals in an ecosystem. Which of the following correctly pairs a student with the element that student most likely believes is the limiting factor with regard to phytoplankton growth?

A. Student 1: Dissolved Oxygen
B. Student 1: Nitrogen
C. Student 2: Dissolved Oxygen
D. Student 2: Nitrogen

Passage III

A group of students added 100 mg of Salt A to an Erlenmeyer flask containing 100 mL of water at 20°C. The mixture was heated over a Bunsen burner, and a thermometer was placed in the flask to acquire temperature readings (Figure 1).

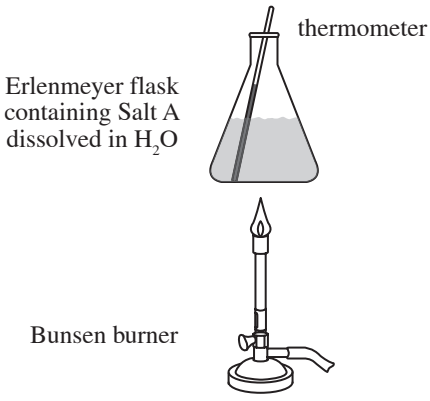


Figure 1

The mixture was heated, and temperature readings were acquired every 30 sec until the solution reached a full boil and the solid had completely dissolved. The boiling temperature for the solution was measured to be 104°C. The procedure was repeated with Salt B, which resulted in a boiling temperature of 110°C.

The teacher asked 3 of the students in the group to explain why the solutions had different boiling temperatures.

Student 1

The solution containing Salt B had a higher boiling point because Salt B produces more ions in solution than Salt A. As the solid dissolves, the salt ionizes and interacts with water molecules. This causes more interactions between the ions and water, thus requiring more energy for water molecules to break these interactions and become a gas (boiling). Since salts become ions in solution, salts that produce more ions will have more interactions with water than salts producing fewer ions. Thus, if two salts of equal amounts are added to water, the solution containing the salt that produces more ions will boil at the higher temperature.

Student 2

The solution containing Salt B had a higher boiling point because it had a lower *molar mass* (the mass of 6.02×10^{23} particles). Consider equal amounts of two salts with different molar masses. The salt with the greater molar mass will require more mass to result in the same number of particles. Since more heat energy is required to boil water with more interactions, the solution with more salt particles will boil at a higher temperature. Thus, if equal amounts of two salts with different molar masses are added, the salt with the lower molar mass will result in more particles and a greater solution boiling point than a salt with a greater molar mass.

Student 3

The solution containing Salt B had a higher boiling point because Salt B releases more heat upon dissolving than Salt A. The *enthalpy change of dissolution* ($\Delta H°_{diss}$) is a measure of the net amount of heat energy absorbed in the process of dissolving a salt. Salts that absorb more energy to dissolve will have more positive $\Delta H°_{diss}$ values and will make the solution cooler. Salts that absorb less energy than they release will have more negative $\Delta H°_{diss}$ values and will make the solution warmer. If equal amounts of two salts with different $\Delta H°_{diss}$ values are dissolved in solution, the solution containing the salt with the more negative $\Delta H°_{diss}$ value will release more heat and thus result in a greater boiling point.

The number of ions produced, molar mass, and enthalpy change dissolution ($\Delta H°_{diss}$) of some common salts are shown in Table 1.

Table 1

Salt	Ions produced	Molar mass (g/mol)	$\Delta H°_{diss}$ (kJ/mol)
Sodium chloride	2	58.4	+ 3.9
Calcium chloride	3	111.0	– 81.2
Ammonium nitrate	2	80.1	+ 25.7
Potassium hydroxide	2	56.11	– 57.6
Magnesium sulfate	2	120.38	– 91.0

1. Suppose that Salt A had been potassium hydroxide and Salt B had been magnesium sulfate. The results of the experiment would have supported the explanation(s) provided by which student(s)?

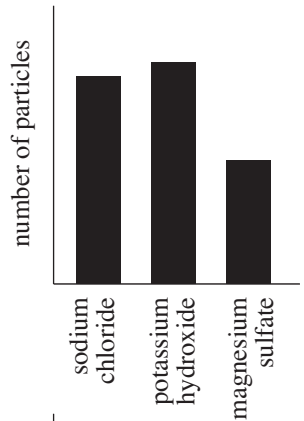
A. Student 2 only
B. Student 3 only
C. Students 1 and 3 only
D. Students 2 and 3 only

2. Suppose that the students also tested ammonium nitrate in the experiment and found it to have resulted in a boiling temperature in solution of 107°C. Student 2 would claim that ammonium nitrate:

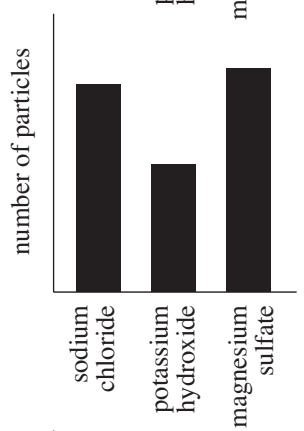
F. has a greater molar mass than Salt A, but a smaller molar mass than Salt B.
G. has a greater molar mass than Salt B, but a smaller molar mass than Salt A.
H. has a greater enthalpy change of dissolution than Salt A, but a smaller enthalpy change of dissolution than Salt B.
J. has a greater enthalpy change of dissolution than Salt B, but a smaller enthalpy change of dissolution than Salt A.

3. Which of the following graphs of the relative number of particles produced is most consistent with Student 2's explanation?

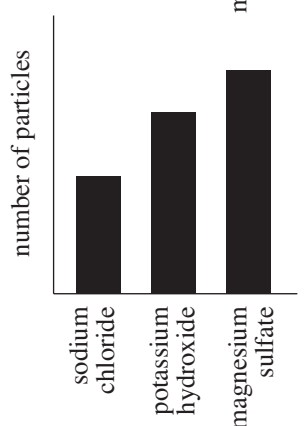
A.



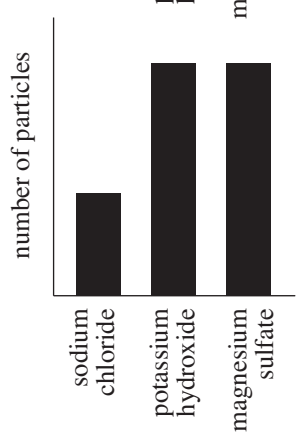
B.



C.



D.



4. Over the course of the experiment, the readings on the thermometer:

F. increased only.
G. decreased only.
H. increased, then decreased.
J. decreased, then increased.

5. Based on Student 3's explanation, which of the salts in Table 1 would result in the greatest solution boiling temperature?

A. Calcium chloride
B. Ammonium nitrate
C. Potassium hydroxide
D. Magnesium sulfate

6. Consider the data for cesium hydroxide shown in the table below:

Ions produced	Molar mass (g/mol)	ΔH°_{diss} (kJ/mol)
2	149.91	–71.6

Which student(s), if any, would predict that cesium hydroxide would produce a solution with a lower boiling temperature than calcium chloride?

F. Student 1 only
G. Students 2 and 3 only
H. Students 1, 2, and 3
J. None of the students

7. Is the claim "If equal amounts of salt are dissolved, sodium chloride will result in a greater boiling point than ammonium nitrate" consistent with Student 2's explanation?

A. No, because sodium chloride has a smaller molar mass than ammonium nitrate.
B. No, because sodium chloride has a more negative enthalpy change of dissolution.
C. Yes, because sodium chloride has a smaller molar mass than ammonium nitrate.
D. Yes, because sodium chloride has a more negative enthalpy change of dissolution.