SCIENCE FULL-LENGTH PRACTICE TESTS 2

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

Moth body coloration (see Figure 1) is a *hereditary* trait that can be passed from organisms to their offspring.

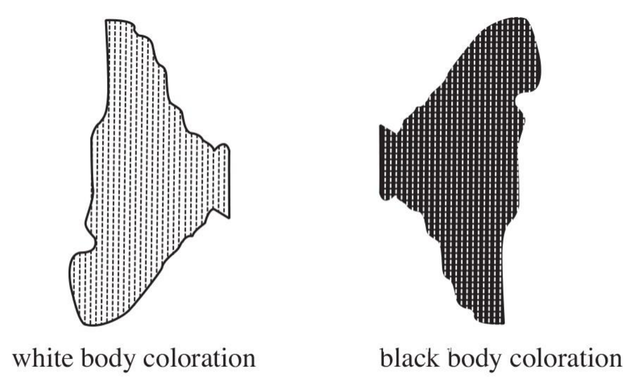


Figure 1

Scientists studied the body coloration of 2 subspecies of moths, *Biston betularia f. typica* and *Biston betularia f. carbonaria*. Both species live in City X. Only *B. betularia f. typica* lives in City Y, while only *B. betularia f.*

carbonaria lives in City Z. Both subspecies live on trees found in temperate climates, such as birch. Moths with light body coloration are camouflaged from predators while living on light-colored trees but are not hidden in heavily polluted areas where the tree bark is darkened. Moths with dark body coloration are camouflaged from predators on trees that are darkened by pollution but not on light-colored trees.

Study 1

Scientists captured 100 *B. betularia f. typica* and 100 *B. betularia f. carbonaria* in City X. They labeled each one, recorded its color, and released it. Then they calculated the percent of moths having each of the body color intensities on a scale of 1 to 10, with 1 being completely white and 10 being completely black. The researchers followed the same methods with 100 *B. betularia f. typica* moths from City Y and 100 *B. betularia f. carbonaria* moths from City Z. The results of this study are shown in Figures 2–4.

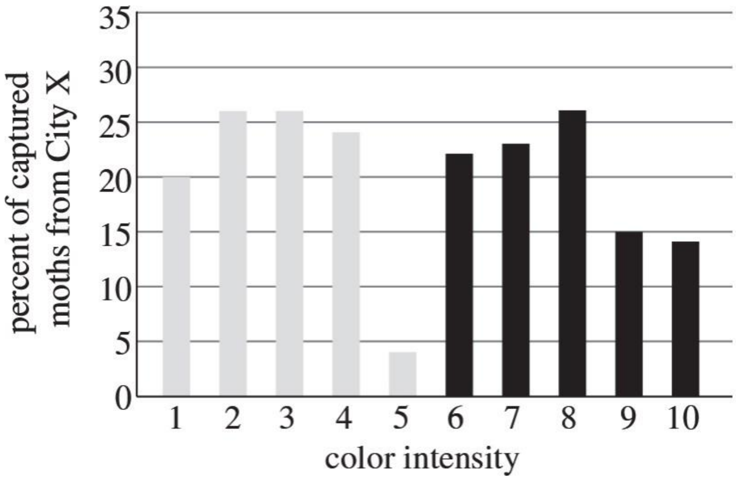


Figure 2

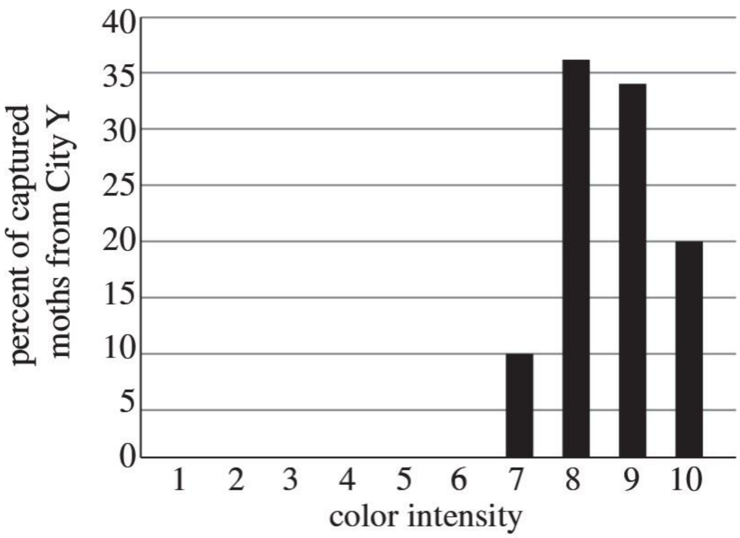


Figure 3

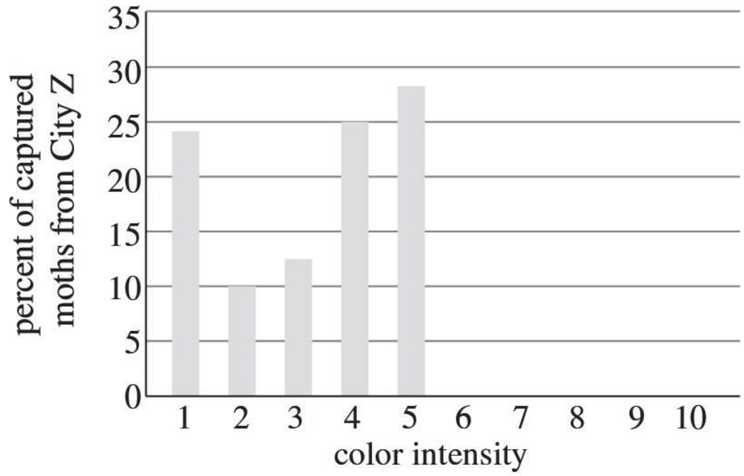


Figure 4

Study 2

After the end of Study 1, the scientists returned to City Y over the course of 10 years, from 1996–2005. During each visit, they captured at least 50 *B. betularia f. typica* moths and measured their body color intensities. They then calculated the average *B. betularia f. typica* body color intensity from the 1–10 scale for each of the 10 years. The scientists noted that during the 10-year period, 3 years were particularly wet, while 2 years were especially dry (see Figure 5). During wet years, pollutants tend to be washed from the surfaces of tree bark. During dry years, pollutants are more likely to concentrate on tree bark, and the tree bark itself tends to become thicker.

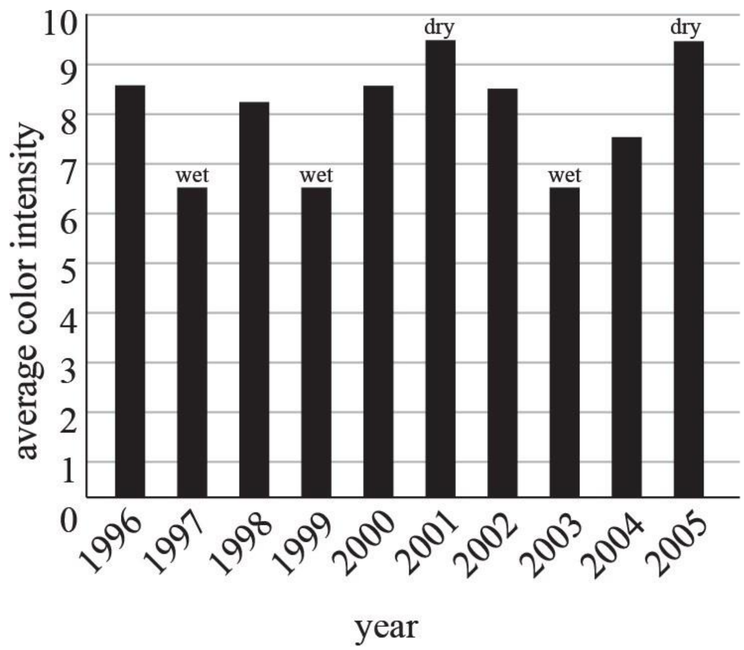


Figure 5

1. Based on the results from Study 1, the largest percentage of moths in City Y and City Z had a color intensity of:

A. City Y: 8, City Z: 1
B. City Y: 8, City Z: 5
C. City Y: 9, City Z: 4 **D.** City Y: 9, City Z: 5

2. During which of the following years was birch bark most likely to be thickest in City Y ?

F. 2000
G. 2001
H. 2002
J. 2003

3. How was Study 1 different from Study 2 ?

A. *B. betularia f. carbonaria* moths were captured in Study 1 but not in Study 2.

B. *B. betularia f. typica* moths were captured in Study 1 but not in Study 2.
C. The moth body coloration was measured in Study 1 but not in Study 2.
D. The moth body coloration was measured in Study 2 but not in Study 1.

4. The scientists most likely labeled the moths in Study 1 to:

F. determine how body coloration was affected by pollution in City X.
G. determine the average wingspan of each population of moths.
H. make sure that the body coloration of each moth was measured only once.
J. make sure that the body coloration of each moth was measured multiple times.

5. Based on the results from Study 2, would a moth with a body color intensity measuring 6.5 or a moth with a body color intensity measuring 9.5 have had a greater chance of surviving in 2005 ?

A. A moth with a body color intensity of 6.5, because pollutants concentrate more on tree bark during dry years.
B. A moth with a body color intensity of 6.5, because pollutants are removed from tree bark during dry years.
C. A moth with a body color intensity of 9.5, because pollutants concentrate more on tree bark during dry years.
D. A moth with a body color intensity of 9.5, because pollutants are removed from tree bark during dry years.

6. A scientist hypothesized that there would be a greater range in body coloration in the *B. betularia f. typica* moths when they are forced to coexist with another subspecies of moths. Do the results from Study 1 support this hypothesis?

F. Yes; the range of body coloration for *B. betularia f. typica* moths was greater in City X than in City Y.
G. Yes; the range of body coloration for *B. betularia f. typica* moths was greater in City Y than in City X.
H. No; the range of body coloration for *B. betularia f. typica* moths was greater in City X than in City Y.
J. No; the range of body coloration for *B. betularia f. typica* moths was greater in City Y than in City X.

7. Based on the information in the passage, would the moth population in City Z have most likely been higher in wet years or dry years?

A. Wet, because the trees are darker and provide better camouflage.
B. Wet, because the trees are lighter and provide better camouflage.
C. Dry, because the trees are darker and provide better camouflage.
D. Dry, because the trees are lighter and provide better camouflage.

Passage II

Ions in seawater, such as Cl–, SO42–, Na+, and Mg2+, are carried down to the ocean floor through a process known as *marine deposition*. SO42– and Mg2+ primarily come from the erosion of rocks, while Cl– and Na+ come from both mineral erosion and underwater volcanoes and hydrothermal vents.

Study 1

A fluid motion sensor was placed on a section of the seabed in the Atlantic Ocean, and data were collected over 12 months. At 6:00 A.M. every morning, the movement of water past the sensor was recorded, and a small amount of water was sequestered. Figure 1 shows the movement of water in millions of cubic meters (m^3) per second.

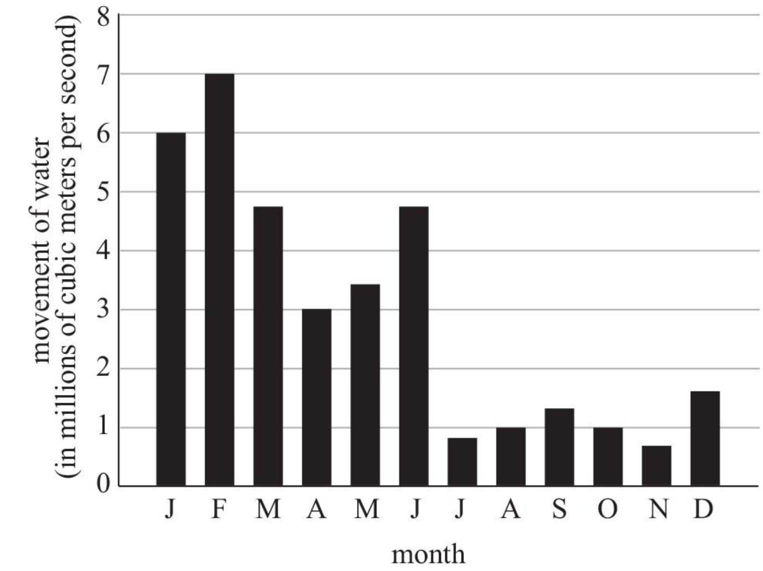
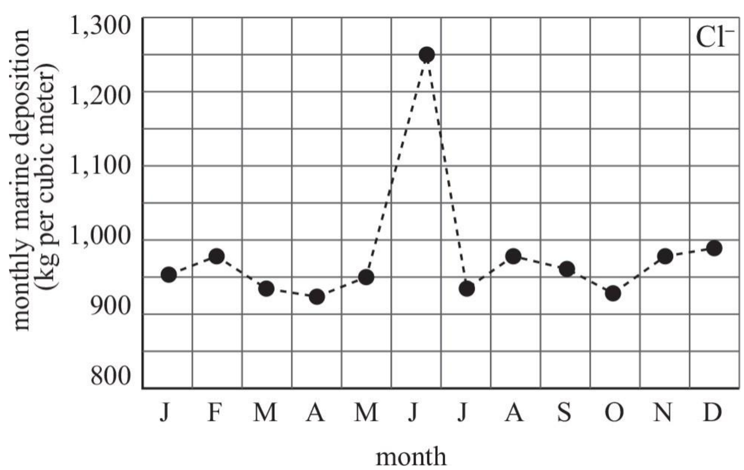


Figure 1

At the end of each month, the sequestered water was extracted by a scientific research crew, and a portion was analyzed for the concentrations of Cl– and SO42– ions. Using these data, the marine deposition was measured in kilograms (kg) per cubic meter (m3) for each substance in each month (see Figure 2).



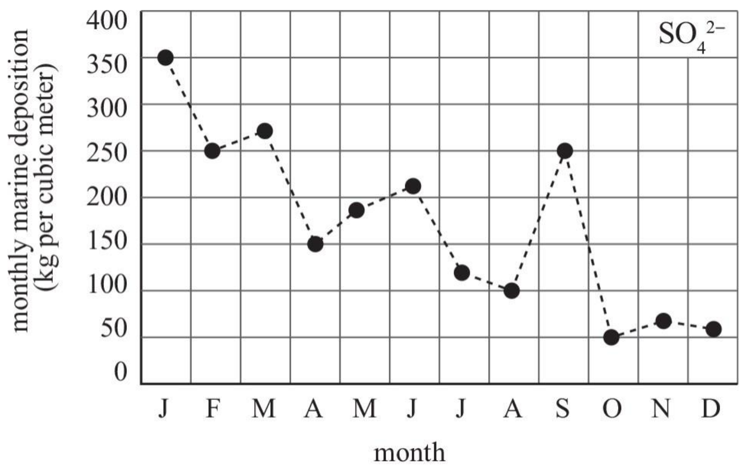


Figure 2

Study 2

Another portion of the monthly water sample was analyzed for concentrations of Na+ and Mg2+ ions. The monthly marine deposition was calculated for each substance in equivalents (Eq) per m3 (see Figure 3).

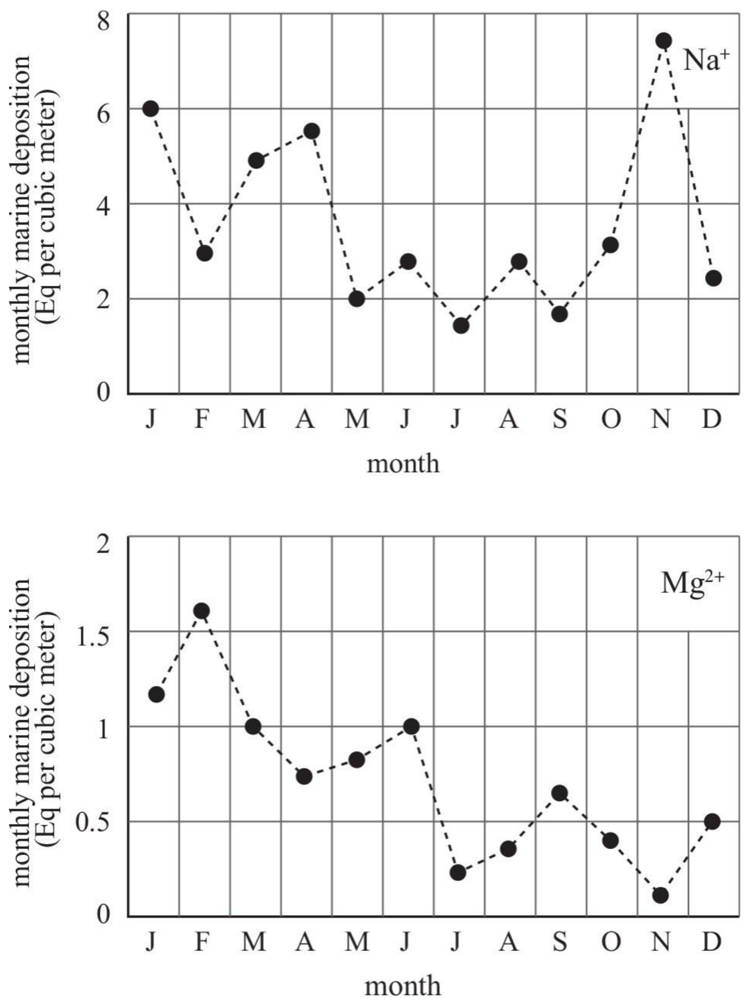


Figure 3

Study 3

The annual marine deposition of Cl– and SO42– ions over the 12-month period was calculated in kg/m3 at the test site in the Atlantic Ocean, and also at two sites in the Arctic Ocean, located 2,000 and 4,000 kilometers due north, respectively (see Figure 4).

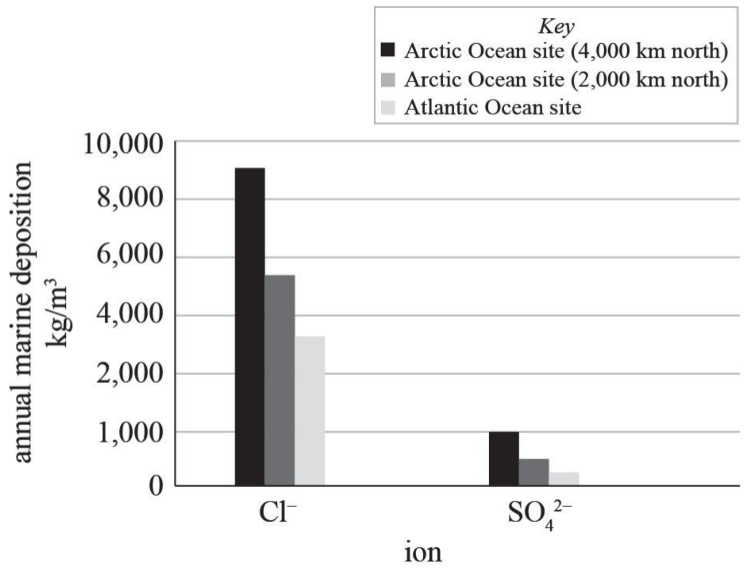


Figure 4

8. Based on the results from Study 1, the mean monthly marine deposition for Cl– over the year of the study was:

F. less than 900 kg/m^3.
G. between 900 kg/m^3 and 1,100 kg/m^3.
H. between 1,100 kg/m^3 and 1,200 kg/m^3.
J. greater than 1,200 kg/m^3.

9. A student states, "The marine deposition of Na^+ is highest in the winter and lowest in the summer, since the winter features greater activity of volcanoes and hydrothermal vents." Is this statement supported by the results of Study 2 ?

A. No, because marine deposition of Na^+ was, on average, greater between November and January than it was between June and August.
B. No, because marine deposition of Na^+ was, on average, less between November and January than it was between June and August.

C. Yes, because marine deposition of Na^+ was, on average, greater between November and January than it was between June and August.

D. Yes, because marine deposition of Na^+ was, on average, less between November and January than it was between June and August.

10. Suppose that the study was repeated with the sensor placed in an underwater cave in the Atlantic Ocean where there is no movement of water. The information provided indicates that during this new study, the researchers would have measured:

F. no marine deposition of any of the 4 substances.

G. no marine deposition of Cl^- and $SO4^{2-}$, but a high level of marine deposition of Na^+ and Mg^{2+}.

H. high marine deposition of Cl^- and $SO4^{2-}$, but no marine deposition of Na^+ and Mg^{2+}.

J. high marine deposition of all 4 substances.

11. According to Study 3, as the distance from the fluid motion sensor in the Atlantic Ocean decreases, the annual marine deposition:

A. decreases for both Cl^- and $SO4^{2-}$.

B. decreases for Cl^- but increases for $SO4^{2-}$.

C. increases for Cl^- but decreases for $SO4^{2-}$.

D. increases for both Cl^- and $SO4^{2-}$.

12. Which of the following variables remained constant in Study 2 ?

F. Marine deposition of $SO4^{2-}$

G. Marine deposition of Mg^{2+}

H. Movement of water during the month

J. Location of the study

13. According to Figure 1, during the year over which data were collected, the movement of water was greatest in February and least in November. According to Figures 2 and 3, the marine deposition of which ion was also greatest in February and least in November?

A. Cl^-
B. Mg^{2+}
C. Na^+
D. $SO4^{2-}$

14. In Study 3, the marine deposition of Cl^- at a site 1,500 km due north of the Atlantic Ocean test site would most likely have been:

F. less than 500 kg/m^3.
G. between 500 and 1,000 kg/m^3.
H. between 3,000 and 5,000 kg/m^3.
J. greater than 5,000 kg/m^3.

Passage III

Oxidation-reduction titration is a method in which precise volumes of a *titrant* (an oxidizing or reducing agent) are added dropwise to a known volume of an *analyte* (a reducing or oxidizing agent, respectively, if the titrant is the oxidizing or reducing agent). This process can be monitored by adding a *redox indicator* (a substance that changes color over a certain range of electrode potentials) to the analyte or by measuring the sample's *voltage* using a potentiometer. Voltage (measured in kilovolts, kV) is a measure of the force of an electrical current that could be transmitted by the solution.

Two titration experiments were performed at 298 K using a 0.10 *M* iodine (I2) solution and either a 0.0010 *M* sulfur dioxide (SO2) solution or a 0.0010 *M* sodium thiosulfate solution (where *M* is the number of moles of oxidizing or reducing agent per liter of solution). All solutions were aqueous. A redox indicator solution of *starch* was also used. When iodine reacts with sulfur dioxide or sodium thiosulfate, the iodine is reduced to 2 iodide ions (I^-) and the sulfur dioxide or sodium thiosulfate is oxidized. Once the sulfur dioxide or sodium thiosulfate is fully oxidized, any additional iodine in the solution will bind with the starch and form a complex with a deep blue color.

Experiment 1

A drop of starch solution was added to an Erlenmeyer flask containing 100.0 mL of the sulfur dioxide solution. A potentiometer, which acts as a control input for electronic circuits, was placed in the solution. The iodine solution was incrementally added to the sulfur dioxide solution. After each addition, the sulfur dioxide solution was stirred and the solution's color and voltage were recorded (see Figure 1).

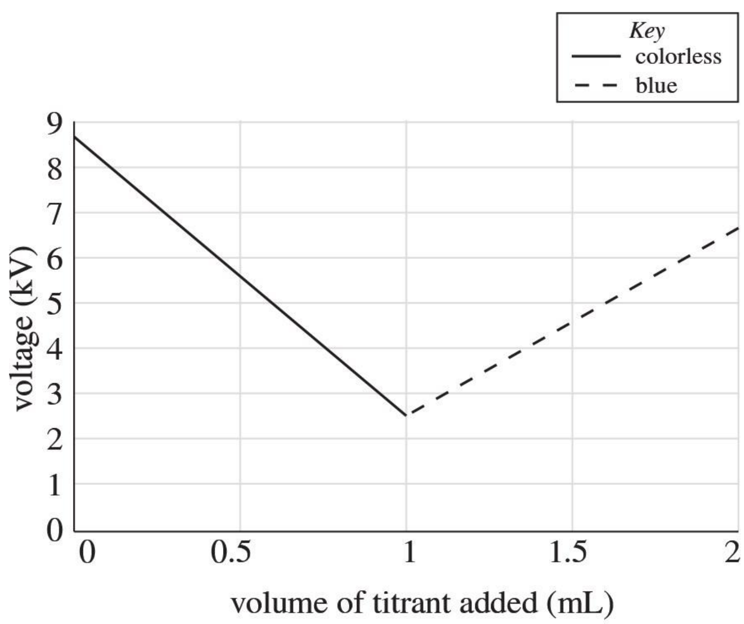


Figure 1

Experiment 2

Experiment 1 was repeated, except that the sodium thiosulfate solution was used instead of the sulfur dioxide solution (see Figure 2).

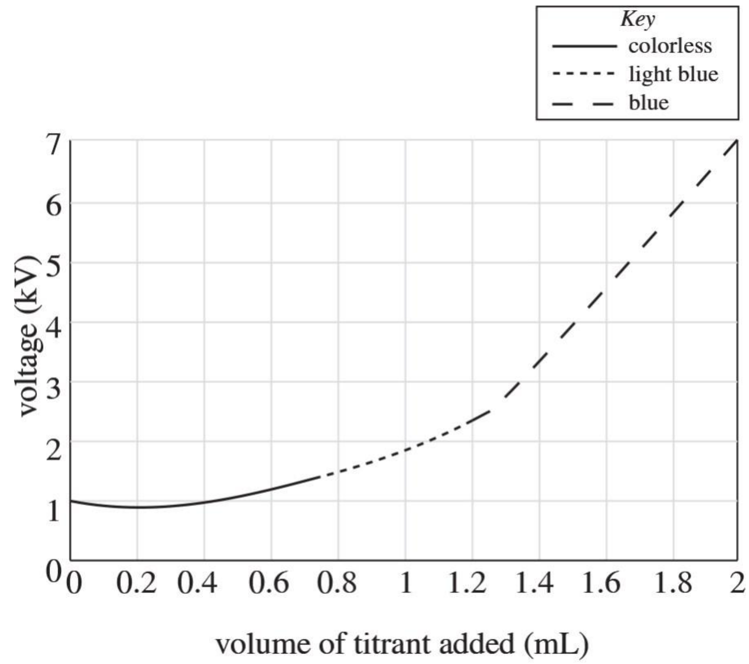


Figure 2

15. Suppose that in Experiment 1, the volume of sulfur dioxide solution used was 120.0 mL instead of 100.0 mL. Based on the information in the passage, how much titrant would need to be added before the solution turned blue?

A. Less than 0.5 mL
B. Between 0.5 mL and 1.0 mL
C. Exactly 1.0 mL
D. Between 1.0 mL and 1.5 mL

16. In Experiment 1, the analyte was blue at which of the following volumes of titrant added?

F. 0.1 mL
G. 0.5 mL
H. 0.9 mL
J. 1.5 mL

17. In Experiment 2, the analyte was in its fully oxidized form for which of the following volumes of titrant added?

A. 0.3 mL
B. 0.6 mL
C. 0.9 mL
D. 1.2 mL

18. In Experiment 1, if 2.5 mL of titrant was added to the analyte, the voltage would most likely have been:

F. less than 1 kV.
G. between 1 kV and 4 kV.
H. between 4 kV and 7 kV.
J. greater than 7 kV.

19. In Experiment 2, which solution was the titrant and which solution was the analyte?

A. titrant: sodium thiosulfate, analyte: iodine
B. titrant: sulfur dioxide, analyte: iodine
C. titrant: iodine, analyte: sodium thiosulfate
D. titrant: iodine, analyte: sulfur dioxide

20. In Experiments 1 and 2, the potentiometer that was placed in the analyte most likely did which of the following?

F. Detected the concentration of starch in the solution
G. Conducted an electric current initiated by ions in the solution
H. Heated the solution to its boiling point
J. Cooled the solution to its freezing point

21. A chemist states that in Experiment 2, the analyte was fully oxidized with 0.2 mL of titrant added, but not with 1.8 mL of titrant added. Do the results of Experiment 2 support this claim?

A. Yes; at a value of 0.2 mL of titrant added, the analyte was blue, while at a value of 1.8 mL of titrant added, the analyte was colorless.
B. Yes; at a value of 0.2 mL of titrant added, the analyte was colorless, while at a value of 1.8 mL of titrant added, the analyte was blue.
C. No; at a value of 0.2 mL of titrant added, the analyte was blue, while at a value of 1.8 mL of titrant added, the analyte was colorless.
D. No; at a value of 0.2 mL of titrant added, the analyte was colorless, while at a value of 1.8 mL of titrant added, the analyte was blue.

Passage IV

An astrophysics class is given the following facts about the burning out of stars.

1. The burning out of a star can be divided into 3 stages: *helium fusion*, *planetary nebula formation*, and *white dwarf development*.
2. Mid-sized stars fuse hydrogen nuclei (composed of protons) into helium nuclei at their centers, in a process known as helium fusion. These include yellow dwarves, like our Sun, and the slightly smaller orange dwarves. Helium fusion releases a significant amount of kinetic energy.
3. As kinetic energy continues to be released, a planetary nebula may form, in which colorful, ionized gas spreads out from the star's center.
4. The remaining material at the center of the planetary nebula condenses into a white dwarf, which is relatively cool and small in size.
5. Red dwarves are smaller stars that can also carry out helium fusion. These stars can develop into white dwarves sooner than yellow and orange dwarves, and they do not form planetary nebulas.

Two students discuss the eventual fate of three stars in the Alpha Centauri system: Alpha Centauri A, a 1.10-solar-mass yellow dwarf star, where one *solar mass* unit is equivalent to the mass of the Sun; Alpha Centauri B, a 0.91-solar-mass orange dwarf star; and Alpha Centauri C, a 0.12-solar-mass red dwarf star. Alpha Centauri A and B comprise a binary star system that revolves around a common center of mass, while Alpha Centauri C revolves around a nearby center of mass.

Student 1

The 3 stars of the Alpha Centauri system all formed at the same time from the same collection of matter. Alpha Centauri C was initially the most massive of the three stars, and Alpha Centauri A and Alpha Centauri B had the same size. The large Alpha Centauri C had more helium fusion than the other two stars, so it quickly became the smallest of the stars. More of its matter flowed to Alpha Centauri A than to Alpha Centauri B, making Alpha Centauri A slightly larger than Alpha Centauri B.

Student 2

Alpha Centauri A and Alpha Centauri B formed at a different time than Alpha Centauri C. Alpha Centauri A and Alpha Centauri B formed at the same time from a common collection of matter, and Alpha Centauri A was initially more massive than Alpha Centauri B. Alpha Centauri C formed later from a different, smaller collection of matter and never became bigger than a red dwarf. At some point, the small Alpha Centauri C was attracted to the other two stars, resulting in a triple star system.

22. Based on Student 2’s discussion, Alpha Centauri C is part of the Alpha Centauri system because of which of the following forces exerted on Alpha Centauri C by the original binary star system?

F. Electromagnetism
G. Gravitation
H. Strong nuclear interaction
J. Weak nuclear interaction

23. Based on Student 1's discussion and Fact 2, while matter flowed between Alpha Centauri C and Alpha Centauri A, Alpha Centauri C released most of its energy by fusing:

A. helium nuclei into hydrogen nuclei at its core.
B. hydrogen nuclei into helium nuclei at its core.
C. helium nuclei into hydrogen nuclei at its periphery.
D. hydrogen nuclei into helium nuclei at its periphery.

24. Suppose that stars that form from the same collection of matter have similar chemical composition, but stars that form from different collections of matter have different chemical compositions. Student 2 would most likely agree with which of the following statements comparing chemical compositions of the stars in the current Alpha Centauri system at the time that they were formed?

F. Alpha Centauri A and Alpha Centauri B had the most similar compositions.
G. Alpha Centauri A and Alpha Centauri C had the most similar compositions.
H. Alpha Centauri B and Alpha Centauri C had the most similar compositions.
J. Alpha Centauri A, Alpha Centauri B, and Alpha Centauri C all had the same compositions.

25. If the mass of the Sun is 2.0 × 1030 g, what is the mass of Alpha Centauri A ?

A. 1.8×10^{30} g
B. 2.0×10^{30} g
C. 2.2×10^{30} g
D. 2.4×10^{32} g

26. Which of the following statements best explains why the process described in Fact 2 requires a high initial temperature and pressure?

F. All electrons are negatively charged, and like charges attract each other.

G. All electrons are negatively charged, and like charges repel each other.

H. All protons are positively charged, and like charges attract each other.

J. All protons are positively charged, and like charges repel each other.

27. Based on Fact 5, which of the three stars, if any, in the Alpha Centauri system would Student 1 expect to most likely develop into a white dwarf first?

A. Alpha Centauri A
B. Alpha Centauri B
C. Alpha Centauri C
D. The three stars will likely develop into white dwarves at the same time.

28. Based on Fact 5, would Student 2 agree that by the time Alpha Centauri B develops into a white dwarf, it will have spent as much time as a mid-sized star as Alpha Centauri A ?

F. Yes, because according to Student 2, Alpha Centauri A has always been less massive than Alpha Centauri B.

G. Yes, because according to Student 2, Alpha Centauri A has always been more massive than Alpha Centauri B.

H. No, because according to Student 2, Alpha Centauri A has always been less massive than Alpha Centauri B.

J. No, because according to Student 2, Alpha Centauri A has always been more massive than Alpha Centauri B.

Passage V

Three experiments were conducted using the gases nitrogen (N2), nitrogen dioxide (NO2), and xenon (Xe). For each gas:

1. A cap was placed on a 2 L metal chamber, containing sensors to measure temperature and pressure and a valve to allow gas to enter.
2. Air was pumped out of the chamber until the pressure inside was measured to be 0.00 mmHg.
3. The chamber was placed on an analytical balance, which was then reset to 0.00 g.
4. A specific mass of gas was added to the chamber.
5. When the gas in the vessel reached room temperature (298 K), the mass and pressure inside were recorded.
6. Steps 4 and 5 were repeated for different masses.

The experiments were repeated using a 4 L metal chamber (see Figures 1 and 2).

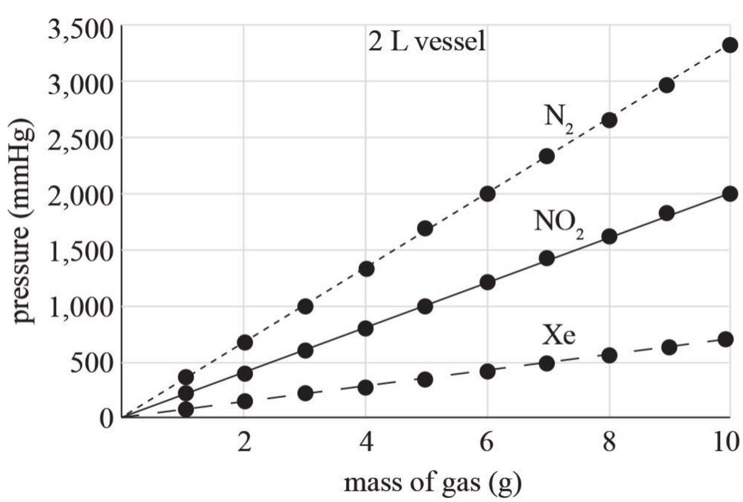


Figure 1

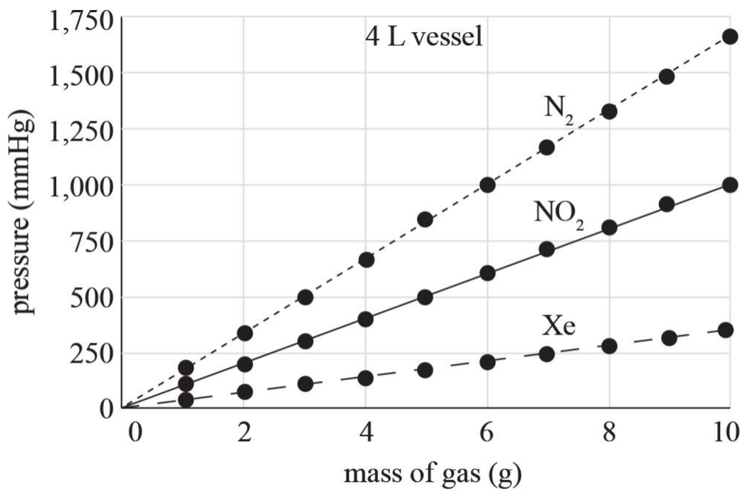


Figure 2

29. Based on Figure 2, if 12 g of Xe had been added to the 4 L vessel, the pressure would have been:

A. less than 300 mmHg.
B. between 300 and 600 mmHg.
C. between 600 mmHg and 900 mmHg.
D. greater than 1,200 mmHg.

30. Suppose the experiments had been repeated, except with a 3 L vessel. Based on Figures 1 and 2, the pressure exerted by 10 g of NO2 would most likely have been:

F. less than 1,000 mmHg.
G. between 1,000 and 2,000 mmHg.
H. between 2,000 and 2,500 mmHg.
J. greater than 2,500 mmHg.

31. Based on Figures 1 and 2, for a given mass of N2 at 298 K, how does the pressure exerted by the N2 in a 4 L vessel compare to the pressure exerted by the N2 in a 2 L vessel? In the 4 L vessel, the N2 pressure will be:

A. half as great as in the 2 L vessel.

B. the same as in the 2 L vessel.
C. twice as great as in the 2 L vessel.
D. four times as great as in the 2 L vessel.

32. Which of the following best explains why equal masses of N2 and NO2 at the same temperature and in vessels of the same size had different pressures? The pressure exerted by the N2 was:

F. greater, because there were fewer N2 molecules per gram than there were NO2 molecules per gram.
G. greater, because there were more N2 molecules per gram than there were NO2 molecules per gram.
H. less, because there were fewer N2 molecules per gram than there were NO2 molecules per gram.
J. less, because there were more N2 molecules per gram than there were NO2 molecules per gram.

33. Suppose the experiment involving N2 and the 4 L vessel had been repeated, except at a temperature of 287 K. For a given mass of N2, compared to the pressure measured in the original experiment, the pressure measured at 287 K would have been:

A. greater, because pressure is directly proportional to temperature.
B. greater, because pressure is inversely proportional to temperature.
C. less, because pressure is directly proportional to temperature.
D. less, because pressure is inversely proportional to temperature.

34. The table below shows the molar masses of N_2, NO_2, and Xe.

Gas	Molar mass (g/mol)
N_2	28.0
NO_2	46.0
Xe	131.3

The molar mass of O_2 is approximately 32 g/mol. Suppose that 6 grams of O_2 were placed into the 4 L chamber using the same procedure described in steps 1–6. Which of the following is most likely closest to the pressure of the O_2 at 298 K ?

F. 610 mmHg
G. 870 mmHg
H. 1,530 mmHg
J. 1,780 mmHg

Passage VI

The *absolute threshold pressure for hearing* is the minimum air pressure at each audio frequency that can produce a sound that is detectable by the human ear. The *pain threshold pressure for hearing* is the maximum air pressure at each audio frequency that the human ear can withstand without sensing pain.

Figure 1 below displays the absolute and pain threshold pressures for hearing in two media: air and water. The figure also shows *P*, the percentage increase in compression of the air or water with increasing sound pressure. Audio frequency is given in cycles per second (cyc/sec), and sound pressure level is given in decibels (db).

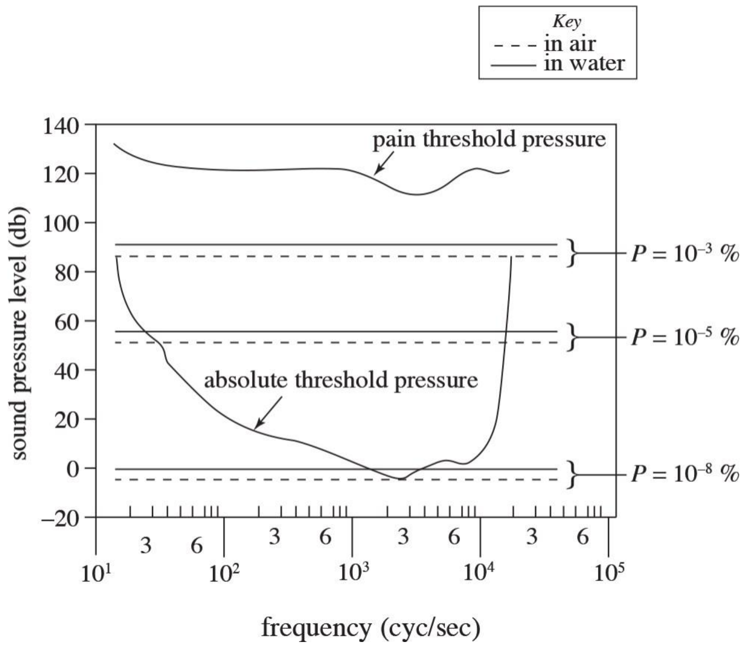


Figure 1

35. At which of the following frequencies can humans hear the widest range of sound pressure levels without pain?

A. 20 cyc/sec
B. 400 cyc/sec
C. 2,500 cyc/sec
D. 20,000 cyc/sec

36. According to Figure 1, which of the following is the closest to the highest frequency that can be heard by a human being?

F. 20 cyc/sec
G. 200 cyc/sec
H. 2,000 cyc/sec
J. 20,000 cyc/sec

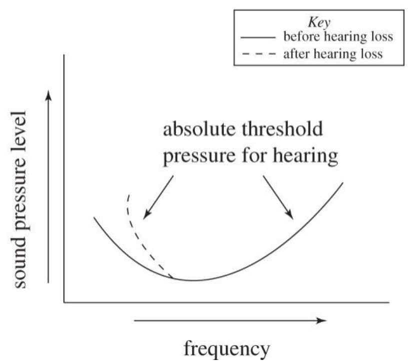
37. Based on Figure 1, a sound of a given frequency will have the highest sound level pressure for which of the following sets of conditions?

A. sound in: air, *P*: 10^{-8}%

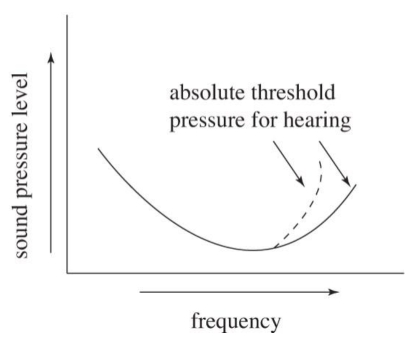
B. <u>sound in</u>: air, <u>*P*</u>: $10^{-3}\%$
C. <u>sound in</u>: water, <u>*P*</u>: $10^{-8}\%$
D. <u>sound in</u>: water <u>*P*</u>: $10^{-3}\%$

38. As humans grow older, there is often a loss in the ability to hear sounds at high frequencies. Which of the following figures best illustrates this?

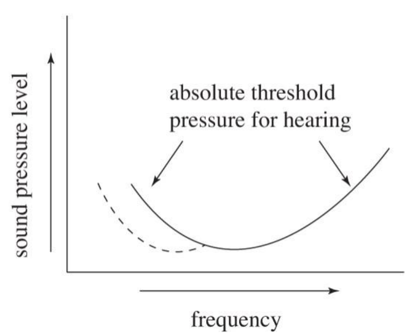
F.



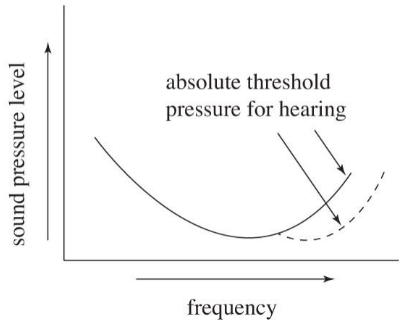
G.



H.



J.



39. A sound with a frequency of 3×10^3 cyc/sec causes pain at 115 db. Which of the following actions would eliminate the pain?

I. Reducing the frequency to 10^3 cyc/sec

II. Increasing the frequency to 10^4 cyc/sec

III. Reducing the sound pressure level by 5 db

A. II only
B. I and III only
C. III only
D. I, II, and III

40. Based on Figure 1, does *P* depend on the frequency of sound at a given sound pressure level?

F. No, because as frequency increases, *P* increases.
G. No, because as frequency increases, *P* remains constant.
H. Yes, because as frequency increases, *P* increases.
J. Yes, because as frequency increases, *P* remains constant.

END OF TEST.
STOP! DO NOT TURN THE PAGE UNTIL TOLD TO DO SO.

Answers and Explanations

SCIENCE PRACTICE TEST 2 EXPLANATIONS

Passage I

1. **B**

The question asks for the color intensity of the largest percentage of moths from City Y and City Z. The color intensity for the moths in City *Y* is shown in Figure 3, and the highest percentage of these moths had a color intensity of 8. Eliminate (C) and (D). The color intensity for the moths in City *Z* is shown in Figure 4, and the highest percentage of these moths had a color intensity of 5. Eliminate (A), and the only remaining answer is (B).

2. **G**

The question asks in which year was birch bark likely to be the thickest in City Y. The blurb in Study 2 contains the following information: *During dry years, pollutants are more likely to concentrate on tree bark, and the tree bark itself tends to become thicker*. Therefore, bark is thickest during dry years, and of the years listed in the answer choices, only 2001 is identified on Figure 5 as a *dry* year, so (G) is the correct answer.

3. **A**

The question asks how Study 1 differed from Study 2. Use POE. Moth color intensity is on the horizontal axis of Figures 2–4 from Study 1 and on the vertical axis of Figure 5 from Study 2. Eliminate (C) and (D) since moth color is measured in both studies. Now, read the text for reference to the type of moths used in each study. Study 2 contains the following information: *During each visit they captured at least 50* B. betularia f. typica *moths.* Eliminate (B). Only (A) remains.

4. **H**

The question asks for the most likely reason that the scientists labeled the moths in Study 1. Use POE. Choice (F) is incorrect because pollution is discussed in the description of Study 2 not Study 1. Choice (G) is incorrect because wingspan is not measured in either study. You'll need to use a bit of science common sense here to choose between (H) and (J). In Study 1, the scientists are trying to count the number of moths in these various cities; therefore, in order to make this count accurate, they will need to make sure that each moth is counted only once. Eliminate (J). The correct answer is (H).

5. **C**

The question asks if, according to Study 2, a moth with a body color intensity measuring 6.5 or a moth with a body color intensity measuring 9.5 would have a greater chance of surviving in 2005. Figure 5 shows that 2005 was a dry year, and the average color intensity was 9.5. Given that the average color intensity for both dry years shown in Figure 5 are higher than 9, it can be concluded that a moth with a color intensity of 9.5 is more likely to survive in a dry year. Eliminate (A) and (B). Then, notice that Study 2 contains the following information: *During dry years, pollutants are more likely to concentrate on tree bark.* The correct answer is (C).

6. **F**

The question asks if the results of Study 1 would support the hypothesis that there would be a greater range in body coloration in the *B. betularia f. typica* moths when they are forced to coexist with another subspecies of moths. This question is difficult to answer *Yes* or *No* immediately, so work with the reasons given in each of the answer choices. In City *X*, the coloration of *B. betularia f. typica* ranges from 6 to 10. Note that in City Z, the *B. betularia f. carbonaria* species is found only at body intensity colors from 1–5, so it is reasonable to assume that all of the body intensities of 6 and above in City X are of the *B. betularia f. typica* species. In City *Y*, the coloration of *B. betularia f. typica* ranges from only 7 to 10. Eliminate (G) and (J). The hypothesis that a greater range in body coloration is produced by a diversity in the subspecies is therefore supported by this information because City *X* contains two subspecies and City *Y* contains only one. The correct answer is (F).

7. **B**

The question asks if the moth population in City Z would most likely have been higher in wet years or dry years. Use POE on this question. Figure 4 shows that the moths in City Z are the lighter colored moths (*Betularia f. carbonaria*). Therefore, lighter trees would provide better camouflage. Eliminate (A) and (C). Study 2 states, *During wet years, pollutants tend to be washed from the surfaces of tree bark. During dry years, pollutants are more likely to concentrate on tree bark.* Since concentrated pollutants would darken the surface of a tree, the wet years will have lighter tree bark. The correct answer is (B).

Passage II

8. **G**

The question asks for the mean monthly marine deposition for Cl^- over the course of Study 1. Look carefully at Figure 2. The marine deposition of Cl– is around 950 kg/m3 except in June, at which point it is much higher. Because it has only this single outlier, you can reasonably expect that the *mean*, or *average*, monthly deposition will be only slightly higher than 950. The correct answer is (G).

9. **C**

The question asks if the statement *The marine deposition of* Na^+ *is highest in the winter and lowest in the summer, since the winter features greater activity of volcanoes and hydrothermal vents* is supported by the results of Study 2. Use POE with the reasons given in each of the answer choices. According to Figure 3, the monthly deposition of Na^+ is higher between November and January than it is between June and August. Eliminate (B) and (D). This information then *supports* the statement in the question that the *marine deposition of* Na^+ *is highest in the winter and lowest in the summer*, thus making (C) the correct answer.

10. **F**

The question asks what level of marine deposition the researchers would have measured if the study was repeated with the sensor placed in an underwater cave in the Atlantic Ocean where there is no movement of water. The introduction to the passage gives the following information: *Ions in seawater, such as* Cl^-, SO_4^{2-}, Na^+, *and* Mg^{2+}, *are carried down to the ocean floor through a process known as* marine deposition. Therefore, in order for there to be *marine deposition*, ions must be *carried down* somewhere. If the water does not move past the sensor, then no marine deposition will be measured at the sensor location. The correct answer is (F).

11. **A**

The question asks what happens to the annual marine deposition as the distance from the fluid motion sensor in the Atlantic Ocean decreases in Study 3. Make sure you pay careful attention to the key in Figure 4. According to Figure 4, the annual marine depositions of both ions were highest in the Arctic Ocean at the site farthest from the Atlantic Ocean. The annual marine depositions of both ions decrease as the sensor gets closer to the Atlantic Ocean site. The correct answer is (A).

12. **J**

The question asks which variable remained constant in Study 2. According to Figure 3, the marine deposition of $SO_4$2– was not studied, eliminating (F). The marine deposition of Mg2+ changed during the study; eliminate (G). According to Figure 1, the movement of water during the month changed every month during the twelve-month period, eliminating (H). Only the location of the study, the Atlantic Ocean, was held constant. The location did not change until Study 3. The correct answer is (J).

13. **B**

The question asks which ion had the greatest marine deposition in February and least in November. Use POE. In Figures 2 and 3, only the marine deposition of Mg2+ is highest in February and lowest in November, making (B) the correct answer.

14. **H**

The question asks what the marine deposition of Cl^- at a site 1,500 km due north of the Atlantic Ocean test site in Study 3 would most likely have been. Refer to Figure 4. For Cl^-, marine deposition increases as the distance north of the Atlantic Ocean test site increases. At the Atlantic Ocean test site, the deposition is 3,000 kg/m^3, and at 2,000 km north of the Atlantic Ocean test site, the deposition is 5,000 kg/m^3. Therefore, the deposition at 1,500 km north would be between these two values. The correct answer is (H).

Passage III

15. **D**

The question asks how much titrant would need to be added to a sulfur dioxide solution of 120.0 mL before the solution turned blue. The passage states that *Once the sulfur dioxide or sodium thiosulfate is fully oxidized, any additional iodine in the solution will bind with the starch and form a complex with a deep blue color.* Therefore, the solution turns blue only after the iodine has reacted with all of the analyte. If the amount of sulfur dioxide were increased to 120.0 mL, the amount of titrant necessary to fully oxidize the sulfur dioxide would also increase. In Experiment 1, the solution currently turns blue at 1.0 mL of titrant, so it would require more than 1.0 mL if the sulfur dioxide volume were increased. The only possible answer is (D).

16. **J**

The question asks for a volume of titrant at which the analyte was blue in Experiment 1. Use Figure 1. The key in the corner of the graph says that anything graphed with a solid line is *colorless,* and anything graphed with a dotted line is *blue*. The curve shown in this graph changes from solid to dotted at 1 mL of titrant added, meaning that the solution at all values of titrant less than 1 mL will be colorless, and the solution at all values greater than 1 mL will be blue. Eliminate (F), (G), and (H) because they are not greater than 1 mL. The correct answer is (J).

17. **D**

The question asks for a volume of titrant in Experiment 2 at which the analyte was in its fully oxidized form. The passage states that *Once the sulfur dioxide or sodium thiosulfate is fully oxidized, any additional iodine in the solution will bind with the starch and form a complex with a deep blue color.* In other words, the analyte is not fully oxidized until the solution turns a deep blue color. According to Figure 2, the solution is blue (and therefore fully oxidized) above 1 mL of titrant added. The correct answer is (D).

18. **J**

The question asks what the voltage would most likely have been in Experiment 1 if 2.5 mL of titrant was added to the analyte. Figure 2 does not show the voltage at 2.5 mL of titrant added, but the curve follows a clear trend. As the volume of titrant added increases, the voltage increases as well. At 2 mL of titrant added, the voltage is equivalent to 7 kV. Therefore, at 2.5 mL of titrant added, the voltage will most likely be greater than 7 kV. The correct answer is (J).

19. **C**

The question asks which solution in Experiment 2 was the titrant and which solution was the analyte. Start by eliminating (B) and (D) because sulfur dioxide was not used in Experiment 2 at all. The passage describes oxidation-reduction titration as *a method in which precise volumes of a* titrant *(an oxidizing or reducing agent) are added dropwise to a known volume of an* analyte *(a reducing or oxidizing agent, respectively)*. In other words, one substance (the titrant) is added gradually to a certain amount of another substance (the analyte). Therefore, when Experiment 1 says that the iodine solution was incrementally added to the sulfur dioxide solution, it can be inferred that the iodine is the titrant, and the sulfur dioxide is the analyte. In Experiment 2, the sodium thiosulfate solution was used instead of the sulfur dioxide solution; therefore, in Experiment 2, the iodine is still the titrant, and the sodium thiosulfate solution is the analyte. The correct answer is (C).

20. **G**

The question asks what the potentiometer in Experiments 1 and 2 most likely did. Use POE. Experiment 1 contains the following information: *A potentiometer, which acts as a control input for electronic circuits, was placed in the solution.* The key phrase here is *electric circuits*. There's nothing to suggest that the potentiometer has anything to do with *concentration*, eliminating (F), or *freezing* or *boiling point*, eliminating (H) and (J). Only (G) contains any reference to *electric circuits*, so (G) is the correct answer.

21. **D**

The question asks if the results of Experiment 2 support the claim that in Experiment 2, *the analyte was fully oxidized with 0.2 mL of titrant added but not with 1.8 mL of titrant added.* Use POE. If you're not sure how to answer *Yes* or *No*, look at the reasons. At 0.2 mL of titrant added, the solution is colorless, and at 1.8 mL of titrant added, the solution is blue. Eliminate (A) and (C), which have answers that contradict this information. According to the introduction, a solution turns blue after it is fully oxidized, so the analyte was not yet oxidized at 0.2 mL; eliminate (B). The correct answer is (D).

Passage IV

22. **G**

The question asks, according to Student 2's discussion, which of the forces exerted on Alpha Centauri C by the original binary star system caused Alpha Centauri C to be part of the Alpha Centauri system. Student 2 concludes with the following sentence: *At some point, the small Alpha Centauri C was attracted to the other two stars, resulting in a triple star system.* Some outside knowledge is necessary here: gravity is the attraction between two objects with mass, so (G) is the correct answer.

23. **B**

The question asks, according to Student 1's discussion and Fact 2, while matter flowed between Alpha Centauri C and Alpha Centauri A, Alpha Centauri C released most of its energy by fusing which of the following? Student 1’s hypothesis contains the following sentence: *The large Alpha Centauri C had more helium fusion than the other two stars, so it quickly became the smallest of the stars.* According to Fact 2, *Mid-sized stars fuse hydrogen nuclei (composed of protons) into helium nuclei at their centers, in a process known as helium fusion*. Only (B) matches the description of helium fusion in Fact 2, so (B) is the correct answer.

24. **F**

The question asks which statement Student 2 would most likely agree with. Student 2’s hypothesis contains the following sentence: *Alpha Centauri A and Alpha Centauri B formed at the same time from a common collection of matter*. As the question suggests, stars that form from the same collection of matter have similar chemical compositions. Therefore, Student 2 would likely suggest that Alpha Centauri A and Alpha Centauri B have similar chemical compositions because they formed *from a common collection of matter*. Alpha Centauri C formed from a different collection of matter, eliminating (G), (H), and (J). The correct answer is (F).

25. **C**

The question asks what the mass of Alpha Centauri A is if the mass of the Sun is 2.0×10^{30} g. The introduction to this passage contains the following information: *Alpha Centauri A, a 1.10-solar-mass yellow dwarf star, where one solar mass unit is equivalent to the mass of the Sun.* The question states that the mass of the Sun is 2.0 × 1030 g. Therefore, the mass of Alpha Centauri A must be 1.10 times this value, given the definition of solar mass. Don’t worry about calculating the exact value: you know that this value must be slightly greater than the mass of the Sun. Eliminate (A) and (B) because these are less than the mass of the Sun. Eliminate (D) because this is more than 100 times the mass of the Sun. The correct answer is (C).

26. **J**

The question asks which of the statements best explains why the process described in Fact 2 requires a high initial temperature and pressure. Use POE. This question involves a bit of outside knowledge, but it can be solved easily with a bit of common sense. First of all, Fact 2 states that the nuclei being fused are *composed of protons*. It is therefore not likely that the answer to this question will have anything to do with *electrons*, eliminating (F) and (G). *Helium fusion* describes the process by which these protons are *fused*, or put together. Think about it this way: if these protons are attracted to each other to begin with, do you think it would take a bunch of extra energy to put them together? Not likely! Eliminate (H). The correct answer is (J).

27. **C**

The question asks which of the three stars, if any, in the Alpha Centauri system Student 1 would expect to most likely develop into a white dwarf first based on Fact 5. Fact 5 contains the following information: *Red dwarves are smaller stars that can also carry out helium fusion. These stars can develop into white dwarves sooner than yellow and orange dwarves.* Student 1 states, *The large Alpha Centauri C had more helium fusion than the other two stars, so it quickly became the smallest of the stars.* Therefore, Student 1 would likely believe that the smallest star, Alpha Centauri C, would develop into a white dwarf first. The correct answer is (C).

28. **J**

The question asks if, according to Fact 5, Student 2 would agree that by the time Alpha Centauri B develops into a white dwarf it will have spent as much time as a mid-sized star as Alpha Centauri A. Use POE. If you're not sure how to answer *Yes* or *No*, look at the reasons. Student 2's hypothesis contains the following information: *Alpha Centauri A was initially more massive than Alpha Centauri B.* This eliminates (F) and (H) immediately. Fact 5 contains the following information: *Red dwarves are smaller stars that can also carry out helium fusion. These stars can develop into white dwarves sooner than yellow and orange dwarves*. Therefore, since the introduction indicates that currently Alpha Centauri B is smaller, it *can develop into a white dwarf.* Student 2 also states that *Alpha Centauri A and Alpha Centauri B formed at the same time.* Combine these facts together: if the stars formed at the same time and Alpha Centauri B will develop into a white dwarf sooner, then it will spend less time as a mid-size star. Eliminate (G). The correct answer is (J).

Passage V

29. **B**

The question asks what the pressure would have been in Figure 2 if 12 g of Xe had been added to the 4 L vessel. Figure 2 only gives the information up to 10 g of gas added, but fortunately, all these lines have a very consistent relationship: as the mass of gas goes up, the pressure goes up. In the 4 L vessel, when 10 g of Xe is added, the pressure is approximately 300 mmHg. At 12 g of Xe, the pressure should be slightly higher, somewhere around 450 mmHg. Only (B) gives a range that contains this value.

30. **G**

The question asks what the pressure exerted by 10 g of NO_2 would most likely have been, based on Figures 1 and 2, if the experiments had been repeated with a 3 L vessel. In the 2 L vessel in Figure 1, 10 g of NO_2 gives a pressure of approximately 2,000 mmHg. In the 4 L vessel in Figure 2, 10 g of NO_2 gives a pressure of approximately 1,000 mmHg. Therefore, in a 3 L vessel, 10 g of NO_2 should give a pressure between 1,000 and 2,000 mmHg. The correct answer is (G).

31. **A**

The question asks, according to Figures 1 and 2, how the pressure exerted by a given mass of N_2 at 298 K in a 4 L vessel compares to the pressure exerted by the N_2 in a 2 L vessel. Temperature is not mentioned in either figure, but the passage indicates that the experiments were conducted at 298 K, so use Figures 1 and 2. Since you need to compare the N_2 values from Figures 1 and 2, it's best to find values as exact as possible. Notice that at mass 6 g, the 2 L vessel has a pressure of 2,000 mmHg, and the 4 L vessel has a pressure of 1,000 mmHg. Therefore, the pressure in the 4 L vessel is *half as great as* the pressure in the 2 L vessel. The correct answer is (A).

32. **G**

The question asks which of the given statements best explains why equal masses of N_2 and NO_2 at the same temperature and in vessels of the same size had different pressures. Use POE. In Figures 1 and 2, the pressure when N_2 is used is consistently greater than the pressure when the NO_2 is used. Eliminate (H) and (J). Then you'll need some outside knowledge to complete the question. Simply stated, an N_2 molecule has fewer components than an NO_2 molecule, so it has a smaller mass. Therefore, in order to get the same mass of both molecules, you will need more N_2 molecules per gram, eliminating (F). The correct answer is (G).

33. **C**

The question asks what would happen to the pressure for a given mass of N_2 in a 4 L vessel if the experiment had been repeated at a temperature of 287 K. This question requires outside knowledge, but you can still eliminate some answers even without knowing the relationship between temperature and pressure. The question describes a scenario in which the temperature decreases, so there are only two possible answers: either the pressure increases because it's an inverse relationship, or the pressure decreases because it's a direct relationship. Eliminate (A) and (D). To choose between (B) and (C), you need to know the relationship between pressure and temperature: as pressure increases, so does temperature. This is a *direct* relationship; eliminate (B). As the temperature decreases from 298 K to 287 K, the pressure will decrease also. The correct answer is (C).

34. **G**

The question asks what the pressure would most likely be if 6 grams of O_2 at 298 K were placed into the 4 L chamber using the same procedure described in Steps 1–6 given that the molar mass of O_2 is approximately 32 g/mol. First, compare the given table with Figure 2 to find the link between molar mass and pressure. Notice that N_2 has the lowest molar mass, but the highest pressure at every mass. Xe has the highest molar mass and the lowest pressure at every mass. Therefore, molar mass is inversely related to pressure. The molar mass of O_2 is between those of N_2 and NO_2, so the pressure will be between those of N_2 and NO_2 at 6 grams, which are approximately 1,000 mmHg and approximately 625 mmHg, respectively. Only (G) falls within this range. The correct answer is (G).

Passage VI

35. **C**

The question asks at which frequency humans can hear the widest range of sound pressure levels without pain. Use POE. The difference between the pain threshold pressure and the absolute threshold pressure represents the full range of sound pressure levels that a human can hear at a given frequency. Notice that the numbers on the *x*-axis are a logarithmic scale instead of a linear scale. For each order of magnitude, the hashmarks indicate 1×10^n, 2×10^n, 3×10^n, etc. So 20 cyc/sec is the hashmark following the one for 1×10^1. At this point, the pain threshold pressure is approximately 130 db and the absolute threshold pressure is approximately 80 db. This leads to a range of 50 db that humans can hear without pain. Once you understand the concept of this question, you can ballpark this visually without calculating every amount. Of the four choices given, the two lines are furthest apart at 2,500 cyc/sec (just before the "3" hashmark at the 10^3 order of magnitude). The correct answer is (C).

36. **J**

The question asks which of the following frequencies is the closest to the highest frequency that can be heard by a human being, according to Figure 1. The first line of the passage states the following: *The* absolute threshold pressure for hearing *is the minimum air pressure at each audio frequency that can produce a sound that is detectable by the human ear.* In other words, humans cannot hear any sounds below the absolute threshold pressure for hearing at any given frequency. In order to answer this question, you will need to use Figure 1 and the curve labeled *absolute pressure threshold,* and you will need to find its maximum frequency, listed on the x-axis. Notice that the numbers on the x-axis are a logarithmic scale instead of a linear scale. For each order of magnitude (10^n), the hashmarks indicate 1×10^n, 2×10^n, 3×10^n, etc. According to Figure 1, this curve becomes vertical right around 2 × 104 cyc/sec, or 20,000 cyc/sec, indicating that humans cannot hear any frequencies beyond this point. The correct answer is (J).

37. **D**

The question asks with which of the sets of conditions will a sound of a given frequency have the highest sound level pressure. Use POE. Note the key at the top of Figure 1. According to this key, *in water* is shown on the graph with a solid line, and *in air* is shown on the graph with a dotted line. The solid line is consistently higher than the dotted, suggesting that *water* has a higher sound level pressure at each value of *P,* eliminating (A) and (B). Then note the *P*-values on the right side of the graph. The *P*-value closest to the top of the graph, where sound pressure levels are higher, is 10^{-3} %. The correct answer is (D).

38. **G**

The question asks which of the figures best illustrates the information that as humans grow older, there is often a loss in the ability to hear sounds at high frequencies. Use POE. The graph will need to show a change at high frequency, rather than low frequency. Based on this information alone, you can eliminate (F) and (H). The dotted curve (*after hearing loss*) should indicate some kind of hearing *loss* at high frequencies, so it should show a curve that does not quite reach the highest frequencies. Eliminate (J). The correct answer is (G).

39. **D**

The question asks which of the actions listed would eliminate the pain caused by a sound with a frequency of 3×10^3 cyc/sec at 115 db. Note the exponential scale on the *x*-axis of Figure 1. The hashmark labeled *3* between 10^3 and 10^4 represents 3×10^3 cyc/sec. At this point, the pain threshold pressure is 111 db, which means that anything over 111 db will cause pain. Use POE. If the frequency was reduced to 10^3, the pain threshold would increase to 119 db, and a sound at 115 db would no longer be painful. Eliminate (A) and (C) because you know that (I) works. Now check (II). If the frequency was increased to 10^4, the pain threshold pressure increases to approximately 121 db. This means that (II) would eliminate the pain as well. Eliminate (B). The correct answer is (D).

40. **G**

The question asks if, based on Figure 1, *P* depends on the frequency of sound at a given sound pressure level. Use POE. If you're unsure whether to answer *Yes* or *No*, check the reasons. Use Figure 1. Frequency appears on the *x*-axis, and sound pressure level appears on the *y*-axis. According to the lines showing the pressure *in air* and *in water*, the increasing frequency has no effect on *P*. Eliminate (F) and (H). *P* does *not* depend on the frequency, making (G) the correct answer.