

## PASSAGE II

Marcos Nunes is not likely to forget his first holiday in Brazil's Pantanal wilderness. One afternoon last October he was coaxing his horse through a lonely tuft of woods when he suddenly  
(5) found himself staring down a fully grown spotted jaguar. He held his breath while the painted cat and her cub paraded silkily through the grove, not 10 meters away.... "Thank you," he wrote later in a hotel visitor's log, "for the wonderful fright!"

- (10) As Nunes and other ecotourists are discovering, these big, beautiful animals, once at the brink of extinction, are now staging a comeback. Exactly how dramatic a comeback is difficult to say because jaguars—*Panthera onca*, the largest feline  
(15) in the New World—are solitary, secretive, nocturnal predators. Each cat needs to prowl at least 35 square kilometers by itself. Brazil's Pantanal, vast wetlands that spill over a 140,000-square-kilometer swath of South America the size of Germany, gives  
(20) them plenty of room to roam. Nevertheless, scientists who have been tagging jaguars with radio transmitters for two decades have in recent years been reporting a big increase in sightings. Hotels, campgrounds, and bed-and-breakfasts have sprung  
(25) up to accommodate the half-million tourists a year (twice the number of five years ago) bent on sampling the Pantanal's wildlife, of which the great cats must be the most magnificent example.

- Most sightings come from local cattle herders—  
(30) but their jaguar stories have a very different ring. One day last September, ranch hand Abel Monteiro was tending cattle near the Rio Vermelho, in the southern Pantanal, when, he says, a snarling jaguar leaped from the scrub and  
(35) killed his two bloodhounds. Monteiro barely had time to grab his .38 revolver and kill the angry cat. Leonelson Ramos da Silva says last May he and a group of field hands had to throw flaming sticks all night to keep a prowling jaguar from invading  
(40) their forest camp.... The Brazilian interior, famous for its generous spirit and cowboy *bon-homie*, is now the scene of a political cat fight between the scientists, environmentalists, and ecotourists who want to protect the jaguars and the  
(45) embattled ranchers who want to protect themselves and their livelihood.

- The ranchers, to be sure, have enough headaches coping with the harsh, sodden landscape without jaguars attacking their herds and threatening their livelihoods. Hard data on cattle losses due to jaguars in the Pantanal are nonexistent, but there are stories. In 1995, Joo Julio Dittmar bought a 6,200-hectare strip of ideal breeding ground, only to lose 152 of his 600 calves  
(50) to jaguars, he claims. Ranchers chafe at laws that forbid them to kill the jaguars. "This is a question of democracy," says Dittmar. "We ranchers ought to be allowed to control our own environment."

- Man and jaguar have been sparring for territory ever since 18th-century settlers, traders, and herdsmen began to move into this sparsely populated serto, or back lands. By the 1960s, the Pantanal was a vast, soggy canvas, white with gleaming herds of Nelore cattle. Game hunters  
(60) were bagging 15,000 jaguars a year in the nearby Amazon Basin (no figures exist on the Pantanal) as the worldwide trade in pelts reached \$30 million a year. As the jaguars grew scarce, their chief food staple, the capybaras—a meter-long rodent,  
(65) the world's largest—overran farmers' fields and spread trichomoniasis, a livestock disease that renders cows sterile.

- Then in 1967, Brazil outlawed jaguar hunting, and a world ban on selling pelts followed in 1973.  
(75) Weather patterns also shifted radically—due most likely to global warming—and drove annual floods to near-Biblical proportions. The waters are only now retreating from some inundated pasturelands. As the Pantanal herds shrank from  
(80) 6 million to about 3.5 million head, the jaguars advanced. Along the way they developed a taste for the bovine intruders.

- The ranchers' fear of the big cats is partly cultural. The ancient Inca and Maya believed that  
(85) jaguars possessed supernatural powers. In Brazil, the most treacherous enemy is said to be *o amigo da onca*, a friend to the jaguar....

- Some people believe there may be a way for ranchers and jaguars to coexist. Sports hunters on  
(90) "green safaris" might shoot jaguars with immobilizing drugs, allowing scientists to fit the cats with

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radio collars. Fees would help sustain jaguar research and compensate ranchers for livestock losses. (Many environmentalists, though, fear

- (95) fraudulent claims.) Scientists are setting up workshops to teach ranchers how to protect their herds with modern husbandry, pasture management, and such gadgets as blinking lights and electric fences.

- (100) Like many rural folk, however, the wetland ranchers tend to bristle at bureaucrats and foreigners telling them what to do. When the scholars go home and the greens log off, the *pantaneiros* will still be there—left on their own to deal with  
(105) the jaguars as they see fit.

Excerpt from "The Return of the Big Cats" by Mac Margolis, *Newsweek*, December 11, 2000, copyright © 2000 by Newsweek, Inc. All rights reserved. Reprinted by permission.

11. As it is used in the passage, *canvas* (line 63) most closely means:
- A. a survey of public opinion.
  - B. a background.
  - C. a coarse cotton fabric.
  - D. a painting.
12. According to the passage, one result of the decline of the jaguar population during the 1960s was:
- B. the increase in the population of the settlers.
  - G. an increase in Brazil's ecotourist business.
  - H. an increase in the price of a jaguar pelt.
  - J. an increase in the population of their most common source of food, the capybaras.
13. According to the passage, it is difficult to determine the extent of the jaguar's comeback because:
- A. the area they inhabit is so large.
  - B. the stories that the local ranchers tell about jaguars contradict the conclusions reached by scientists.
  - C. jaguars are solitary, nocturnal animals that can have a territory of 35 square kilometers.
  - D. scientists have only used radio transmitters to track the movements of the jaguar population.
14. The information about ecotourism in the first and second paragraphs of the passage (lines 1–28) suggests that:
- F. the jaguars are seen as a threat to the safety of tourists.
  - G. the jaguars are important to the success of Brazil's growing ecotourism industry.
  - H. the growth of the ecotourism industry is threatening the habitat of the jaguars.
  - J. it is common for ecotourists to spot one or more jaguars.
15. According to the passage, which of the following is NOT a method for protecting cattle herds that scientists are teaching ranchers?
- A. "Green safaris"
  - B. Pasture management
  - C. The use of blinking lights and electric fences
  - D. Modern husbandry
16. It is most likely that the author of the passage included the jaguar stories of three ranchers (lines 29–40, 52–58) in order to:
- F. express more sympathy toward the ranchers than toward the environmentalists and scientists.
  - G. illustrate the dangers and economic losses that the jaguars currently pose to ranchers.
  - H. show the violent nature of the ranchers.
  - J. provide a complete picture of the Pantanal landscape.

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17. From information in the passage, it is most reasonable to infer that the cattle herds "shrank from 6 million to about 3.5 million head" (lines 79–80) because:
- A. the jaguars had killed so many cattle.
  - B. environmentalists and scientists worked to convert pastureland into refuges for the jaguars.
  - C. many cows had become sterile from trichomoniasis and annual floods submerged much of the pastureland used by ranchers.
  - D. the cattle could not tolerate the increase in the average temperature caused by global warming.
18. The main conclusion reached about the future of the relationship between the people and the jaguars in the Pantanal is that:
- F. the increase in ecotourism will ensure the continued growth in the jaguar population.
  - G. the ranchers themselves will ultimately determine how they will cope with the jaguars.
  - H. the jaguar population will continue to fluctuate with the number of tourists coming into Pantanal.
  - J. the scientists' new ranching methods will make it easy for the ranchers and jaguars to coexist.
19. According to the passage, which of the following groups want to protect the jaguar?
- I. Ecotourists
  - II. Environmentalists
  - III. Scientists
- A. I and II only
  - B. I and III only
  - C. II and III only
  - D. I, II, and III
20. According to the passage, there is no accurate data available on:
- E. the number of cattle killed by jaguars.
  - G. the number of ranchers attacked by jaguars.
  - H. the growth rate of ecotourism in Brazil.
  - J. the percentage of the Pantanal wetlands inhabited by jaguars.

## PASSAGE IV

Astronomers noted more than 150 years ago that sunspots wax and wane in number in an 11-year cycle. Ever since, people have speculated that the solar cycle might exert some influence on the Earth's weather. In this century, for example, scientists have linked the solar cycle to droughts in the American Midwest. Until recently, however, none of these correlations has held up under close scrutiny.

- (10) One problem is that sunspots themselves are so poorly understood. Observations have revealed that the swirly smudges represent areas of intense magnetic activity where the sun's radiative energy has been blocked and that they are considerably cooler than bright regions of the sun. Scientists have not been able, however, to determine just how sunspots are created or what effect they have on the solar constant (a misnomer that refers to the sun's total radiance at any instant).
- (20) The latter question, at least, now seems to have been resolved by data from the *Solar Maximum Mission* satellite, which has monitored the solar constant since 1980, the peak of the last solar cycle. As the number of sunspots decreased through 1986, the satellite recorded a gradual dimming of the sun. Over the past year, as sunspots have proliferated, the sun has brightened. The data suggest that the sun is 0.1 percent more luminous at the peak of the solar cycle, when the number of sunspots is greatest, than at its nadir, according to Richard C. Willson of the Jet Propulsion Laboratory and Hugh S. Hudson of the University of California at San Diego.

- The data show that sunspots do not themselves make the sun shine brighter. Quite the contrary. When a sunspot appears, it initially causes the sun to dim slightly, but then after a period of weeks or months islands of brilliance called faculas usually emerge near the sunspot and more than compensate for its dimming effect. Willson says faculas may represent regions where energy that initially was blocked beneath a sunspot has finally breached the surface.

- Does the subtle fluctuation in the solar constant manifest itself in the Earth's weather? Some recent reports offer statistical evidence that it does, albeit rather indirectly. The link seems to be mediated by a phenomenon known as the quasi-biennial oscillation (QBO), a 180-degree shift in the direction of stratospheric winds above the Tropics that occurs about every two years.

- Karin Labitzke of the Free University of Berlin and Harry van Loon of the National Center for Atmospheric Research in Boulder, Colorado, were the first to uncover the QBO link. They gathered temperature and air-pressure readings from various latitudes and altitudes over the past three solar cycles. They found no correlation between the solar cycle and their data until they sorted the data into two categories: those gathered during the QBO's west phase (when the stratospheric winds blow west) and those gathered during its east phase. A remarkable correlation appeared: temperatures and pressures coincident with the QBO's west phase rose and fell in accordance with the solar cycle.

- Building on this finding, Brian A. Tinsley of the National Science Foundation discovered a statistical correlation between the solar cycle and the position of storms in the North Atlantic. The latitude of storms during the west phase of the QBO, Tinsley found, varied with the solar cycle: storms occurring toward the peak of a solar cycle traveled at latitudes about six degrees nearer the Equator than storms during the cycle's nadir.

- Labitzke, van Loon, and Tinsley acknowledge that their findings are still rather mysterious. Why does the solar cycle seem to exert more of an influence during the west phase of the QBO than it does during the east phase? How does the 0.1 percent variance in solar radiation trigger the much larger changes—up to six degrees Celsius in polar regions—observed by Labitzke and van Loon? Van Loon says simply, "We can't explain it."


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- (85) John A. Eddy of the National Center for Atmospheric Research, nonetheless, thinks these QBO findings as well as the *Solar Maximum Mission* data "look like breakthroughs" in the search for a link between the solar cycle and weather. With further research, for example, into how the oceans damp the effects of solar flux, these findings may lead to models that have some predictive value. The next few years may be particularly rich in solar flux.

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31. According to the passage, the main source of information about the effect of sunspots on the solar constant is provided by:
- A. studies of droughts in the Midwest.
  - B. data from the *Solar Maximum Mission* satellite.
  - C. temperature and air pressure readings taken in Colorado.
  - D. discussions between various eminent astronomers.
32. As it is used in the passage, the term *solar constant* refers to:
- F. magnetic activity.
  - G. the sun's total radiance.
  - H. the sun's surface temperature.
  - J. wind direction.
33. The main purpose of this passage is to:
- A. explain why scientists have failed to find any direct correlation between sunspots and the Earth's weather.
  - B. describe a possible correlation between the solar cycle and the Earth's weather.
  - C. describe the solar cycle and its relation to the solar constant.
  - D. prove conclusively that sunspots dramatically influence the Earth's weather.
34. As it is used in line 27, the word *proliferated* means:
- F. grown in size.
  - G. brightened.
  - H. decreased in number.
  - J. increased in number.
35. Which of the following explains why the sun appears brighter during periods of sunspot activity?
- A. Energy that has been blocked is finally released.
  - B. The sun shines brighter when sunspots first appear.
  - C. Magnetic activity increases the sun's temperature.
  - D. Air pressure in the Earth's atmosphere falls.
36. The shift in the direction of stratospheric winds that occurs every two years is known as:
- F. a facula.
  - G. the solar flux.
  - H. North Atlantic storms.
  - J. the quasi-biennial oscillation.
37. Which of the following best summarizes the main point of the last paragraph?
- A. Scientists will soon be in a position to accurately predict the Earth's weather.
  - B. Many findings of the *Solar Maximum Mission* cannot yet be explained.
  - C. The relationship between the solar cycle and the Earth's weather may become clear with further research.
  - D. Scientists disagree as to whether studying sunspots will ever have any practical value.

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38. According to the passage, changes in the solar cycle may influence the Earth's weather in which of the following ways?
- I. Changing the direction of stratospheric winds
  - II. Altering temperature and pressure levels
  - III. Influencing the latitude of storms
- E. I only  
G. I and II only  
H. II and III only  
J. I, II, and III
39. From the information in the first paragraph, it may be inferred that scientists now consider a correlation between the solar cycle and droughts in the American Midwest to be:
- A. probable.  
B. unlikely.  
C. confusing.  
D. useful.
40. According to the passage, which of the following statements best describes the current understanding of the relationship between sunspot activity and solar luminosity?
- F. At the peak of sunspot activity, the solar constant decreases in magnitude.  
G. At the peak of sunspot activity, the solar constant increases in magnitude.  
H. At the low point of sunspot activity, the sun is 0.1 percent brighter than it is at the peak of such activity.  
J. Scientists have yet to demonstrate a relationship between the two phenomena.

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON  
THIS SECTION ONLY. DO NOT TURN TO ANY OTHER SECTION IN THE TEST.

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## SCIENCE TEST

35 Minutes—40 Questions

**Directions:** Each of the following seven passages is followed by several questions. After reading each passage, decide on the best answer to each question and fill in the corresponding oval on your answer sheet. You are allowed to refer to the passages while answering the questions. Calculator use is not allowed on this test.

## PASSAGE I

Glaciers are large masses of ice that move slowly over the earth's surface due to the force of gravity and changes in elevation. Glacial *calving* occurs when one edge of a glacier borders a body of water. A calving glacier's *terminus* (the lower edge) periodically produces icebergs as they break away from the glacier and into the water.

## Study 1

A computer was used to create a model of a typical calving glacier. It was hypothesized that a primary factor determining the calving rate is the glacier's velocity at its terminus. Figure 1 shows the calving rate, in meters per year, and length of the computer-generated glacier over a period of 2,000 years.

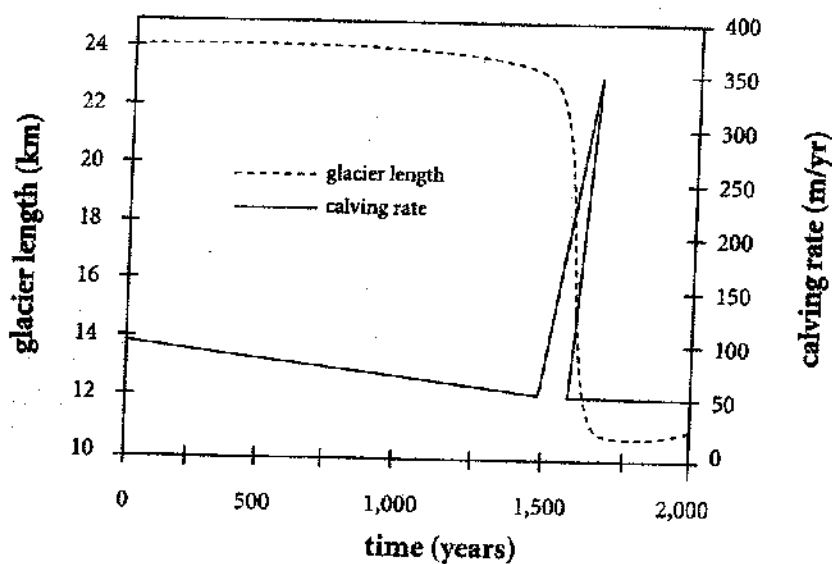


Figure 1

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## Study 2

Four calving glaciers (A–D) were studied over a period of 10 years. The average velocity at the terminus of each glacier was recorded for years 1–5, and again for years 6–10. The calving rate of each glacier was estimated for the same time periods. The results are recorded in Table 1.

Table 1

Glacier	Years 1–5		Years 6–10	
	Average velocity (m/yr)	Calving rate (m/yr)	Average velocity (m/yr)	Calving rate (m/yr)
A	72	72	63	64
B	51	52	45	47
C	98	106	256	312
D	160	189	53	54

## Study 3

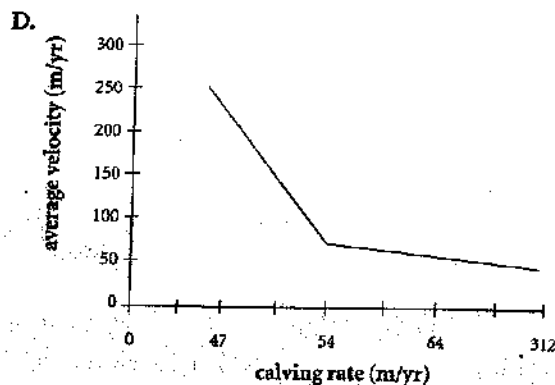
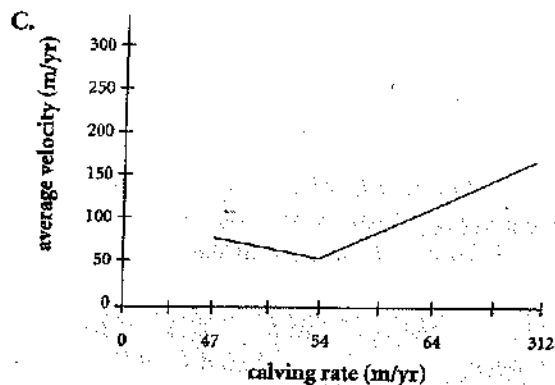
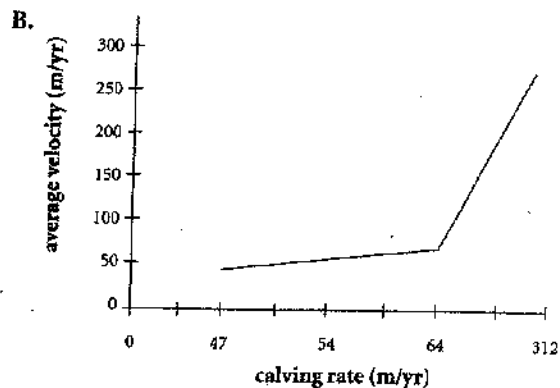
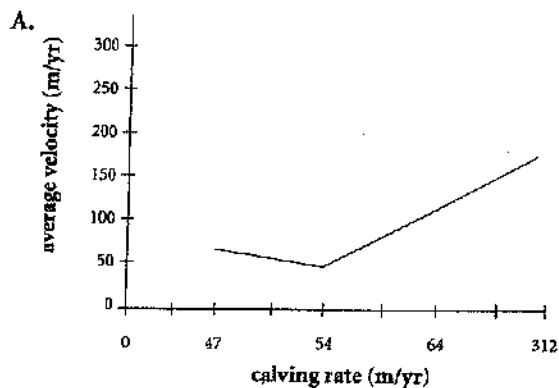
Meteorologists reported unusually high average temperatures in the regions of Glacier C and Glacier D during the same 10-year period examined in Study 2. It was hypothesized that the high temperatures were responsible for the relatively rapid variations in velocity and calving rate evident for Glacier C and Glacier D in Table 1.

- If the glacier model used in Study 1 is typical of all calving glaciers, the scientists would draw which of the following conclusions about the relationship between glacier length and calving rate?
  - As calving rate decreases, glacier length always increases.
  - As glacier length decreases, calving rate always decreases.
  - A sharp increase in calving rate results in a sharp decrease in glacier length.
  - A sharp increase in calving rate results in a sharp increase in glacier length.
- The meteorologists in Study 3 hypothesized that the faster the calving rate, the faster the sea level at a calving glacier's terminus would rise. If this hypothesis is correct, which of the following glaciers resulted in the fastest rise in sea level during years 6–10?
  - Glacier A
  - Glacier B
  - Glacier C
  - Glacier D
- Based on the results of Study 2, a calving glacier traveling at a velocity of 80 m/yr would most likely have a calving rate:
  - between 72 m/yr and 106 m/yr.
  - between 106 m/yr and 189 m/yr.
  - between 189 m/yr and 312 m/yr.
  - over 312 m/yr.
- Which of the following statements best describes the behavior of the glaciers observed during Study 2?
  - All of the glaciers observed traveled faster during the first five years than during the last five years.
  - All of the glaciers observed traveled faster during the last five years than during the first five years.
  - The calving rate is always less than the average velocity for all of the glaciers observed.
  - The calving rate is always greater than or equal to the average velocity for all of the glaciers observed.

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5. Which of the following graphs best represents the relationship between the calving rate and the average velocity of the glaciers observed in Study 2 for years 6–10?



6. If the hypothesis made by the meteorologists in Study 3 is correct, the glacier modeled in Study 1 most likely experienced unusually high temperatures at approximately what time during the simulated 2,000-year study?

- F. 500 years
- G. 1,000 years
- H. 1,500 years
- J. 2,000 years

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## PASSAGE II

*Allergic rhinitis* refers to a person's nasal reaction to small airborne particles called *allergens*.

Table 1 shows the specific allergen, its type, and the approximate number of reported cases of allergic symptoms for a population of 1,000 people living in northern Kentucky during a single year.

Table 1

Month	ALLERGEN TYPE	Pollen			Mold		
	SPECIFIC ALLERGEN	Trees	Grass	Weeds	Alternaria	Cladosporium	Aspergillus
January					⊗	⊗	⊗
February		⊗			⊗	⊗	⊗
March		⊗⊗			⊗	⊗	⊗
April		⊗⊗⊗⊗			⊗	⊗	⊗
May		⊗⊗⊗	⊗⊗⊗		⊗	⊗	⊗
June			⊗⊗⊗⊗		⊗	⊗	⊗
July			⊗⊗	⊗	⊗⊗	⊗	⊗
August				⊗⊗⊗	⊗⊗⊗⊗	⊗⊗⊗	⊗⊗⊗⊗
September				⊗⊗	⊗⊗⊗	⊗⊗⊗⊗	⊗⊗⊗⊗
October				⊗⊗	⊗⊗⊗	⊗⊗	⊗⊗⊗
November					⊗⊗	⊗	⊗
December					⊗	⊗	⊗

Note: Each ⊗ equals 100 reported cases of allergic rhinitis.

Weekly tree pollen and total mold spore concentrations were measured in grains per cubic meter ( $\text{gr}/\text{m}^3$ ) for samples of air taken in southern Iowa for eight weeks. The pollen and mold spore counts are shown in Figures 1 and 2, respectively.

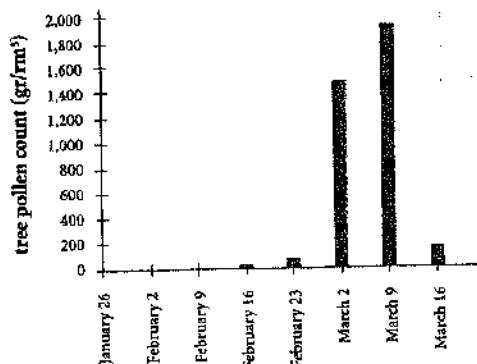


Figure 1

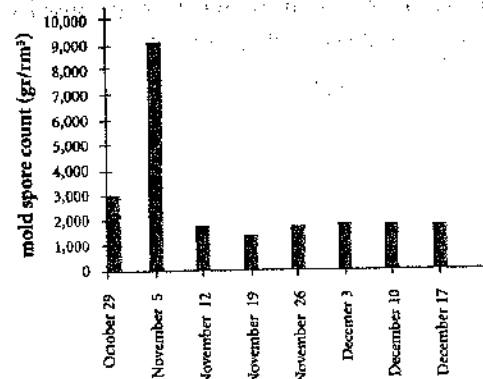


Figure 2

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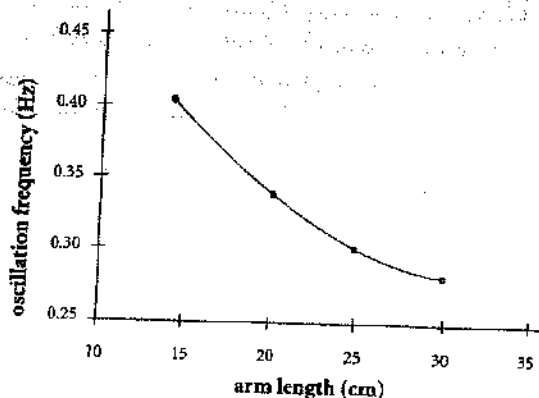
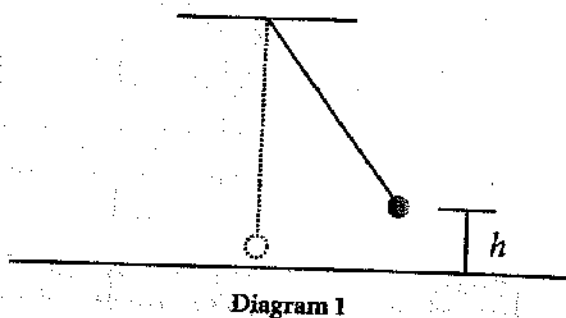
7. Based on Figure 1, the tree pollen count on March 2 was closest to:
- 75  $\text{gr}/\text{m}^3$ .
  - 150  $\text{gr}/\text{m}^3$ .
  - 1,500  $\text{gr}/\text{m}^3$ .
  - 1,900  $\text{gr}/\text{m}^3$ .
8. According to Figure 2, the mold spore count in the weeks after November 5:
- increased.
  - decreased.
  - varied between 1,000  $\text{gr}/\text{m}^3$  and 2,000  $\text{gr}/\text{m}^3$ .
  - remained above 2,000  $\text{gr}/\text{m}^3$ .
9. Based on the data in Figure 1, the tree pollen count increased the most between which two dates?
- February 9 to February 16
  - February 23 to March 2
  - March 2 to March 9
  - October 29 to November 5
10. According to Figure 1, which of the following conclusions about the tree pollen count is most valid?
- The tree pollen count was highest on March 9.
  - The tree pollen count was highest on March 16.
  - The tree pollen count was lowest on February 23.
  - The tree pollen count was lowest on March 16.
11. Based on Table 1, most of the cases of allergic rhinitis in May in northern Kentucky were caused by which of the following allergens?
- Tree and grass pollen
  - Grass and weed pollen
  - Alternaria
  - Aspergillus

### PASSAGE III

Simple harmonic motion (SHM) is motion that is periodic, or repetitive, and can be described by a frequency of oscillation. Students performed three experiments to study SHM.

#### Experiment 1

The students assembled the pendulum shown in Diagram 1. The mass at the end of the arm was raised to a small height,  $h$ , and released. The frequency of oscillation was measured in oscillations per second, or Hertz (Hz), and the process was repeated for several different arm lengths. The results are shown in Figure 1.



## Experiment 2

A spring was suspended vertically from a hook, and a mass was connected to the bottom of the spring, as shown in Diagram 2. The mass was pulled downward a short distance and released, and the frequency of the resulting oscillation was measured. The procedure was repeated with 4 different springs and 4 different masses, and the results are shown in Figure 2.

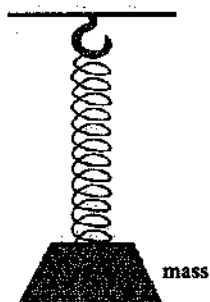


Diagram 2

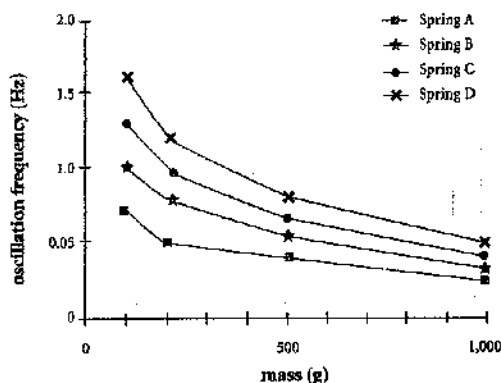


Figure 2

## Experiment 3

Using the apparatus from Experiment 2, the mass-spring system was allowed to come to rest, and the equilibrium length of the spring was measured. The same 4 masses and 4 springs were used, and the results are shown in Figure 3.

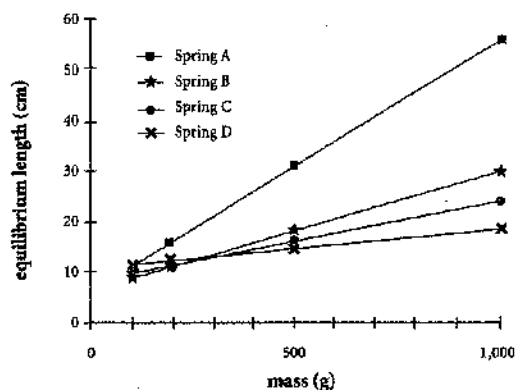


Figure 3

12. In Experiment 3, for which of the following masses would Spring B, Spring C, and Spring D have closest to the same equilibrium lengths?
- F. 100 g  
G. 270 g  
H. 500 g  
J. 1,000 g
13. A student has hypothesized that as the length of the arm of a pendulum increases, the oscillation frequency of the pendulum during SHM will decrease. Do the results of Experiment 1 support her hypothesis?
- A. Yes; the oscillation frequency of the pendulum observed in Experiment 1 decreased as the arm length increased.  
B. Yes; although the longest pendulum arm resulted in the highest oscillation frequency, the frequency decreased with increasing arm length for the other 3 lengths tested.  
C. No; the oscillation frequency of the pendulum observed in Experiment 1 increased as the arm length increased.  
D. No; although the longest pendulum arm resulted in the lowest oscillation frequency, the frequency increased with increasing arm length for the other 3 lengths tested.

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14. Based on the results of Experiment 2, if an engineer needs a spring that oscillates most slowly after being stretched and released, which of the following springs should be chosen?

F. Spring A  
G. Spring B  
H. Spring C  
J. Spring D

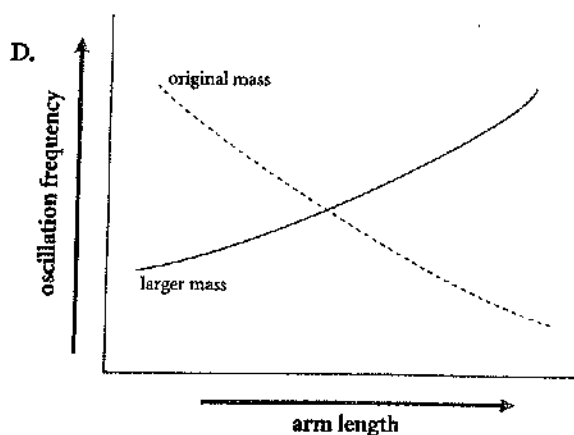
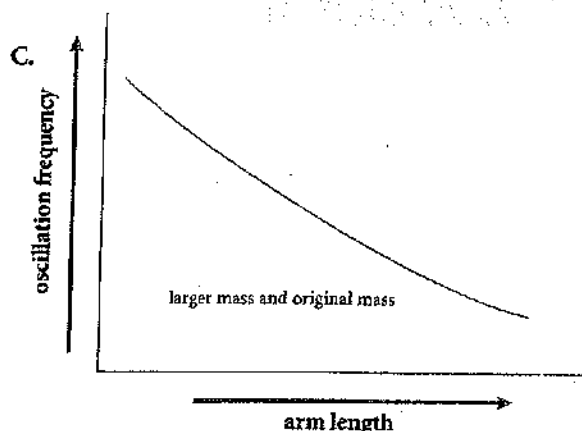
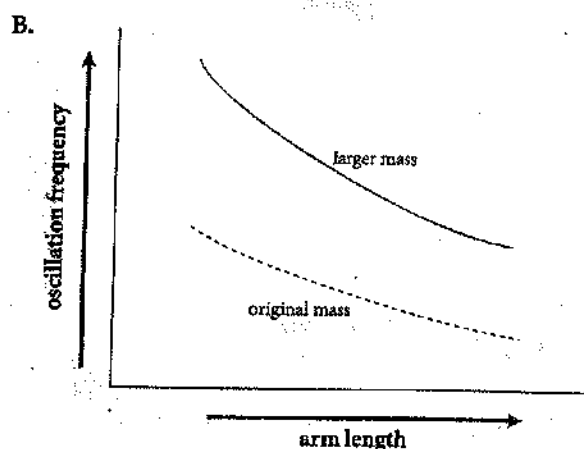
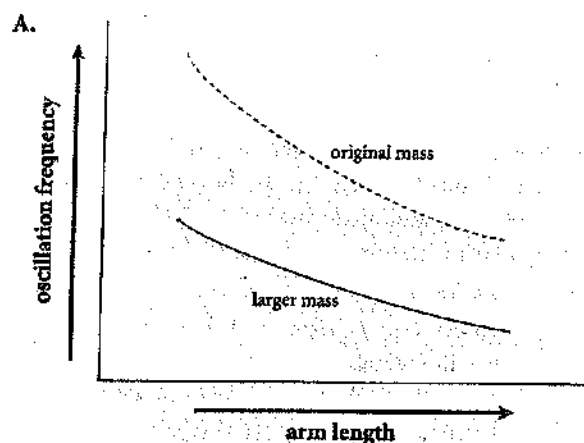
15. Based on the results of Experiment 3, if a 700 g mass was suspended from Spring A, at what equilibrium length would the system come to rest?

A. Less than 20 cm  
B. Between 20 cm and 30 cm  
C. Between 30 cm and 50 cm  
D. Greater than 50 cm

16. The students tested a fifth spring, Spring E, in the same manner as in Experiment 2. With a 100 g mass suspended from Spring E, the oscillation frequency was 1.4 Hz. Based on the results of Experiment 2, which of the following correctly lists the 5 springs by their oscillation frequency with a 100 g mass suspended from *fastest to slowest*?

F. Spring E, Spring B, Spring C, Spring A, Spring D  
G. Spring D, Spring A, Spring C, Spring B, Spring E  
H. Spring A, Spring B, Spring C, Spring E, Spring D  
J. Spring D, Spring E, Spring C, Spring B, Spring A

17. Experiment 1 was repeated using a larger pendulum mass. Which of the following figures best expresses the comparison between the results found using the larger pendulum mass and using the original mass?



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## PASSAGE IV

An *alloy* is a uniform mixture of two or more metals. When the melting point of an alloy is lower than the melting point of any of its metal components, the alloy is referred to as a *eutectic* system. Figure 1 is a *phase diagram* that illustrates the states of matter of the gold-silicon (Au-Si) eutectic system over a range of temperatures and alloy compositions. For the Au-Si system, 0 percent Si means pure Au, and 100 percent Si means pure Si.

Note: (Au) and (Si) represent the solid forms of gold and silicon, respectively.

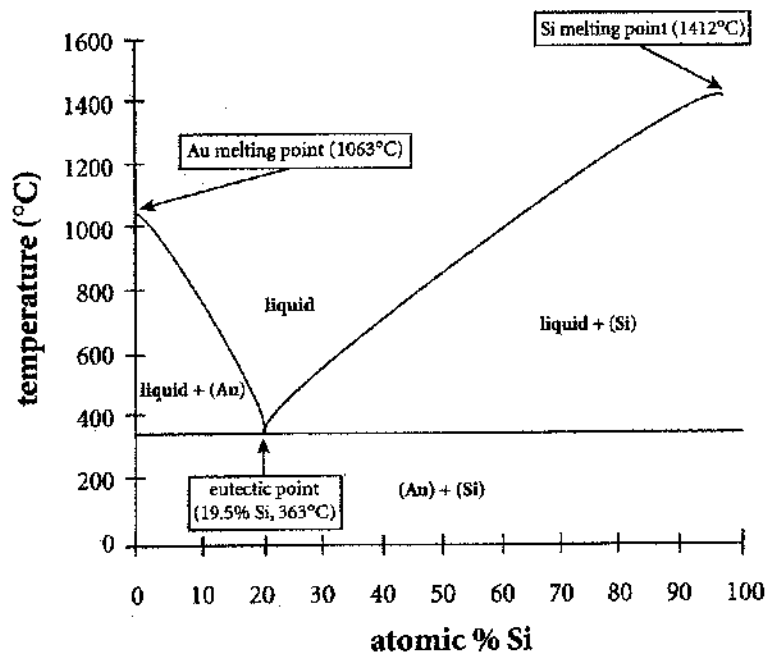


Figure 1

18. According to Figure 1, at what temperature will Au begin to boil?
- F. 363°C  
G. 1063°C  
H. 1412°C  
J. The boiling point of Au is not included on the figure.
19. Based on Figure 1, an alloy that is atomically 50% Si and 50% Au will be in what state at a temperature of 600°C?
- A. Completely liquid  
B. Liquid with some amount of solid Si  
C. Liquid with some amount of solid Au  
D. Completely solid
20. A *solder* is a metallic material designed specifically to have a very low melting point. To make a solder out of a Au-Si alloy, what atomic percentages of Au and Si would be most appropriate?
- F. 0% Si, 100% Au  
G. 19.5% Si, 80.5% Au  
H. 80.5% Si, 19.5% Au  
J. 100% Si, 0% Au

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21. Based on the information in Figure 1, one could generalize that for Au-Si alloy compositions containing atomically less than 10 percent Si, the temperature at which the alloy becomes completely liquid decreases with:
- A. increasing Si atomic percentage.
  - B. decreasing Si atomic percentage.
  - C. increasing Au atomic percentage.
  - D. neither increasing nor decreasing Si atomic percentage. The melting point is constant for all alloy compositions.
22. A liquid Au-Si alloy of unknown composition is gradually cooled from an initial temperature of  $1,500^{\circ}\text{C}$ . Solid particles are observed to begin forming as the temperature drops to  $1,200^{\circ}\text{C}$ . The particles must consist of which material, and what must be the approximate atomic composition of the alloy?
- F. The particles are Au, and the atomic composition of the alloy is 10% Si, 90% Au.
  - G. The particles are Au, and the atomic composition of the alloy is 19.5% Si, 80.5% Au.
  - H. The particles are Si, and the atomic composition of the alloy is 73% Si, 27% Au.
  - J. The particles are Si, and the atomic composition of the alloy is 90% Si, 10% Au.

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## PASSAGE V

A person requires a certain percentage of oxygen in the blood for proper respiratory function. The amount of oxygen in the air varies enough with altitude that people normally accustomed to breathing near sea level may experience respiratory problems at significantly higher altitudes. Table 1 shows the average percentage of oxygen saturation in the blood, as well as the blood concentrations of 3 enzymes, GST, ECH, and CR, for 3 populations of high altitude (ha) dwellers and 3 populations of sea level (sl) dwellers. Enzyme concentrations are given in arbitrary units (a.u.). Figure 1 shows average oxygen partial pressure and average temperature at various altitudes.

Table 1

Population	Altitude range (m)	Oxygen saturation (%)	Enzyme concentration (a.u.)		
			GST	ECH	CR
ha1	3,500–4,000	98.1	121.0	89.2	48.8
ha2	3,300–3,700	99.0	108.3	93.5	45.6
ha3	3,900–4,200	97.9	111.6	91.9	52.3
sl1	0–300	98.5	86.7	57.1	44.9
sl2	0–150	99.2	79.8	65.8	53.1
sl3	0–200	98.7	82.5	61.4	47.0

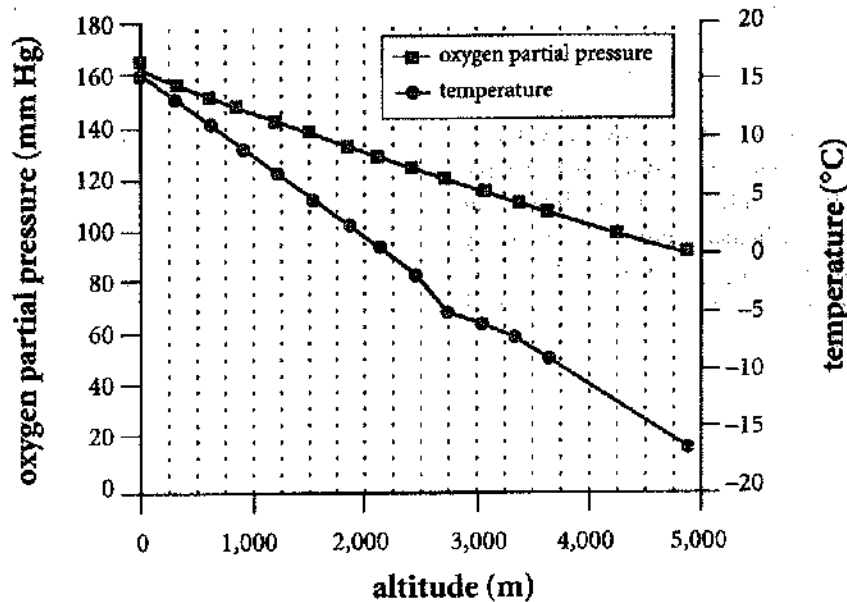


Figure 1

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23. Based on the data in Table 1, one would conclude that the blood of high altitude dwellers contains a higher concentration of:
- A. CR than ECH.
  - B. CR than GST.
  - C. ECH than GST.
  - D. GST than CR.
24. Based on the information given, one would expect that, compared to the high altitude dwellers, the sea level dwellers:
- F. have blood with a lower percentage oxygen saturation.
  - G. have blood with a lower GST concentration.
  - H. can tolerate lower oxygen partial pressures.
  - J. can tolerate lower temperatures.
25. According to Figure 1, an atmospheric sample found at an oxygen partial pressure of 110 mm Hg was most likely found at a temperature of about:
- A. 8.1°C.
  - B. 0°C.
  - C. -5.4°C.
  - D. -12.5°C.
26. ECH is an enzyme that improves the efficiency of cellular energy production. Assume that people with higher ECH concentrations in the blood can function normally at higher altitudes without any respiratory difficulties. Based on Table 1, people from which population can function normally at the highest altitude?
- F. sl 1
  - G. sl 2
  - H. ha 2
  - J. ha 3
27. Assume that a person's blood oxygen saturation percentage is determined only by the oxygen partial pressure at the location at which they live and the efficiency of the person's respiratory system at incorporating oxygen into the blood. Which of the following pieces of information supports the hypothesis that people from population ha 2 can incorporate oxygen into their blood more efficiently than people from population sl 1?
- A. Population ha 2 lives where the oxygen partial pressure is lower than that of where population sl 1 lives, yet population ha 2 has a higher blood oxygen saturation percentage than does population ha 1.
  - B. Population ha 2 lives where the oxygen partial pressure is higher than that of where population sl 1 lives, yet population ha 2 has a lower blood oxygen saturation percentage than does population ha 1.
  - C. Population ha 2 has a higher CR concentration than does population sl 1.
  - D. Population ha 2 has an unusually high GST concentration.

## PASSAGE VI

Two students explain why lakes freeze from the surface downward. They also discuss the phenomena of the melting of ice under the blades of an ice skater's skates.

## Student 1

Water freezes first at the surface of lakes because the freezing point of water decreases with increasing pressure. Under the surface, *hydrostatic pressure* causes the freezing point of water to be slightly lower than it is at the surface. Thus, as the air temperature drops, it reaches the freezing point of water at the surface before reaching that of the water beneath it. Only as the temperature becomes even colder will the layer of ice at the surface become thicker.

Pressure is defined as *force* divided by the *surface area* over which the force is exerted. An ice skater exerts the entire force of her body weight over the tiny surface area of two very thin blades. This results in a very large pressure, which quickly melts a small amount of ice directly under the blades.

## Student 2

Water freezes first at the surface of lakes because the density of ice is less than that of liquid water. Unlike most liquids, the volume of a given mass of water expands upon freezing, and the density therefore decreases. As a result, the *buoyant force* of water acting upward is greater than the force of gravity exerted downward by any mass of ice, and all ice particles float to the surface upon freezing.

Ice melts under an ice skater's skates because of friction. The energy used to overcome the force of friction is converted to heat, which melts the ice under the skates. The greater the weight of the skater, the greater the force of friction, and the faster the ice melts.

28. According to Student 1, which of the following quantities is *greater* for water molecules beneath a lake's surface than for water molecules at the surface?
- F. Temperature
  - G. Density
  - H. Buoyant force
  - J. Hydrostatic pressure
29. When two ice skaters, wearing identical skates, skated across a frozen lake at the same speed, the ice under the blades of Skater B was found to melt faster than the ice under the blades of Skater A. What conclusion would each student draw about which skater is heavier?
- A. Both Student 1 and Student 2 would conclude that Skater A is heavier.
  - B. Both Student 1 and Student 2 would conclude that Skater B is heavier.
  - C. Student 1 would conclude that Skater A is heavier; Student 2 would conclude that Skater B is heavier.
  - D. Student 1 would conclude that Skater B is heavier; Student 2 would conclude that Skater A is heavier.
30. Which student(s), if either, would predict that ice will melt under the blades of an ice skater who is NOT moving?
- F. Student 1 only
  - G. Student 2 only
  - H. Both Student 1 and Student 2
  - J. Neither Student 1 nor Student 2
31. A beaker of ethanol is found to freeze from the bottom upward, instead of from the surface downward. Student 2 would most likely argue that the density of frozen ethanol is:
- A. greater than the density of water.
  - B. less than the density of ice.
  - C. greater than the density of liquid ethanol.
  - D. less than the density of liquid ethanol.

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32. A toy boat was placed on the surface of a small pool of water, and the boat was gradually filled with sand. After a certain amount of sand had been added, the boat began to sink. Based on Student 2's explanation, the boat began to sink because:
- F. hydrostatic pressure became greater than the buoyant force of the water on the boat.
  - G. atmospheric pressure became greater than the buoyant force of the water on the boat.
  - H. the force of gravity of the boat on the water became greater than the buoyant force of the water on the boat.
  - J. the force of gravity of the boat on the water became less than the buoyant force of the water on the boat.
33. According to Student 2, if friction between the ice and the blades of an ice skater's skates is reduced, which of the following quantities simultaneously decreases at the point where the blades and the ice are in contact?
- A. Pressure exerted by the blades on the ice
  - B. Heat produced
  - C. Force of gravity of the blades on the ice
  - D. Freezing point of water
34. Based on Student 2's explanation, the reason a hot air balloon is able to rise above the ground is that the balloon and the air inside it are:
- F. less dense than the air outside the balloon.
  - G. more dense than the air outside the balloon.
  - H. at a higher pressure than the air outside the balloon.
  - J. less buoyant than the air outside the balloon.

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## PASSAGE VII

In many communities, chemicals containing fluoride ions ( $F^-$ ) are added to the drinking water supply to help prevent tooth decay. Use of  $F^-$  is controversial because studies have linked  $F^-$  with bone disease. Students performed 2 experiments to measure  $F^-$  levels.

## Experiment I

Five solutions, each containing a different amount of  $Na_2SiF_6$  (sodium silicofluoride) in  $H_2O$  were prepared. Five identical *electrodynamic cells* were filled with equal volumes of each of the five solutions, and a sixth identical cell was filled with a *blank* solution (one containing no added  $Na_2SiF_6$ ). The cells were activated to measure the electrical *conductivity* for each. The conductivities were then corrected by subtracting the conductivity of the blank solution from each value (see Table 1 and Figure 1).

Table 1

Concentration of $F^-$ (mg/L*)	Measured conductivity ( $\mu S/cm^{**}$ )	Corrected conductivity ( $\mu S/cm^{**}$ )
0.0	15.96	0.00
0.1	16.13	0.17
0.5	16.80	.084
1.0	17.63	1.67
2.0	19.30	3.34
4.0	22.64	6.68

\* mg/L is milligrams per Liter

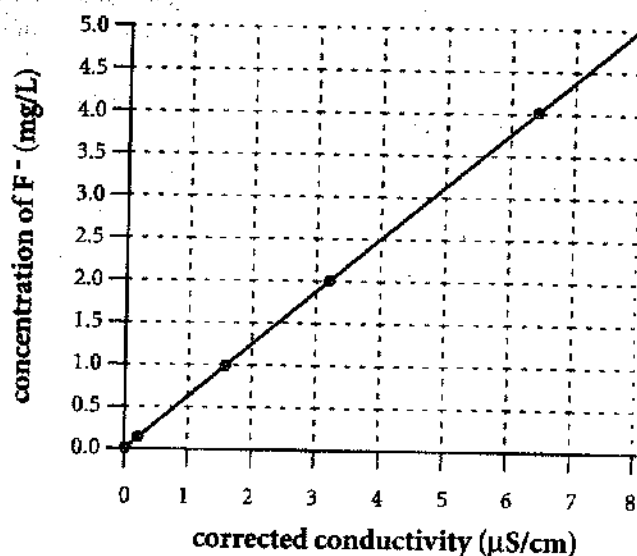
\*\*  $\mu S/cm$  is microSeimens per centimer

Figure 1

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## Experiment 2

A water sample was taken directly from the drinking water supply of one community. An electrodynamic cell identical to those used in Experiment 1 was filled with water from this sample, and the cell was activated. The procedure was repeated for water samples from several communities, and the conductivities were measured (Table 2).

Table 2

Community	Measured conductivity ( $\mu\text{S}/\text{cm}$ )	Concentration of $\text{F}^-$ (mg/L)
Newton	22.31	3.8
Springfield	16.46	0.3
Lakewood	18.63	1.6
Reading	19.47	2.1

35. Based on the results of Experiment 1, if the concentration of  $\text{F}^-$  in a solution is doubled, then the corrected conductivity of the solution will approximately:
- remain the same.
  - halve.
  - double.
  - quadruple.
36. A sample was also taken from the drinking water supply of the community of Bluewater in Experiment 2 and its conductivity was measured to be  $20.69 \mu\text{S}/\text{cm}$ . Which of the following correctly lists the drinking water supplies of Newtown, Lakewood, and Bluewater in increasing order of  $\text{F}^-$  concentration?
- Lakewood, Newtown, Bluewater
  - Bluewater, Newtown, Lakewood
  - Newtown, Bluewater, Lakewood
  - Lakewood, Bluewater, Newtown
37. Based on the results of Experiment 1, if a solution with a concentration of  $3.0 \text{ mg/L F}^-$  had been tested, the corrected conductivity would have been closest to which of the following values?
- $1.3 \mu\text{S}/\text{cm}$
  - $3.3 \mu\text{S}/\text{cm}$
  - $5.0 \mu\text{S}/\text{cm}$
  - $6.5 \mu\text{S}/\text{cm}$
38. If Experiments 1 and 2 were repeated to measure the concentration of chloride ions ( $\text{Cl}^-$ ) in drinking water, then which of the following changes in procedure would be necessary?
- The solutions in Experiment 1 should be prepared by adding different concentrations of  $\text{NaCl}$  (or another chemical containing  $\text{Cl}^-$ ) to  $\text{H}_2\text{O}$ .
  - The conductivity of the blank solution should be added to the measured conductivities.
  - The electrodynamic cells should be set to measure resistivity instead of conductivity.
  - Both  $\text{NaCl}$  and  $\text{Na}_2\text{SiF}_6$  should be added to all of the samples.
39. Based on the results of Experiments 1 and 2, if the measured conductivities for the samples tested in Experiment 2 were compared with their corrected conductivities, the measured conductivities would be:
- lower for all of the samples tested.
  - higher for all of the samples tested.
  - lower for some of the samples tested, higher for others.
  - the same for all of the samples tested.
40. The presence of other negative ions, such as  $\text{Cl}^-$ , results in an increase in the electrical conductivity of a solution. If all of the samples tested in Experiment 2 contained trace concentrations of  $\text{Cl}^-$ , how would the measurements have been affected? Compared to the actual  $\text{F}^-$  concentrations, the  $\text{F}^-$  concentrations apparently measured would be:
- higher.
  - lower.
  - the same.
  - higher for some of the samples, lower for others.

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON THIS SECTION ONLY. DO NOT TURN TO ANY OTHER SECTION IN THE TEST.

STOP

