

# Welcome to AllPencilsDown ACT Prep Class

Math / Science  
English / Reading

## **WARNING!**

*These resources are only  
helpful if used!!!*

**AllPencilsDown**



*Your Source for Standardized Test Preparation*

■ ACT ■ SAT ■ PSAT

One-On-One Tutoring ♦ Classroom Instruction ♦ Online Video Courseware





## ***Overview of the Math / Science AllPencilsDown ACT Prep Course***

Course structure - the first class is primarily focused on Science. Once we have completed the Science overview and practice material then the remaining time is spent on Math. Each class session after the first class will start with several Science passages and then the rest of the time will be spent on Math. You will have Math/Science homework after each class and are completely expected to come to class with the homework completed. I do not plan to go over homework during class time because the ACT red book has every problem completely and thoroughly explained. The other practice homework that we provide will either be reviewed in class or we have already developed video explanations on our website that you can use to review any items that you may have missed or not fully understood.

The Science part of the ACT test requires a strong reading and comprehension skill to be able to complete on time. During this course you will see Science passages from many different former, real ACT tests during class practice as well as 5 or 6 practice tests that you will do as homework or additional practice. Each Science class we will practice on time for each passage and then review every question on the passage before proceeding to the next passage. This is the best time to ask questions about particular aspects of the passage that you may not understand. I typically review each student's progress while you are working on each passage to help me determine which questions might be causing the most difficulty so I can provide more in-depth explanations for those questions.

The Math part of the course started with all the math videos that I provided online. Each student really needed to review each of those videos prior to the course beginning. I will be conducting the class assuming that you have reviewed all of the videos. The videos allowed me to more slowly and carefully explain the many math concepts that are foundational to the ACT math test. During class we will progress from the easier math problems ( numbers 1 - 30) quickly and spend more time as the classes progress with the harder math problems (31-60). I observe each student's work as the class is working on each page of math problems to determine the ones I need to explain for the class. My goal is to try to answer everyone's questions - even those who did not ask a question. If, you need me to go over a problem again or explain anything please ask. That is what the class is all about.

# ACT SCIENCE TEST OVERVIEW

## Scientific Process

### Purpose / Objective

Generally, this is the first sentence or two of the passage. The purpose is usually to answer a question. Usually 1-2 per test.

### Experimental Procedure

How will the experiment be conducted? What equipment will be utilized? What parameters will be measured? Probably 3-4 per test.

### Data

Most of the questions come from this area.

This is the graphs, charts and tables. Usually the first 2 or 3 questions for a passage deal with the data lookup questions. Understanding how to read the various types of charts and graphs is essential to this part of the test.

### Data Analysis

Focuses on data trends - increasing/decreasing. Extrapolation/interpolation. What region increases or decreases the most, the least? These questions review the data presented in the data section.

### Conclusions

This is the hardest section for most students. Typically these answers will not be found explicitly in the passage. This requires you to understand the experiment, discussion, or the question itself and make your choice.

## Decision Making

### Do Not Skip Around

This is like adding questions to the test.

### Bulletized Thinking

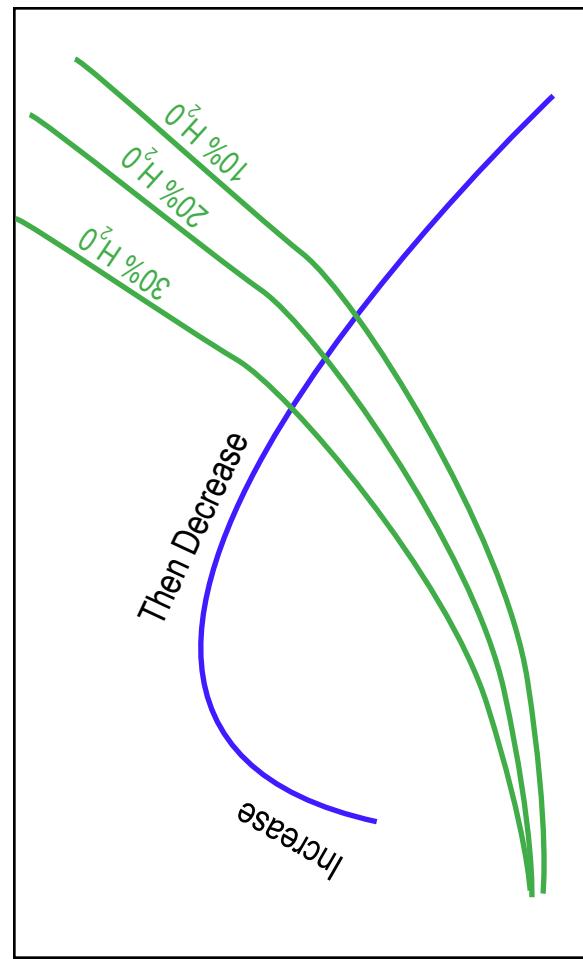
Is it A, B, C, or D? Decide on each answer as you go through the choices. Rule an answer either “In” or “Out” as you go down the list. Make your decision and move on. *If you really need to look at it again, come back when you have finished the test.*

## Time Management

- 3 psgs - 5 Q - 4 min each**
- 3 psgs - 6 Q - 5 min each**
- 1 psg - 7 Q - 6 min each**

This totals 33 minutes. If you work at it you should be able to get the 4 and 5 minute passages on time. Save the extra time for the 7 question passage. This passage has differing opinions of scientists or differing hypotheses. It takes more time to compare and contrast.

## What information is in the graph or table?



Y Axis - What is on it and  
Which direction gets bigger?

X Axis - What is on it & Which direction gets bigger?

**Table 3**

Gas	Initial Temperature of gas (°C)	Final Temperature of gas (°C)	Change in volume (L)
Helium	-6	4	0.0374
Helium	4	14	0.0361
Helium	14	24	0.0348
Oxygen	-6	4	0.0374
Oxygen	4	14	0.0361
Oxygen	14	24	0.0348
Methane	-6	4	0.0374
Methane	14	24	0.0348

Based on Table 3, if 1.0000 L of helium at 24°C is heated to 34°C at constant pressure, the change in volume will most likely be closest to which of the following:

- A. 0.0335 L
- B. 0.0348 L
- C. 0.0361 L
- D. 0.0374 L

### PRIOR KNOWLEDGE

SO<sub>4</sub> containing aerosols are produced today in large quantities by human activity. Scientist 1 would most likely predict that the climatic effect in an area where large amounts of SO<sub>4</sub> containing aerosols are put into the atmosphere would be a *decrease* in the:

- F. amount of ultraviolet light reaching Earth's surface in that area
- G. average pH of rainfall in that area.
- H. amount of rainfall in that area.
- J. average wind speed in that area.

### FACTS

In 1908, an object from outer space devastated 2,000 km<sup>2</sup> of forest in Siberia. The object was between 10 m and 100 m in diameter and traveled at a maximum speed of 15 km/sec. It exploded at an altitude of 8 km and released energy equivalent to 20 million tons of TNT. Two scientists discuss whether this object was a comet or an asteroid.

Which of the following statements would both scientists most likely use to explain the damage to the forest caused by the object's explosion? Energy from the explosion:

- A. traveled rapidly down to Earth's surface.
- B. dissipated in the upper atmosphere.
- C. was released less than 1 km above Earth's surface.
- D. was released as the object struck Earth's surface.

### RIDICULOUS ANSWER CHOICES

Based on the description of the procedures in the studies, the scientists had to extract complete and intact fossil snail shells instead of fossil shell fragments from the rock layers in order to:

- F. describe the colors of a living snail's shell.
- G. make accurate measurements of each shell's dimensions.
- H. determine the present-day climate of Bonin Island.
- J. determine the rock layers' ages using radiocarbon dating.

Scientist 2 says that a protein may be trapped in a moderately high-energy shape. Which of the following findings, if true, could be used to *counter* this argument?

- A. Once a protein has achieved its tertiary structure, all of the folding patterns at the local level are stable.
- B. Enough energy is available in the environment to overcome local energy barriers, driving the protein to its lowest-energy shape.
- C. During protein synthesis, the secondary structure of a protein is determined before the tertiary structure is formed.
- D. Proteins that lose their tertiary structure or quaternary structure also tend to lose their biological functions.

Which of the following is the most likely explanation for the difference in the depth of the bog water table in the 2 years?

- A. The amount of groundwater discharged to the bog was higher during the drought, and therefore the bog received more water than normal.
- B. The amount of groundwater discharged to the bog was higher during the drought, and therefore the bog received less water than normal.
- C. The amount of rainfall received by the bog was higher during the drought, and therefore the bog received more water than normal.
- D. The amount of rainfall received by the bog was lower during the drought, and therefore the bog received less water than normal.

### Divide and Conquer

Which gas does a plant use to create its food by combining with water and sunlight?

- A. **Oxygen**, which uses chlorophyll from the air to mix with water and make carbon dioxide.
- B. **Oxygen**, which uses sugar to make air.
- C. **Carbon dioxide**, which combines water and chlorophyll with light from the sun to make sugar and give off oxygen.
- D. **Carbon dioxide**, which uses water and sugar to make air.

Closer examination of Section 1 in Study 1 revealed that the largest grains (up to 20 mm in diameter) were at the bottom of the section. According to the studies, which of the following statements best explains why such large grains were found at the bottom of the section?

- A. The water velocity at the time the sediment was deposited was high enough to carry away all but the largest grains.
- B. The water velocity at the time the sediment was deposited was too slow to carry away even the smallest grains.
- C. The water depth at the time the sediment was deposited was too shallow for large grains to settle to the bottom.
- D. The water depth at the time the sediment was deposited was too deep for large grains to settle to the bottom.

**Passage I**

In certain solutions, beet cells undergo membrane disruption, causing the cells to release *betacyanin* (a red pigment). As membrane disruption increases, more betacyanin is released. To determine the amount of betacyanin released, the amount of light absorbed (at a specific wavelength) by the solution is measured. As the concentration of betacyanin in the solution increases, the amount of light absorbed increases.

To determine the amount of light absorbed by a solution, light is directed through a sample of the solution onto a detector (see Figure 1).

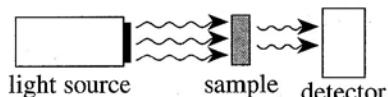


Figure 1

By measuring the amount of light that hits the detector, the amount of light absorbed by the sample can be determined.

**Experiment 1**

For each of 9 trials, a student placed a beet section ( $2\text{ cm} \times 2\text{ cm} \times 1\text{ cm}$ ) in 100 mL of water at a specific temperature for 10, 20, or 30 min. The student then removed a sample of the solution and determined its absorbance (see Table 1).

Table 1			
Trial	Temperature ( $^{\circ}\text{C}$ )	Time (min)	Absorbance
1	25	10	0.12
2	25	20	0.14
3	25	30	0.16
4	50	10	0.31
5	50	20	0.37
6	50	30	0.43
7	75	10	0.62
8	75	20	0.71
9	75	30	0.82

**Experiment 2**

Experiment 1 was repeated, except that in each trial an acetone/water solution was used instead of water and the temperature was kept constant at  $25^{\circ}\text{C}$  (see Table 2).

Table 2			
Trial	Acetone concentration (% by volume)	Time (min)	Absorbance
10	10	10	0.31
11	10	20	0.38
12	10	30	0.45
13	30	10	0.69
14	30	20	0.76
15	30	30	0.86
16	50	10	0.82
17	50	20	0.90
18	50	30	0.96

**Experiment 3**

Experiment 2 was repeated, except that in each trial a methanol/water solution was used instead of an acetone/water solution (see Table 3).

Table 3			
Trial	Methanol concentration (% by volume)	Time (min)	Absorbance
19	10	10	0.15
20	10	20	0.18
21	10	30	0.20
22	30	10	0.21
23	30	20	0.24
24	30	30	0.26
25	50	10	0.29
26	50	20	0.33
27	50	30	0.36

The student then determined the absorbance of water, of acetone, and of methanol. Each had an absorbance of 0.00.

1. Suppose that in Experiment 3 a beet section had been placed in a solution that was 40% methanol by volume for 20 min. The absorbance of the sample from the resulting solution would most likely have been closest to which of the following?
- A. 0.15  
B. 0.30  
C. 0.45  
D. 0.60
2. Based on the results of Experiment 2, which of the following additional trials would have resulted in an absorbance closest to 0.80?
- F. 10% acetone for 15 min  
G. 10% acetone for 25 min  
H. 30% acetone for 25 min  
J. 30% acetone for 35 min
3. The results of Experiment 1 are most consistent with which of the following conclusions about the effects of temperature on membrane disruption and absorbance? Higher temperatures resulted in:
- A. greater membrane disruption and higher absorbances.  
B. greater membrane disruption and lower absorbances.  
C. less membrane disruption and higher absorbances.  
D. less membrane disruption and lower absorbances.
4. The student concluded that at a given concentration, acetone causes more membrane disruption than does methanol. Is this conclusion supported by the results of Experiments 2 and 3?
- F. No, because at each concentration tested, more betacyanin was released in the acetone solution than was released in the methanol solution.  
G. No, because at each concentration tested, less betacyanin was released in the acetone solution than was released in the methanol solution.  
H. Yes, because at each concentration tested, more betacyanin was released in the acetone solution than was released in the methanol solution.  
J. Yes, because at each concentration tested, less betacyanin was released in the acetone solution than was released in the methanol solution.
5. Suppose that in Experiment 1, betacyanin concentration was directly proportional to absorbance. Accordingly, the betacyanin concentration in the sample in Trial 7 was most likely twice as great as the betacyanin concentration in the sample in:
- A. Trial 3.  
B. Trial 4.  
C. Trial 5.  
D. Trial 6.
6. In Experiment 1, the student directly varied 2 *independent variables* and measured how these changes affected the value of the *dependent variable*. Which of the following lists an independent variable and the dependent variable in Experiment 1?
- | <u>Independent variable</u> | <u>Dependent variable</u> |
|-----------------------------|---------------------------|
| F. absorbance               | water concentration       |
| G. water concentration      | methanol concentration    |
| H. methanol concentration   | temperature               |
| J. temperature              | absorbance                |

**Passage II**

Plants from Species X can be tall or short, and they can have red, pink, or white flowers. Height in Species X plants is controlled by Gene T, which has 2 alleles, *T* and *t*. Flower color in Species X plants is controlled by Gene R, which also has 2 alleles, *R* and *r*. To determine how height and flower color are inherited in Species X, a student conducted the following crosses.

*Cross 1*

Two tall Species X plants, each with the genotype *Tt*, were crossed. The numbers and phenotypes of the resulting offspring are shown in Table 1.

Table 1	
Number of offspring	Height phenotype
154	tall
46	short

*Cross 2*

Two pink-flowered Species X plants, each with the genotype *Rr*, were crossed, and the numbers and phenotypes of the resulting offspring are shown in Table 2.

Table 2	
Number of offspring	Flower phenotype
46	red
102	pink
52	white

*Cross 3*

Two Species X plants, each with the genotype *TtRr*, were crossed. The numbers, genotypes, and phenotypes of the resulting offspring are shown in Table 3.

Table 3			
Number of offspring	Genotype	Height phenotype	Flower phenotype
10	<i>TTRR</i>	tall	red
18	<i>TTRr</i>	tall	pink
11	<i>TTrr</i>	tall	white
19	<i>TtRR</i>	tall	red
41	<i>TtRr</i>	tall	pink
20	<i>Ttrr</i>	tall	white
12	<i>ttRR</i>	short	red
19	<i>ttRr</i>	short	pink
10	<i>ttrr</i>	short	white

6. The ratio of tall offspring to short offspring in Cross 1 is closest to which of the following?

- F. 1:1
- G. 1:3
- H. 3:1
- J. 1:2:1

7. What was the genotype for Gene T in the offspring from Cross 2?

- A. *TT* only
- B. *Tt* only
- C. *tt* only
- D. Cannot be determined from the given information

8. The percent of offspring from Cross 2 with pink flowers was closest to which of the following?

- F. 0%
- G. 25%
- H. 50%
- J. 100%

9. Suppose a gardener wants to produce tall pink-flowered Species X plants. Based on the results of Cross 3, which of the following pairs of plants, if crossed, would produce offspring with this phenotype?

- A. *TTRR* and *TTrr*
- B. *TTrr* and *Ttrr*
- C. *ttrr* and *ttRR*
- D. *ttrr* and *ttRr*

10. A student had hypothesized that the majority of the offspring from Cross 3 would be tall and have white flowers. Are the results shown in Table 3 consistent with this hypothesis?

- F. Yes; 31 of the offspring from Cross 3 were tall with white flowers.
- G. Yes; 119 of the offspring from Cross 3 were tall with white flowers.
- H. No; only 11 of the offspring from Cross 3 were tall with white flowers.
- J. No; only 31 of the offspring from Cross 3 were tall with white flowers.

11. Suppose a short red-flowered Species X plant is crossed with a short pink-flowered Species X plant. The percent of the resulting offspring with the genotype *ttRr* will most likely be closest to which of the following?

- A. 0%
- B. 25%
- C. 50%
- D. 100%

**Passage III**

Ice cream was made by stirring an ice cream mixture (M1) at a constant rate in the apparatus shown in Figure 1.

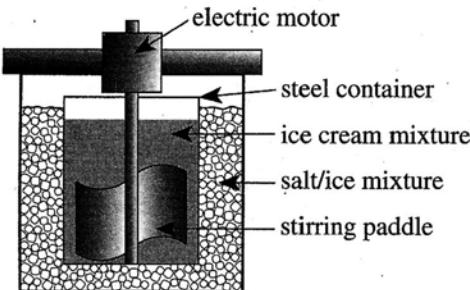


Figure 1

Figure 2 shows how the temperature of M1 and the temperature of the salt/ice mixture varied with mixing time.

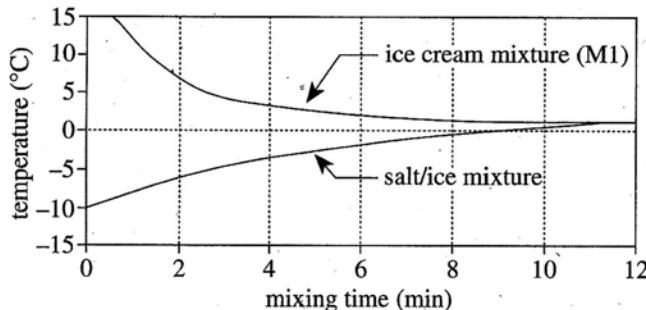


Figure 2

The viscosity (resistance to flow) of M1 was monitored by measuring how the current drawn by the motor turning the stirring paddle changed with mixing time. Two other ice cream mixtures (M2 and M3) were also monitored under conditions identical to those used during the mixing of M1 (see Figure 3).

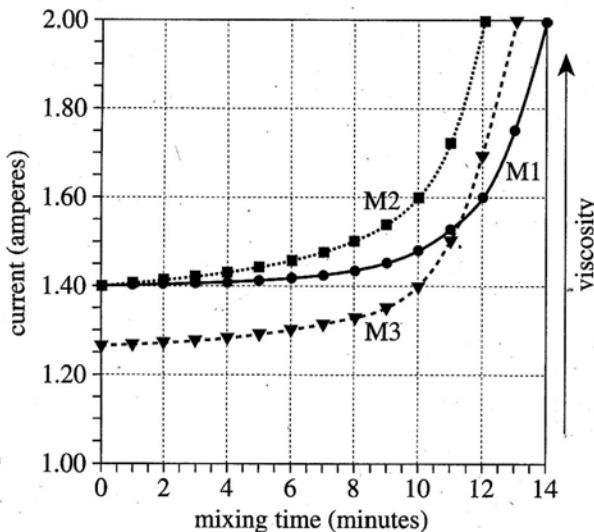


Figure 3

Figures adapted from D. Gibbon et al., "The Thermodynamics of Home-Made Ice Cream." ©1992 by Division of Chemical Education, Inc., American Chemical Society.

12. Based on Figures 2 and 3, for M1, as the temperature of the salt/ice mixture increased, the electrical current:
  - F. increased only.
  - G. decreased only.
  - H. increased, then decreased.
  - J. decreased, then increased.
  
13. A fourth ice cream mixture (M4) was monitored under the same conditions used to gather the data for Figure 3. The current at 0 min was 1.33 amperes. How did the initial viscosity of M4 compare with that of M1–M3? The initial viscosity of M4 was:
  - A. less than that of M1, M2, and M3.
  - B. less than that of M1 and M2, but greater than that of M3.
  - C. greater than that of M1 and M2, but less than that of M3.
  - D. greater than that of M1, M2, and M3.
  
14. According to Figure 3, the current drawn by the motor at a mixing time of 8 min for M2 was closest to which of the following?
  - E. 1.40 amperes
  - G. 1.45 amperes
  - H. 1.50 amperes
  - J. 1.55 amperes
  
15. Some ice cream makers automatically shut off when the current drawn by the electric motor reaches 2 amperes to indicate that the process is complete. Based on Figure 3, in this type of ice cream maker, which ice cream mixture, if any, would have the longest completion time?
  - A. M1
  - B. M2
  - C. M3
  - D. All 3 mixtures would have the same completion time.
  
16. Based on Figure 1, which of the following best explains the trends in the results shown in Figure 2? Overall, as mixing time increased, heat was conducted by the:
  - F. steel container from the ice cream mixture to the salt/ice mixture.
  - G. steel container from the salt/ice mixture to the ice cream mixture.
  - H. electric motor from the stirring paddle to the ice cream mixture.
  - J. electric motor from the ice cream mixture to the stirring paddle.

**Passage V**

Nutrients in seawater are removed by phytoplankton and other marine organisms. Figure 1 shows the concentrations of 3 nutrients—nitrate ( $\text{NO}_3^-$ ), dissolved inorganic phosphorus (DIP), and silicic acid ( $\text{H}_4\text{SiO}_4$ )—at various depths in the Atlantic, Pacific, and Indian Oceans. Table 1 shows the average concentrations and the estimated *residence times* (how long an ion or molecule of a nutrient remains in the ocean) for the 3 nutrients in deep (> 3 km) Atlantic and Pacific waters. Figure 2 shows how the  $\text{NO}_3^-$  concentration in Pacific surface waters (< 0.3 km depth) varies with latitude.

Nutrient	Average concentration in deep (> 3 km) ocean water ( $\mu\text{mol/L}$ )		Estimated residence time in ocean water (years)
	Atlantic	Pacific	
$\text{NO}_3^-$	20	35	57,000
DIP	1.8	2.8	69,000
$\text{H}_4\text{SiO}_4$	25	170	20,000

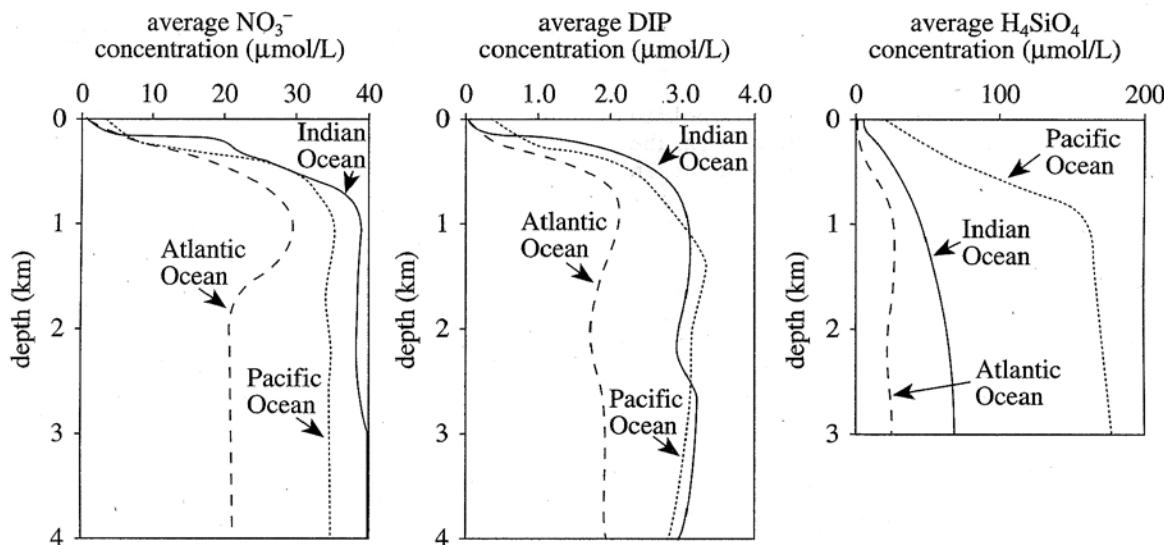


Figure 1

Figure 1 adapted from J. Andrews, P. Brimblecombe, T. Jickells, and P. Liss, *An Introduction to Environmental Chemistry*. ©1996 by Blackwell Science Ltd.

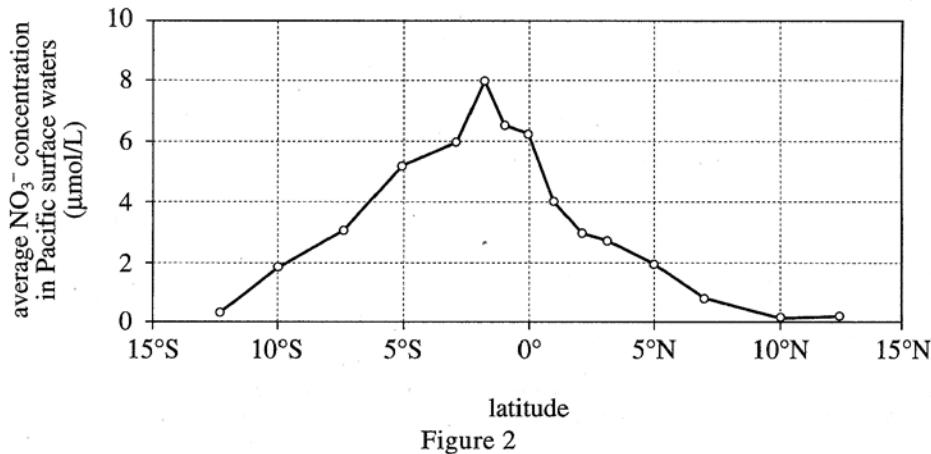


Figure 2

Figure 2 adapted from James Murray et al., "Physical and Biological Controls on Carbon Cycling in the Equatorial Pacific." ©1994 by the American Association for the Advancement of Science.

25. According to Figure 1, which of the following best describes the relationship between average  $\text{H}_4\text{SiO}_4$  concentration and depth in the Indian Ocean? As depth in the Indian Ocean increases from 0.5 km to 2.0 km, the average  $\text{H}_4\text{SiO}_4$  concentration:
- A. increases only.
  - B. increases, then decreases.
  - C. decreases only.
  - D. remains the same.
26. A scientist hypothesizes that the highest average  $\text{NO}_3^-$  concentration in Pacific surface waters would be found at the equator ( $0^\circ$  latitude). Is this hypothesis supported by the data in Figure 2?
- F. Yes; the average  $\text{NO}_3^-$  concentration at the equator is higher than that at any other given latitude.
  - G. Yes; the average  $\text{NO}_3^-$  concentration at the equator is lower than that at any other given latitude.
  - H. No; the highest average  $\text{NO}_3^-$  concentration is found a few degrees south of the equator.
  - J. No; the highest average  $\text{NO}_3^-$  concentration is found a few degrees north of the equator.
27. According to Table 1, an ion of  $\text{NO}_3^-$  would remain in the ocean, on average, approximately how many times longer than a molecule of  $\text{H}_4\text{SiO}_4$ ?
- A. 1.5 times
  - B. 2 times
  - C. 3 times
  - D. 3.5 times
28. According to Figure 1, the average DIP concentration is the same at which of the following depths in the Indian and the Pacific Oceans?
- E. 2.0 km
  - G. 2.5 km
  - H. 3.0 km
  - J. 3.5 km
29. Which of the following correctly ranks the concentrations of the 3 nutrients in the Indian Ocean at a depth of 3 km from largest to smallest?
- A.  $\text{H}_4\text{SiO}_4$ ,  $\text{NO}_3^-$ , DIP
  - B.  $\text{H}_4\text{SiO}_4$ , DIP,  $\text{NO}_3^-$
  - C. DIP,  $\text{H}_4\text{SiO}_4$ ,  $\text{NO}_3^-$
  - D.  $\text{NO}_3^-$ , DIP,  $\text{H}_4\text{SiO}_4$

**Passage VI**

The *total mechanical energy* (TME) of an object is defined as the sum of its *potential energy* (energy of position, abbreviated PE) and its *kinetic energy* (energy of motion, abbreviated KE). The object's PE =  $mgh$ , where  $m$  is its mass,  $h$  is its height above an arbitrary reference point, and  $g$  is the acceleration due to gravity ( $9.8 \text{ m/sec}^2$ ). The object's KE =  $mv^2/2$ , where  $v$  is its velocity.

When the object's motion changes but the sum KE + PE does not change, the TME is said to be *conserved*.

A group of students performed 2 experiments to investigate the conservation of TME.

**Experiment 1**

Starting from rest at Point P (see Figure 1), a 1 kg toy cart was released and allowed to move along a frictionless track in an airless vacuum chamber.

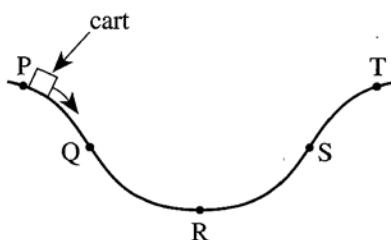


Figure 1

At various points along the track, the students determined both the cart's KE and PE in joules, J (see Table 1).

Table 1

Position	Height (m)	KE (J)	PE (J)
P	1.00	0.0	9.8
Q	0.50	4.9	4.9
R	0.00	9.8	0.0
S	0.50	4.9	4.9
T	1.00	0.0	9.8

**Experiment 2**

The students performed an experiment in air at atmospheric pressure using the cart from Experiment 1 and the track shown in Figure 2; this track was NOT frictionless.

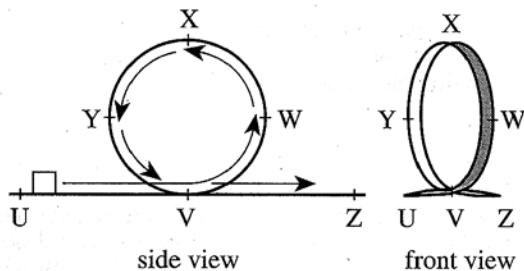


Figure 2

On this track, Positions W and Y were at the same altitude; the altitude at Positions U, V, and Z was zero. The cart was launched at Position U with a given KE, after which the students did not interfere with the cart's motion. The cart had to have enough KE between Positions W and Y to prevent the cart from falling away from the track.

(Note: The results of Experiment 2 are not provided; some of the questions will ask you to decide what those results most likely were.)

30. In Experiment 2, suppose the students wanted to directly determine the difference, if any, in the cart's TME at Positions U and Z. Which of the following measurements should they have made?

- F. The height of Position X
- G. The heights of Positions U and Z
- H. The speed of the cart at Position X
- J. The speeds of the cart at Positions U and Z

31. The purpose for conducting Experiment 1 in a vacuum was to:
- increase the cart's potential energy at a given position.
  - increase the frictional force exerted on the cart.
  - decrease the cart's potential energy at a given position.
  - decrease the frictional force exerted on the cart.
32. Suppose, in Experiment 1, instead of simply releasing the cart from Position P, the students had given the cart a push down the track. At Position T, compared to the cart's KE and TME when the cart was simply released, the cart's KE and TME when the cart was pushed would have been:
- | KE         | TME     |
|------------|---------|
| E. greater | smaller |
| G. smaller | greater |
| H. greater | greater |
| J. smaller | smaller |
33. In Experiment 2, as the cart's speed decreased, air resistance decreased. At which of the following positions was air resistance most likely *lowest*?
- Position U
  - Position V
  - Position W
  - Position X
34. The results of Experiment 1 support the conclusion that as the cart's KE increased, its PE:
- always increased.
  - always decreased.
  - sometimes increased, and sometimes decreased.
  - remained constant.
35. In Experiment 2, the KE of the cart at Positions U, W, and X would best be represented by which of the following bar graphs?
- | Position | KE          |
|----------|-------------|
| U        | High        |
| W        | Medium-High |
| X        | Medium-Low  |
  - | Position | KE          |
|----------|-------------|
| U        | Medium-Low  |
| W        | Medium-High |
| X        | High        |
  - | Position | KE         |
|----------|------------|
| U        | Medium-Low |
| W        | High       |
| X        | Medium-Low |
  - | Position | KE     |
|----------|--------|
| U        | Medium |
| W        | Medium |
| X        | Medium |

**Passage IV**

The Mediterranean Sea is home to many volcanic islands. Studying the volcanic ash that has settled on the islands and the ocean floor around the islands can tell scientists about the sequence of eruptions, the ash source, and the magma source, or sources, that feed the volcanoes.

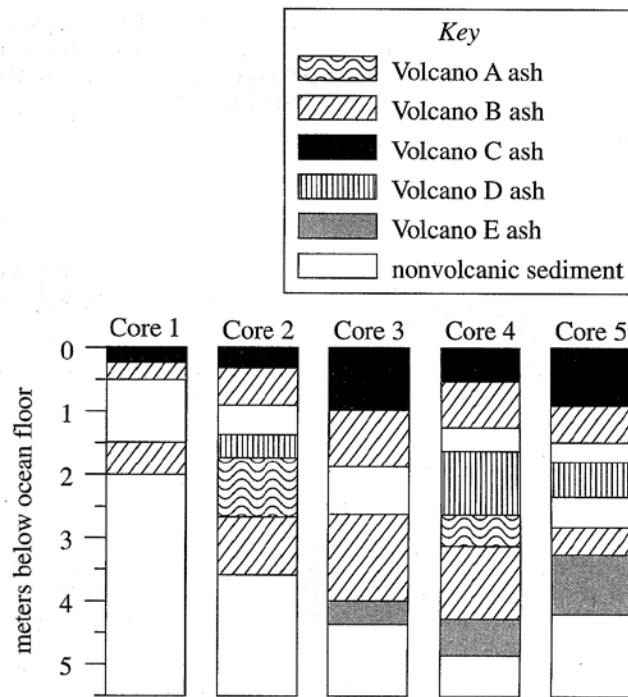
**Study 1**

Scientists took 10 ash samples from a volcano on each of 5 islands. The samples were analyzed for their percent silica ( $\text{SiO}_2$ ) and potassium oxide ( $\text{K}_2\text{O}$ ) contents. Also measured were the zirconium (Zr), yttrium (Y), and rubidium (Rb) contents, in parts per million (ppm). The averaged sample analyses are shown in Table 1.

Table 1					
Chemical component	Ash sample analysis from Volcano:				
	A	B	C	D	E
$\text{K}_2\text{O}$ (%)	3.3	3.3	3.0	7.0	6.2
$\text{SiO}_2$ (%)	68.2	68.9	68.4	60.2	60.2
Zr (ppm)	350	221	125	540	461
Y (ppm)	52	48	12	55	55
Rb (ppm)	118	118	84	412	392

**Study 2**

A 6 m long hollow tube was dropped to the ocean floor at 5 different sites around the volcanic islands to collect cores of undisturbed ocean floor sediments. Each core was sampled every 25 cm, and the samples were analyzed as in Study 1. Those analyses were compared to the results of Study 1 in order to identify the volcano that had produced a given ash layer present in the cores. The sediment and ash layers identified in each core are shown in Figure 1.



Note: The rate at which sediment was deposited was constant throughout the study area.

Figure 1

**Study 3**

To determine whether one or more magma sources feed volcanoes in the study area, scientists plotted the  $\text{SiO}_2$  content of ash samples versus the respective  $\text{K}_2\text{O}$  content of those samples. The  $\text{SiO}_2$  and  $\text{K}_2\text{O}$  contents of the ash derived from a given magma source will fall within a narrow range of values. The 8 ash samples included samples from the 5 volcanoes in Study 1. The results are shown in Figure 2.

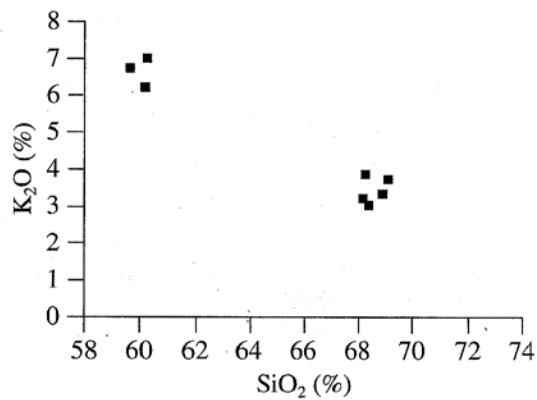


Figure 2

Table 1 and Figure 2 adapted from Darlene Richardson and Dragoslav Ninkovich, "Use of  $\text{K}_2\text{O}$ , Rb, Zr, and Y versus  $\text{SiO}_2$  in Volcanic Ash Layers of the Eastern Mediterranean to Trace Their Source." ©1976 by the Geological Society of America.

19. It is known that ocean floor sites closer to a given volcanic island usually have thicker layers of ash from the volcano on that island than sites farther away. Based on this information and Study 2, one would most likely conclude that which of the following cores was taken at the site closest to Volcano D?

- A. Core 1
- B. Core 2
- C. Core 3
- D. Core 4

20. According to Study 2, during the time it took to deposit the 5.5 m of sediment in the study area, the smallest amount of volcanic ash settled to the ocean floor at the site of:

- F. Core 1.
- G. Core 2.
- H. Core 3.
- J. Core 4.

21. Given that the 5 cores contained undisturbed sediment, according to Study 2, which of the following volcanoes erupted most recently?

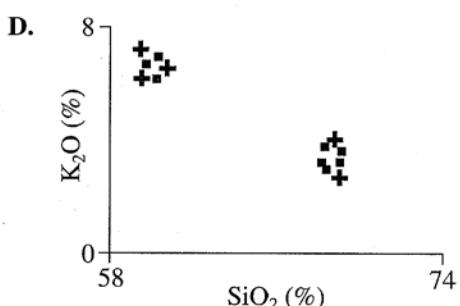
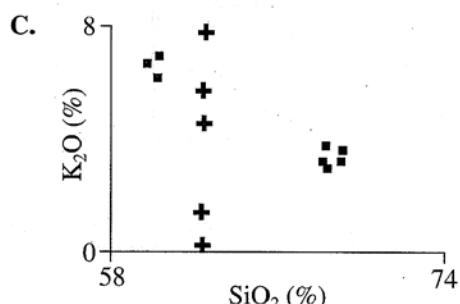
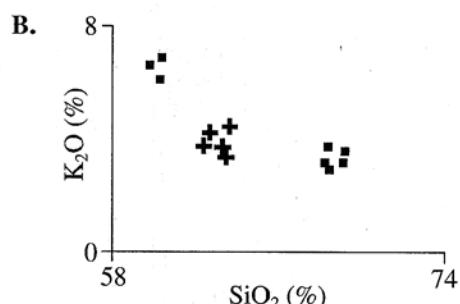
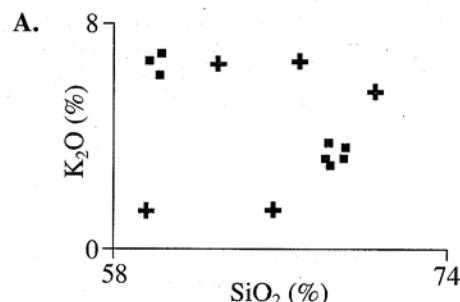
- A. Volcano A
- B. Volcano B
- C. Volcano C
- D. Volcano E

22. According to Study 1, as the content of Zr in ash samples from Volcanoes A, B, and C increases, the content of Y:

- F. increases, then decreases.
- G. decreases, then increases.
- H. increases.
- J. decreases.

23. If ash samples from volcanoes fed by a previously undiscovered magma source in the study area were analyzed, and their  $\text{SiO}_2$  and  $\text{K}_2\text{O}$  contents were also plotted on Figure 2, which of the following figures would most likely result?

(Note: The new ash sample contents are represented by the following symbol: +)



24. According to Study 1, what chemical component was found in the largest relative amount in the ash samples from Volcano A?

- F.  $\text{SiO}_2$
- G. Zr
- H. Y
- J. Rb

**Passage VII**

Students dissolved ammonium chloride ( $\text{NH}_4\text{Cl}$ ) and silver cyanate ( $\text{AgOCN}$ ) together in water. A solid, Product 1 (P1), formed and was isolated. Product 2 (P2) was then recovered from the water in the solution. Samples of the products had the properties listed below:

P1: Melting point >  $400^\circ\text{C}$ ; hard and brittle; not soluble in water; not flammable; formula unknown

P2: Melting point =  $132^\circ\text{C}$ ; soft and nonbrittle; soluble in water; flammable; formula is  $\text{CH}_4\text{N}_2\text{O}$

Two students discuss the identity of these products.

*Student 1*

$\text{NH}_4\text{Cl}$  and  $\text{AgOCN}$  both are salts. Salts are composed of positively charged cations and negatively charged anions that hold together because they have opposite charges. When salts dissolve in water, they *dissociate*, or break apart, into anions and cations. When  $\text{NH}_4\text{Cl}$  and  $\text{AgOCN}$  are dissolved in water, the following occurs:



The ions in solution then form new salts, silver chloride ( $\text{AgCl}$ ) and ammonium cyanate ( $\text{NH}_4\text{OCN}$ ):



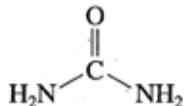
P1 is  $\text{AgCl}$ .  $\text{AgCl}$  is insoluble in water, and salts tend to be hard and brittle, to be nonflammable, and to have high melting points. P2 is  $\text{NH}_4\text{OCN}$ , which is a salt composed of an ammonium ion and a cyanate ion:



This sample of  $\text{NH}_4\text{OCN}$  is soft and nonbrittle because it absorbed water from the air after it was isolated. This also caused the melting point to be lower than expected for a salt.

*Student 2*

P1 is  $\text{AgCl}$ , but P2 is not a salt. Ammonium ions do react with cyanate ions to form  $\text{NH}_4\text{OCN}$ , but this compound is unstable. To isolate P2, the solution was heated at  $70^\circ\text{C}$  to remove the water. This caused the salt to rearrange and form a more stable *covalent* compound. In a covalent compound, the atoms are held together by bonds, not by their opposite charges. P2 is *urea*, which has the following structure:



Covalent compounds are generally not as brittle as salts and tend to have lower melting points. Also, covalent compounds are much more likely to be flammable than are salts. Urea is also a compound that is found in mammalian urine, so it must be soluble in water.

34. A compound is *hygroscopic* if it absorbs water from the air. According to Student 1's hypothesis, which of the following compounds is hygroscopic?

- F. Urea
- G.  $\text{AgCl}$
- H.  $\text{NH}_4\text{Cl}$
- J.  $\text{NH}_4\text{OCN}$

35. Which of the students' hypotheses, if either, would be weakened if it were determined that P1 was NOT  $\text{AgCl}$ ?

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

36. Based on the data collected for P2, which of the following compounds represents a possible structure for P2?

- F. 

A structural diagram of a cyclic amide. It shows a central carbon atom (C) double-bonded to an oxygen atom (O) above it and single-bonded to an amino group (NH<sub>2</sub>) on one side, and to another carbon atom on the other side. The second carbon atom is also single-bonded to an amino group (NH<sub>2</sub>) and has a hydrogen atom (H) attached to it.
- G. 

A structural diagram of a linear diamine. It shows a central carbon atom (C) double-bonded to a hydroxyl group (HO) on one side and a secondary amino group (NH<sub>2</sub>) on the other side. The carbon atom is also single-bonded to another carbon atom, which is single-bonded to a primary amino group (NH<sub>2</sub>).
- H.  $[\text{NH}_4^+][\text{CN}^-]$
- J.  $[\text{N}_2\text{H}_5^+][\text{OCN}^-]$

37. In arguing that urea is soluble in water, Student 2 makes which of the following assumptions?

- A. Mammalian urine is a water-based solution.
- B. Mammalian urine contains many dissolved salts.
- C. Urea dissociates when dissolved in water.
- D. Urea absorbs water from the atmosphere.

38. Which of the following claims about the compounds discussed in the passage, if true, would NOT be consistent with Student 2's hypothesis?

- F.  $\text{AgCl}$  is a salt.
- G.  $\text{NH}_4\text{OCN}$  is a salt.
- H.  $\text{NH}_4\text{Cl}$  is a salt.
- J. Urea is a salt.

39. Compounds that have the same chemical formula but different chemical structures are called *isomers*. Based on the information in the passage, which of the following pairs of compounds are isomers?
- A. Silver chloride and silver cyanate
  - B. Silver cyanate and ammonium chloride
  - C. Ammonium chloride and ammonium cyanate
  - D. Ammonium cyanate and urea
40. According to both Students 1 and 2, what solid was observed to form when the  $\text{NH}_4\text{Cl}$  and  $\text{AgOCN}$  were dissolved together in water?
- F.  $\text{NH}_4\text{OCN}$
  - G. Urea
  - H.  $\text{AgCl}$
  - J.  $\text{CH}_4\text{N}_2\text{O}$



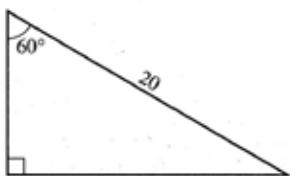
## Math Overview

The math part of the ACT test is a comprehensive review of pretty much all the math you have ever had in school up to trigonometry. Understanding all the basic triangles is a key part of a lot of ACT math questions. The ACT does not use math problems more than 1 time so every test will cover 60 new math problems like you will have not seen before but they will all be based on the basic math concepts you should have seen in school.

Timing is not as big of a problem on the Math section as it is on the Science section of the ACT test. However, there is one timing objective that works very well. The test always starts with the easier math concepts and works their way up slowly to the more difficult problems. Problems 50-60 are definitely harder than the rest of the test. Problems 1-30 are easy and you should be able to complete these in 23 minutes or less. It is definitely a fact that 60 problems in 60 minutes does NOT mean 1 minute per problem. You will NOT have time to complete all 60 problems if you are not through with the first 30 in 23 minutes.

Since the easier problems are in the first 30 problems it is a good idea to remain conscious of where you are on the test. If you are on a #17 problem and you start trying to make it a difficult problem, keep in mind that it is a #17 and you have probably missed something that makes it an easy problem. A good example of this is in a problem like this one:

23. The figure below shows a right triangle whose hypotenuse is 20 inches long. How many inches long is the longer leg of this triangle?

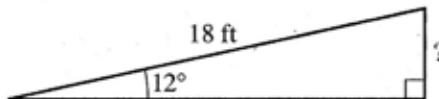


- A. 10
- B. 40
- C.  $10\sqrt{3}$
- D.  $\frac{10\sqrt{3}}{3}$
- E.  $\frac{40\sqrt{3}}{3}$

In this problem you are supposed to see at a glance that it is a 30 - 60 - 90 triangle. Knowing that it is a 30 - 60 - 90 triangle you should remember that the short side (across from the 30 degree angle) is half of the hypotenuse which equals 10 and that the long leg is the square root of 3 times the short leg. That makes the answer "C".

Or one like this -

25. As shown below, an 18-foot ramp forms an angle of  $12^\circ$  with the ground, which is horizontal. Which of the following is an expression for the vertical rise, in feet, of the ramp?



- A.  $18 \sin 12^\circ$
- B.  $18 \cos 12^\circ$
- C.  $18 \tan 12^\circ$
- D.  $18 \cot 12^\circ$
- E.  $18 \sec 12^\circ$

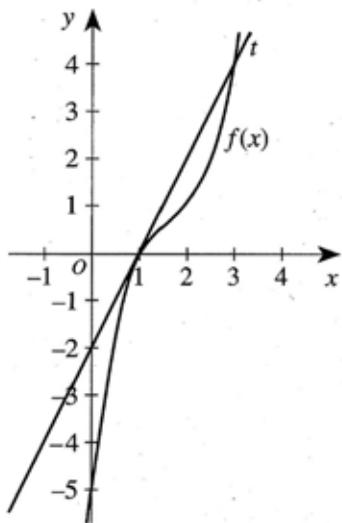
In this problem you are simply scan the answers to see that it is a simple trig problem. Remembering the trig expression - SOH CAH TOA you label the triangle with the side across from the 12 degree angle as "Opposite" and the long leg is "Adjacent" and the side across from the 90 degree angle is the "Hypotenuse". Looking at the SOH formula you see that the Sine function is the one you need and only 1 answer has the Sine in it.

Simple observations like this can increase your confidence significantly and help you move through the easy questions very quickly. The next strategy is that your first goal is to NOT miss any of the easy questions. Too many times students get worried about not knowing how to do a particular type of problem. Then when we go over their test they find that they missed 8 - 10 easy problems. Why worry about the problems you do not know how to do when you still have a lot of points to gain by just getting the easy problems correct.

The library of Math videos that I have put online are designed to go through many of these simple concepts that can help you get quick and correct on the easy math problems. Many other problems might look hard but always look at what the ACT has asked. A good example is this problem that many people skip thinking that they do not know how to do it - only to be amazed at how easy it is.

- 36.** The function  $f(x) = x^3 - 5x^2 + 9x - 5$  and line  $t$  are shown in the standard  $(x,y)$  coordinate plane below. Which of the following is an equation of line  $t$ , which passes through  $(3,4)$  and is tangent to  $f(x)$  at  $(1,0)$ ?

- F.  $y = \frac{1}{2}x + \frac{5}{2}$
- G.  $y = \frac{1}{2}x - \frac{1}{2}$
- H.  $y = 3x + 4$
- J.  $y = 2x + 1$
- K.  $y = 2x - 2$



At first glance the equation at the top seems a bit difficult, but look at the question - Which of the following is the equation of line "t" that passes through the point  $(3,4)$ .

OK, remember that a line equation has to be in the form  $Y = mX + b$ , where  $b$  is the "Y" intercept. So look at the "Y" intercept. It is a -2. How many answers have a "Y" intercept of -2. Only answer "K".

You see a lot of the "difficult" problems are not difficult at all. Try to focus on what the problem has asked for and scan the answers BEFORE you start to work.

A lot of these concepts are covered in the online videos. Make sure that you watch them!!!!!!

***Make sure you watch the online math videos!!!!!!***

***Make sure you watch the online math videos!!!!!!***

A lot of people that score really high on the math test - over 27, tend to think they do not need to review a lot of these math problems but I find that the high scoring students are still missing the easy problems. The hard problems tend to be more like your recent math - Algebra II / Trig in school and the easier problems tend to be fractions, percents, basic geometry problems. These may be problems you have not worked with since the 8th or 9th grade. That is why you need the math review.

OK, let's get started on some of the easier math problems and work our way up.

**Review of Fraction Problems**

1. The expression  $\frac{6 + \frac{1}{8}}{1 + \frac{1}{16}}$  is equal to which of the following?
- A. 3  
B. 4  
C.  $\frac{98}{17}$   
D. 8  
E.  $\frac{833}{8}$
4. Given  $f(x) = \frac{x^3 + \frac{5}{8}}{x + \frac{1}{4}}$ , what is  $f\left(\frac{1}{2}\right)$ ?
- A.  $\frac{30}{32}$   
B. 1  
C.  $\frac{36}{24}$   
D.  $\frac{20}{8}$   
E.  $\frac{7}{2}$
2.  $\frac{3p}{5} + \frac{3q}{2}$  is equivalent to:
- F.  $\frac{9pq}{10}$   
G.  $\frac{6p + 15q}{10}$   
H.  $\frac{6p + 3q}{2}$   
J.  $\frac{3p + 15q}{5}$   
K.  $\frac{3p + 3q}{7}$
5. What is the least common denominator for the fractions  $\frac{1}{12}$ ,  $\frac{1}{18}$ , and  $\frac{1}{30}$ ?
- A. 6  
B. 60  
C. 90  
D. 180  
E. 6,480
3. Which of the following is the least common denominator for the expression below?
- $$\frac{1}{13^2 \cdot 17 \cdot 23} + \frac{1}{17^2 \cdot 23} + \frac{1}{17 \cdot 23^3}$$
- F.  $17 \cdot 23$   
G.  $13 \cdot 17 \cdot 23$   
H.  $13^2 \cdot 17 \cdot 23$   
J.  $13^2 \cdot 17^2 \cdot 23^3$   
K.  $13^2 \cdot 17^4 \cdot 23^5$
6.  $\frac{1}{3} \cdot \frac{2}{4} \cdot \frac{3}{5} \cdot \frac{4}{6} \cdot \frac{5}{7} \cdot \frac{6}{8} \cdot \frac{7}{9} \cdot \frac{8}{10} = ?$
- A.  $\frac{1}{90}$   
B.  $\frac{1}{45}$   
C.  $\frac{1}{5}$   
D. 1  
E.  $\frac{9}{2}$

**Review of Percent Problems**

1. Koko has \$250 to spend on photo equipment. How much money would she have left if she buys a \$140 camera and must also pay 8.2% of the \$140 in sales tax?  
 F. \$ 98.52  
 G. \$101.80  
 H. \$110.00  
 J. \$119.02  
 K. \$130.05
4. What is 10.8% of \$235.00 ?  
 F. \$ 2.53  
 G. \$ 25.00  
 H. \$ 25.38  
 J. \$235.80  
 K. \$253.80
2. Sherry won a cash settlement for a suit she had filed in court. Sherry paid her lawyer 25% of the original settlement and had \$12,000 remaining. How much was the original settlement?  
 A. \$16,000  
 B. \$21,000  
 C. \$28,000  
 D. \$37,000  
 E. \$48,000
5. Mr. Jones earns a total of \$320 each week at his job in Shaba's Supermarket. If 18% of his pay is withheld for taxes, insurance, and other deductions, what is his take-home pay each week?  
 A. \$ 57.60  
 B. \$262.40  
 C. \$300.50  
 D. \$320.00  
 E. \$338.00
3. 23 is what percent of 115 ?  
 A. 500%  
 B. 20%  
 C. 5%  
 D. 2%  
 E. 0.5%
6. A postage stamp measures 2 centimeters by 2.5 centimeters. Angelina estimates that the area is 4 square centimeters. Her estimate is what percent *less* than the actual area?  
 F. 80%  
 G. 50%  
 H. 40%  
 J. 25%  
 K. 20%

**Review of Average Problems**

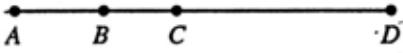
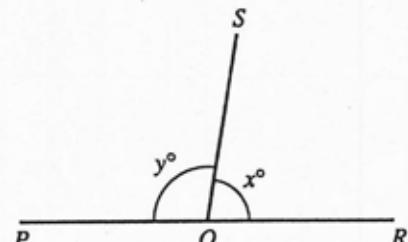
7. The average of a set of 5 integers is 4. If one of the integers in the set is 3, what is the average of the other 4 integers in the set?  
 F. 3  
 G.  $3\frac{2}{5}$   
 H. 4  
 J.  $4\frac{1}{4}$   
 K. 5
8. Melinda's test average after 6 tests was 73. Her score on the 7th test was 87. If all 7 tests were equally weighted, which of the following is closest to her test average after 7 tests?  
 F. 87  
 G. 85  
 H. 80  
 J. 75  
 K. 73

## **Review of Ratio/Proportion Problems**

1. A person 2 meters tall casts a shadow 3 meters long. At the same time, a telephone pole casts a shadow 12 meters long. How many meters tall is the pole?
- F. 4  
G. 6  
H. 8  
J. 11  
K. 18
3. For the class party, the committee needs 60 servings of punch. A recipe that makes 24 servings requires 3 cups of sherbet and 9 cups of orange juice. How many cups of sherbet will be needed to make the 60 servings?
- A. 30  
B. 20  
C.  $7\frac{1}{2}$   
D. 5  
E.  $2\frac{1}{2}$
2. Amelia Earhart's Lockheed Vega was a 27-foot-long airplane with a wingspan of 41 feet. If you are making a  $\frac{1}{20}$  scale model of this airplane, what should be the length of the model's wingspan, in feet?
- A.  $\frac{1}{20}$   
B.  $1\frac{1}{20}$   
C.  $2\frac{1}{20}$   
D.  $2\frac{7}{20}$   
E.  $2\frac{1}{2}$
4. As a salesperson, your commission is directly proportional to the dollar amount of sales you make. If your sales are \$800, your commission is \$112. How much commission would you earn if you had \$1,400 in sales?
- A. \$210  
B. \$196  
C. \$175  
D. \$128  
E. \$ 64

## **Review of Factoring Problems**

5. For nonzero  $x$  and  $y$ , the expression  $\frac{9x^6y^4 - 12x^9}{3x^3}$  is equivalent to which of the following?
- F.  $3x^2y^4 - 12x^3$   
G.  $3x^2y^4 - 4x^3$   
H.  $3x^3y^4 - 4x^6$   
J.  $6x^3y^4 - 9x^6$   
K.  $-12x^9y^4$
6. When  $\frac{x-3}{x^2+x-12}$  is defined, it is equivalent to which of the following expressions?
- A.  $-\frac{3}{x-12}$   
B.  $\frac{1}{x^2+4}$   
C.  $\frac{1}{x+4}$   
D.  $\frac{2}{2x+5}$   
E.  $\frac{1}{4}$

1. A manufacturing company processes raw ore. The number of tons of refined material the company can produce during  $t$  days using Process A is  $A(t) = t^2 + 2t$  and using Process B is  $B(t) = 10t$ . The company has only 7 days to process ore and must choose 1 of the processes. What is the maximum output of refined material, in tons, for this time period?
- A. 8  
B. 10  
C. 51  
D. 63  
E. 70
2. What is the solution statement for the inequality  $a - 5 > 2a$ ?
- F.  $a < -5$   
G.  $a > -5$   
H.  $a < 5$   
J.  $a > 5$   
K.  $-5 < 5$
3. If  $|x - 4| = |x + 2|$ , then  $x = ?$
- A. 1 only  
B. -1 only  
C. -2 or 4  
D. -3 or 3  
E. -4 or 2
4. Points A, B, C, and D lie along a line in the order shown below. Which of the following is an expression for the distance BC in terms of other distances?  
(Note: The notation BC represents the distance from B to C.)
- 
- F.  $AC + BD - AD$   
G.  $AD - AC - BD$   
H.  $\frac{AC + BD}{2}$   
J.  $\frac{AD}{3}$   
K.  $\frac{AD + AC + BD}{3}$
5. If the sum of the roots of the equation  $x^2 + bx = 25$  is zero, what is the value of  $b$ ?
- A. 0  
B. -5  
C. 5  
D. -10  
E. 10
6. If  $n$  represents an even integer, which of the following also represent(s) an even integer?
- I.  $3n + 2$   
II.  $3(n + 1)$   
III.  $(n + 1)^2$   
F. I only  
G. II only  
H. III only  
J. I and II only  
K. I and III only
7. How many meters long is the radius of a circle whose circumference is  $8\pi$  meters?
- A. 4  
B. 8  
C.  $2\sqrt{2}$   
D.  $3\pi$   
E.  $4\pi$
8. In the standard  $(x,y)$  coordinate plane, where do the lines  $y = \frac{1}{2}x + 3$  and  $y = 2x$  intersect?
- F. (-2, 2)  
G. (2, 4)  
H. (2, -2)  
J. (3, 6)  
K. (4, 2)
9. In an isosceles triangle with an angle measuring  $\beta$  radians, where  $\sin \beta = \frac{12}{13}$  and  $\cos \beta = \frac{5}{13}$ , what is the value of  $\tan \beta$ ?
- A.  $\frac{12}{12}$   
B.  $\frac{5}{13}$   
C.  $\frac{13}{5}$   
D.  $\frac{5}{12}$   
E.  $\frac{12}{5}$
10. In the figure below, P, Q, and R are collinear, the measure of  $\angle PQS$  is  $y^\circ$ , and the measure of  $\angle SQR$  is  $x^\circ$ . If  $x = \frac{4}{5}y$ , then  $y = ?$
- 
- F. 36  
G. 50  
H. 80  
J. 100  
K. 144

11. A rectangular room that is 2 feet longer than it is wide has an area of 120 square feet. How many feet long is the room?
- F. 10  
G. 12  
H. 22  
J. 29  
K. 31
12. In the standard  $(x,y)$  coordinate plane, what is the slope of the line joining the points  $(2,-7)$  and  $(5,4)$ ?
- A.  $\frac{1}{9}$   
B.  $\frac{3}{11}$   
C. 1  
D.  $\frac{11}{3}$   
E. 9
13. What is the center of the circle with equation  $(x - 2)^2 + (y + 2)^2 = 2$  in the standard  $(x,y)$  coordinate plane?
- F.  $(-\sqrt{2}, \sqrt{2})$   
G.  $(-2, 2)$   
H.  $(\sqrt{2}, -\sqrt{2})$   
J.  $(2, -2)$   
K.  $(2, 2)$
14. The *domain* of a function  $f$  is the set of all values of  $x$  for which  $f(x)$  is defined. One of the following sets is the domain for the function graphed below. Which set is that domain?
- 
- A.  $\{-2, -1, 0, 1, 2, 3, 4\}$   
B.  $\{-1, 0, 1, 2\}$   
C.  $\{x: -2 \leq x \leq 4\}$   
D.  $\{x: -1 \leq x \leq 2\}$   
E.  $\{x: -1 \leq x \leq 4\}$
15. In the right triangle below, if  $\tan \theta = \frac{2}{\sqrt{77}}$ , then  $\sin \theta = ?$
- F.  $\frac{2}{9}$   
G.  $\frac{4}{77}$   
H.  $\frac{\sqrt{77}}{9}$   
J.  $1 - \frac{2\sqrt{77}}{77}$   
K.  $\sqrt{1 - \left(\frac{2\sqrt{77}}{77}\right)^2}$
- 
16. What is the slope of a line that is parallel to  $x + 2y = 6$ ?
- A. -2  
B.  $-\frac{1}{2}$   
C.  $\frac{1}{2}$   
D. 3  
E. 6
17. In the formula  $A = P(1 + rt)$ ,  $A$  is the principal plus simple interest,  $P$  is the principal,  $r$  is the interest rate, and  $t$  is the time. Which of the following solves this formula for  $r$ ?
- F.  $r = \frac{A}{2Pt}$   
G.  $r = \frac{A - P}{Pt}$   
H.  $r = \frac{A}{P + Pt}$   
J.  $r = \frac{A}{P} - Pt$   
K.  $r = A - P - Pt$
18. Tanya and Charles bought their brother Jerome a concert ticket for his birthday. When Jerome thanked Charles for the ticket, Charles said, "I contributed only  $\frac{1}{2}$  as much as Tanya." If the ticket price was \$24, how much money did Tanya contribute?
- A. \$ 6  
B. \$ 8  
C. \$12  
D. \$16  
E. \$18





## Science - 5 question passage 1

Relative humidity is a percent (%) measurement of how near air is to *saturation* with water vapor (holding all the water vapor it can). The temperature to which air must be cooled to reach saturation (100% relative humidity) is called the *dew point*. Dew point is related to the water vapor content of air. Water vapor condenses at the dew point. Figure 1 shows how relative humidity varies with air temperature for 6 air samples with different dew points. Figure 2 shows the average relative humidity at noon on a typical July day in the United States.

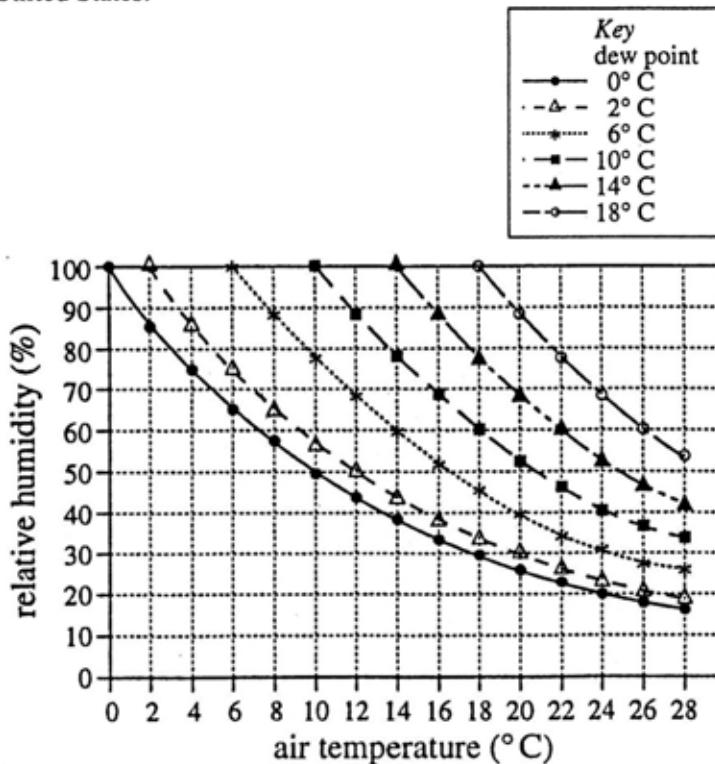


Figure 1

Figure 2 adapted from *The New Encyclopaedia Britannica*, "Climate and Weather." ©1990 by Encyclopaedia Britannica, Inc.

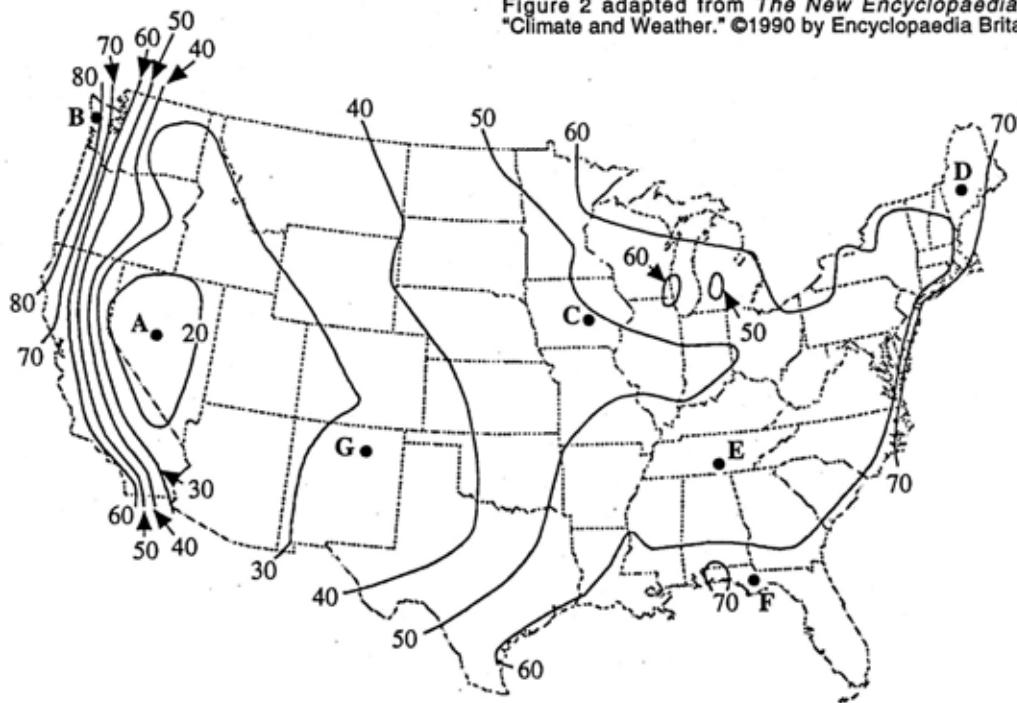
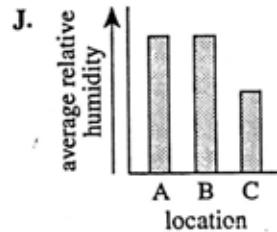
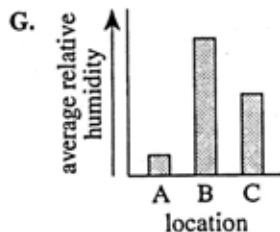
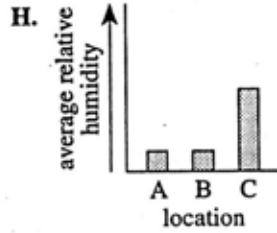
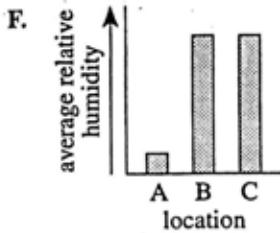


Figure 2

1. Which of the following pairs of locations in Figure 2 have most nearly the same average relative humidity?

A. Locations B and C  
B. Locations C and D  
C. Locations D and F  
D. Locations F and G

2. Which of the following graphs best represents the average relative humidity at noon on a typical July day for Locations A, B, and C in Figure 2?



3. Individuals with certain breathing disorders have difficulty breathing humid air; the greater the relative humidity, the more uncomfortable they become. According to Figure 2, those individuals would live most comfortably at Location:

A. A.  
B. B.  
C. D.  
D. E.

4. According to the data in Figure 1, air at 20° C and with a dew point of 8° C would most likely have which of the following relative humidities?

F. 40%  
G. 46%  
H. 52%  
J. 60%

5. Often, condensed water vapor appears as clouds. According to the information provided, clouds sometimes first appear in air having a dew point of 6° C when the air temperature is:

A. 0° C.  
B. 2° C.  
C. 6° C.  
D. 10° C.

## Science - 5 question passage 2

Researchers were interested in studying the population biology of hibernating bats in the eastern United States. From August 1 through April 1, brown bats at 5 study sites (see Figure 1) were netted at cave entrances, individually marked with color-coded tags, and released. Figure 2 shows the percent of male bats at each of the study sites during the course of the study.



Figure 1

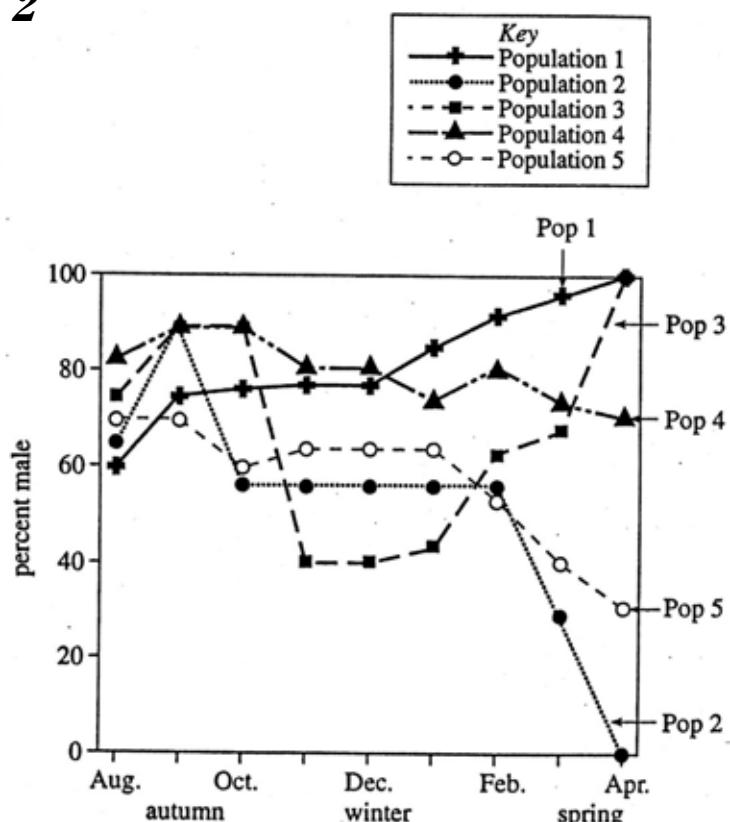


Figure 2

Figure 2 adapted from S. R. Humphrey and J. B. Kope, "Population Ecology of the Little Brown Bat, *Myotis lucifugus*, in Indiana and North-Central Kentucky." ©1976 by the American Society of Mammologists.

6. During which of the following pairs of months does the percent of males remain nearly constant in all five populations?  
  - F. August and September
  - G. September and October
  - H. November and December
  - J. January and February
7. From the data in Figure 2, one can conclude that the *smallest* change in the percent of males during the course of the study occurred in which population?  
  - A. Population 1
  - B. Population 2
  - C. Population 3
  - D. Population 4
8. Assume that brown bats reproduce in March. The higher the percentage of males present in a population, the greater the competition among the males for females. According to the data in Figure 2, one would predict that competition among males for females would be *lowest* in:  
  - F. Population 1.
  - G. Population 2.
  - H. Population 3.
  - J. Population 4.
9. The researchers hypothesized that there would be a greater percentage of female bats than male bats from November through January than in other months. The data from which population(s) supports this hypothesis?  
  - A. Population 3 only
  - B. Population 4 only
  - C. Population 5 only
  - D. Populations 1 and 3 only
10. It was hypothesized that female bats leave the hibernation caves in spring before the male bats leave. Is this hypothesis consistent with the results for Population 3?  
  - F. Yes, because the percent of male bats increased during spring.
  - G. Yes, because the percent of male bats decreased during spring.
  - H. No, because the percent of female bats increased during spring.
  - J. No, because the percent of male bats decreased during spring.

## Science - 5 question passage 3

Earth's atmosphere consists of various gases and suspended liquid and solid matter. The atmosphere can be divided into layers based on air temperature and/or composition. Figure 1 shows the layers of the atmosphere, the altitude of the layer boundaries, in kilometers (km), and the air pressure, in millibars (mb), at those boundaries. Figure 2 shows the average air temperature, in degrees Celsius ( $^{\circ}\text{C}$ ), in *arctic* (cold) and *tropical* (warm) air masses at various altitudes. Table 1 shows air pressure and temperature readings from weather instruments carried into the stratosphere by balloons on 2 separate days.

Layer of atmosphere	Altitude (km)	Air pressure (mb)
thermosphere	500	$1.9 \times 10^{-9}$
ionosphere	400	$3.4 \times 10^{-9}$
F2	190	$3.4 \times 10^{-7}$
F1	140	$3.4 \times 10^{-6}$
E	90	$3.4 \times 10^{-3}$
D	72	$3.4 \times 10^{-2}$
mesosphere	50	3.4
chemosphere	32	10.8
ozonosphere	11	301
stratosphere	0	1,013
troposphere		
surface		

Figure 1

(Note: Figure is NOT drawn to scale.)

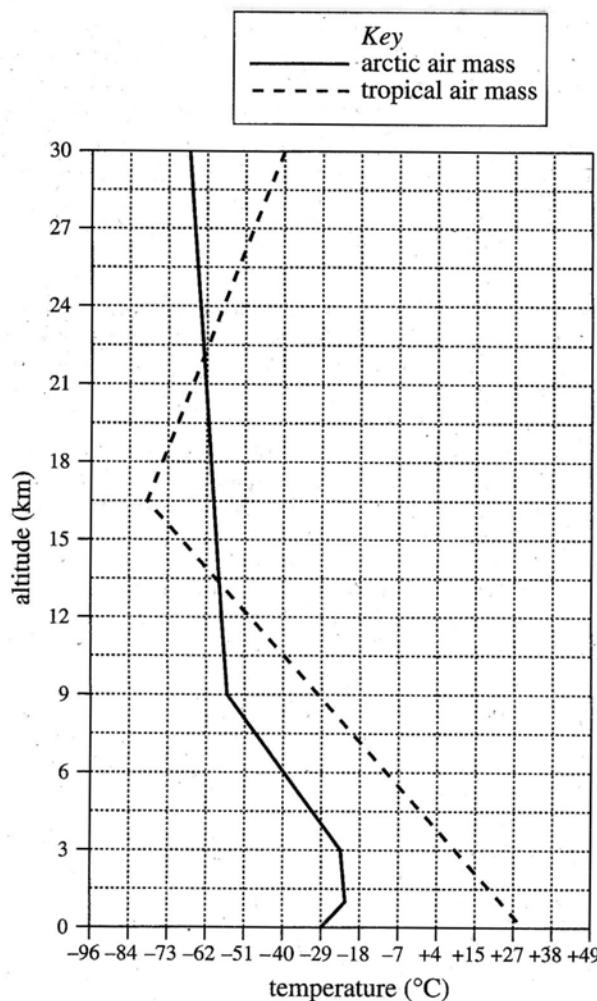


Figure 2

Air pressure (mb)	Altitude (km)	Temperature ( $^{\circ}\text{C}$ ) readings on:	
		Day 1	Day 2
1,000	0	2	25
900	0.9	0	15
700	2.9	-17	6
600	4.2	-25	-2
500	5.6	-30	-12
400	7.2	-40	-20
300	9.1	-50	-32
250	11.4	-50	-50
200	13.7	-48	-58

11. According to Figure 2, at approximately which of the following altitudes would a weather instrument measuring air temperature be unable to distinguish between tropical and arctic air masses?
- A. 12.0 km  
B. 13.5 km  
C. 15.5 km  
D. 16.5 km
12. According to Figure 1, several atmospheric layers overlap one another. Which of the following describes atmospheric layers that share part of a common altitude range?
- F. Stratosphere and mesosphere  
G. Stratosphere and thermosphere  
H. Mesosphere and thermosphere  
J. Mesosphere and chemosphere
13. According to Figure 1 and Table 1, if the weather instruments rose above 13.7 km, the air pressure would most likely:
- A. increase to more than 1,000 mb.  
B. stay at 200 mb.  
C. decrease to less than 200 mb.  
D. decrease to 1,000 mb.
14. According to Figure 1, a weather instrument reading an air pressure of 5 mb is most likely in which of the following layers?
- F. Troposphere  
G. Ozonosphere  
H. Mesosphere  
J. Ionosphere
15. According to Table 1, which of the following statements best describes the relationship between altitude and air temperature?
- A. The air temperature decreased with increasing altitude on Day 1 only.  
B. The air temperature increased with increasing altitude on Day 1 only.  
C. The air temperature decreased with increasing altitude on Day 2 only.  
D. The air temperature increased with increasing altitude on Day 2 only.

## Science - 5 question passage 4

Bacteria, fungi, and viruses (*microorganisms*) cause diseases and infections. *Disinfectants* are chemical agents used on inanimate objects to kill or inhibit the growth of microorganisms. *Antiseptics* are chemical agents used on the skin to kill or inhibit the growth of microorganisms. Several groups of disinfectants and antiseptics are depicted in Table 1.

Table 1

Groups	Chemical agent	Effective against	Mechanism of action	Preferred use
Alcohols	ethanol	bacteria, fungi, some viruses	cell disruption, stops protein function, cleansing	skin antiseptic and thermometer disinfectant
Halogen	iodines	bacteria, fungi, viruses	stops protein function	skin antiseptic
Halogen	chlorines	bacteria, fungi, viruses	stops protein function	water disinfectant; disinfectant used on dairy, restaurant, and household equipment
Heavy metals	Mercurochrome, Merthiolate	bacteria	stops protein function	skin antiseptic
Quaternary ammonium compounds	Zephiran, Cepacol	bacteria, fungi, viruses	cell disruption, stops protein function	skin antiseptic; disinfectant for instruments, utensils, and rubber goods
Detergents	soaps, surfactants	bacteria, fungi, viruses	cleansing, decreases surface tension	mechanical removal of microorganisms by scrubbing

The chemical agents that make up disinfectants and antiseptics can be dissolved either in alcohol (forming a *tincture*) or water (forming an *aqueous solution*). The effectiveness of a variety of antiseptics against the normal microbial flora of the skin is shown in Figure 1.

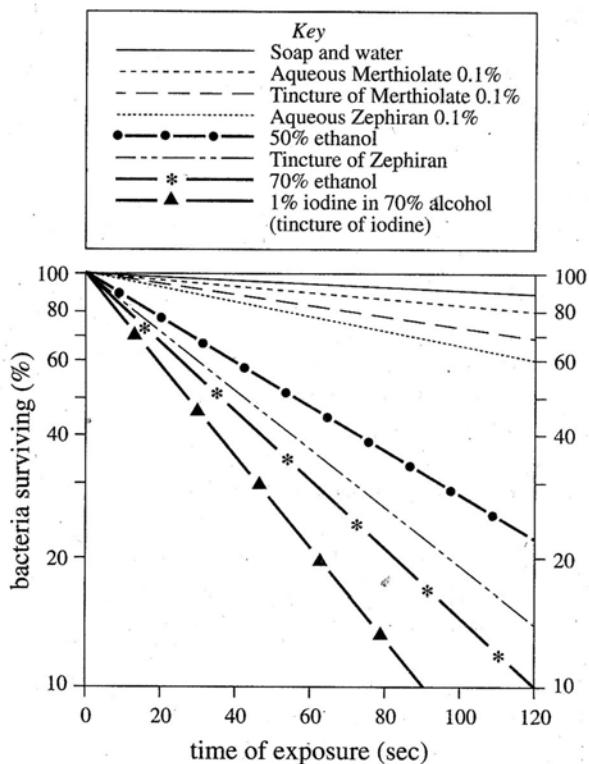


Figure 1

Table and Figure adapted from Tortora, Funke, and Case, *Microbiology: An Introduction*. ©1989 by The Benjamin/Cummings Publishing Company.

16. According to the passage, the most effective antiseptic against microorganisms is the one that leaves the:

- F. lowest percentage of surviving microorganisms in the longest time of exposure.
- G. lowest percentage of surviving microorganisms in the shortest time of exposure.
- H. highest percentage of surviving microorganisms in the longest time of exposure.
- J. highest percentage of surviving microorganisms in the shortest time of exposure.

17. According to the information presented in Table 1 and Figure 1, what conclusion about the use of alcohol as an antiseptic may be reached?

- A. Dissolving chemical agents in alcohol increases their effectiveness as antiseptics.
- B. Using 70% ethanol is ineffective as an antiseptic.
- C. Increasing the concentration of alcohol decreases its overall effectiveness as an antiseptic.
- D. The mechanism of action for alcohol as an antiseptic is unknown.

18. Is the statement "tinctures are more effective against microorganisms than aqueous solutions of the same antiseptic" supported by the information presented in Figure 1, and why?

- F. Yes, because tincture of Merthiolate is more effective against microorganisms than is aqueous Merthiolate.
- G. Yes, because 70% ethanol is more effective against microorganisms than is tincture of Zephiran.
- H. No, because soap and water is more effective against microorganisms than is 50% ethanol.
- J. No, because aqueous Zephiran is more effective against microorganisms than is tincture of Zephiran.

19. After you thoroughly wash your hands with plain soap and water for 2 minutes, your hands probably carry:

- A. the same number of bacteria as before; most are dead.
- B. the same number of bacteria as before; most are still alive.
- C. fewer bacteria than before; most are dead.
- D. fewer bacteria than before; most are still alive.

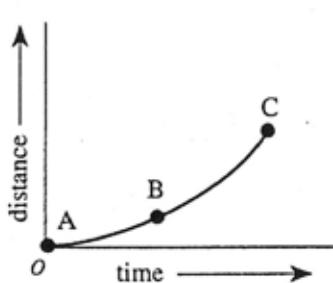
20. According to Figure 1, if a researcher prepared a disinfectant solution of 60% alcohol, the time of exposure required to kill 90% of the bacteria present would be:

- F. 60 to 80 sec.
- G. 80 to 100 sec.
- H. 100 to 120 sec.
- J. greater than 120 sec.

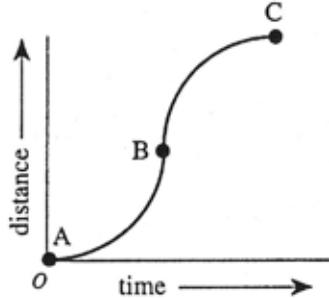
## Science - 5 question passage 5

The 3 sets of graphs below represent the motion of 3 different motorbikes on a straight track. The top graph in each set shows the distance of the motorbike from the starting line versus elapsed time. The middle graph in each set shows the velocity of the motorbike versus elapsed time. The bottom graph in each set shows the *acceleration* of the motorbike (the rate at which the motorbike's velocity changes) versus elapsed time.

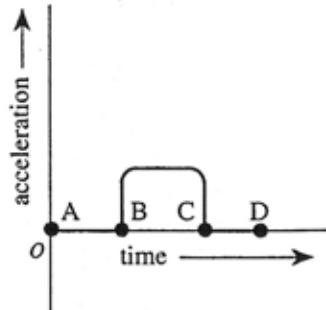
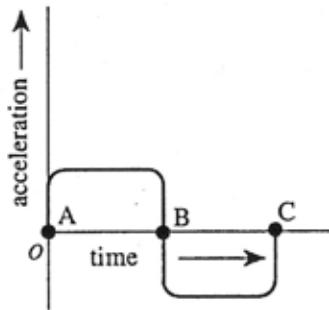
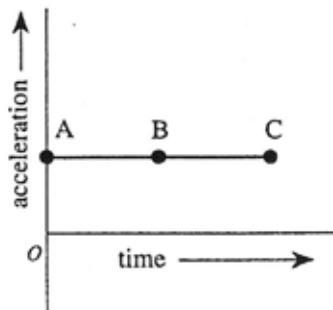
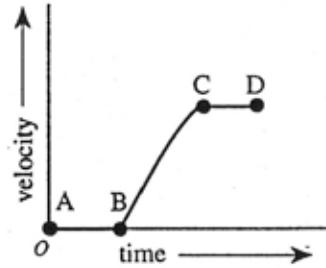
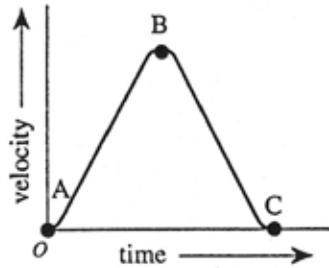
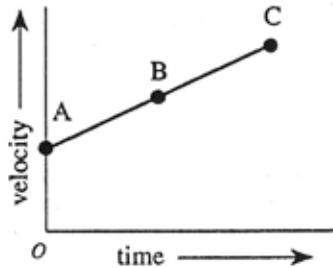
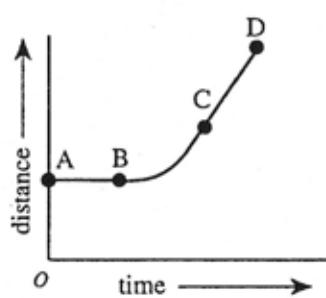
Set 1: Motorbike 1



Set 2: Motorbike 2



Set 3: Motorbike 3



21. According to the distance versus time graphs, which motorbike(s) is(are) NOT at the starting line at time = 0 ?
- F. Motorbike 1 only  
G. Motorbike 3 only  
H. Motorbikes 1 and 2 only  
J. Motorbikes 2 and 3 only
22. The graphs in Set 2 could also represent which of the following descriptions of the motion of a car traveling on a street?
- A. A car travels at a constant velocity for a period of time, then decreases in velocity until it reaches a specific velocity, and continues traveling at that velocity.  
B. A car is stopped along a curb. It then increases in velocity until it reaches a specific velocity, and continues to travel at that velocity.  
C. A car travels at a constant velocity for a period of time, then increases in velocity until it reaches a specific velocity, and continues traveling at that velocity.  
D. A car is stopped at an intersection. It then increases in velocity until it reaches a specific velocity, then immediately decreases in velocity to come to a second stop.
23. In the acceleration versus time graphs for the motorbikes, positive acceleration values are graphed above the horizontal (time) axis and negative acceleration values are graphed below the horizontal axis. The velocity of the motorbike with negative acceleration:
- F. is zero.  
G. is constant.  
H. decreases.  
J. increases.
24. When a motorbike travels forward on the track, it has positive velocity; if it were to travel in reverse, it would have negative velocity. Which of the following descriptions of motion would result in a velocity versus time graph with both positive and negative velocity values?
- A. A baseball is tossed back and forth between two people.  
B. A boulder falls off a cliff to the ground.  
C. A sandbag is passed from person to person in a line.  
D. A balloon is released and floats to the ceiling.
25. The statement "If an object's acceleration is zero during a time period, then the object's velocity is zero during that period" is contradicted by which segment of the graphs in Set 3 ?
- F. Point A to Point B only  
G. Point A to Point C only  
H. Point B to Point C only  
J. Point C to Point D only

## Science - 5 question passage 6

Table 1 lists data about metal elements arranged in order of increasing *atomic number* (the number of protons contained in one atom). The *melting point* is the temperature at which a solid metal liquefies. An electrically neutral atom has an equal number of *protons* (positively charged particles) and *electrons* (negatively charged particles). A positive *ion* is formed when an atom loses one or more electrons. The *first ionization energy* is the energy that removes one electron from the neutral atom to form a +1 ion. The atomic radius and ionic radius indicate the size of the neutral atom and of the +2 ion, respectively.

Table 1					
Element	Atomic number	Melting point (°C)	First ionization energy (kJ/mole)	Atomic radius (Å)*	Ionic radius (+2 ion, in Å)
Sc	21	1,541	631	1.44	—
Ti	22	1,660	658	1.32	1.00
V	23	1,890	650	1.22	0.93
Cr	24	1,857	652	1.18	0.87
Mn	25	1,244	717	1.17	0.81
Fe	26	1,535	759	1.17	0.75
Co	27	1,495	758	1.16	0.79
Ni	28	1,453	737	1.15	0.83
Cu	29	1,083	745	1.17	0.87
Zn	30	420	906	1.25	0.88

\*Å = angstrom =  $10^{-8}$  cm

26. When iron ore is reacted with coke and limestone at a high temperature, iron (Fe) is produced in its molten (liquid) state. At which of the following temperatures can the Fe be drained or poured out of the reactor?

- A. 759° C
- B. 1,244° C
- C. 1,495° C
- D. 1,540° C

27. Which of the following statements best describes the relationship, if any, between the atomic number and the melting point for the metals in Table 1? As the atomic number increases, the melting point:

- F. increases.
- G. decreases.
- H. decreases and then increases.
- J. shows no relationship to atomic number.

28. Which element would require the LEAST amount of energy to form a +1 ion?

- A. Sc
- B. Ti
- C. V
- D. Cr

29. For the metals listed in Table 1, which of the following statements best describes the relationship between atomic radius and ionic radius? For any element the:

- F. atom is larger than its positive ion.
- G. atom is smaller than its positive ion.
- H. size of the atom and its positive ion increases with the melting point.
- J. size of the atom and its positive ion increases with the ionization energy.

30. The *second ionization energy* is the energy needed to remove one electron from the +1 ion. For Zn, this energy is 1,733 kJ/mole. How much energy is required to change the neutral Zn atom into its +2 ion?

- A. 906 kJ/mole
- B. 1,733 kJ/mole
- C. 1,733 kJ/mole – 906 kJ/mole
- D. 1,733 kJ/mole + 906 kJ/mole

## Science - 5 question passage 7

Light causes some metals to eject electrons. The energy of those electrons, in joules (J), depends on the light frequency and the kind of metal. Figure 1 shows how the maximum energy of ejected electrons varies with frequency, in hertz (Hz), for 5 metals. Figure 2 shows how the number of electrons emitted by a metal varies with the intensity of light at a constant frequency. Figure 3 shows the maximum energy an ejected electron can have for a given intensity of light at a constant frequency.

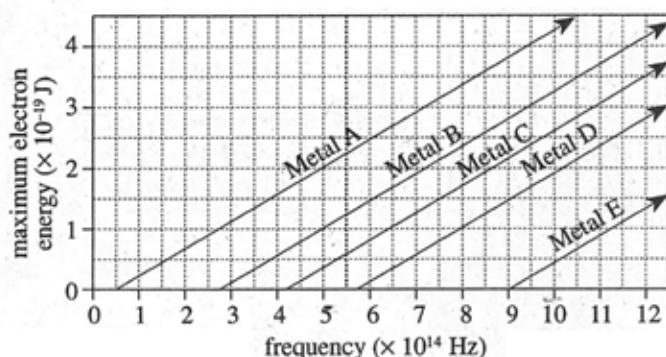


Figure 1

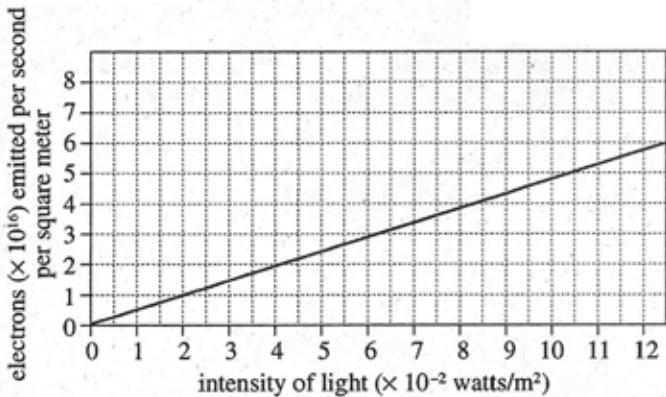


Figure 2

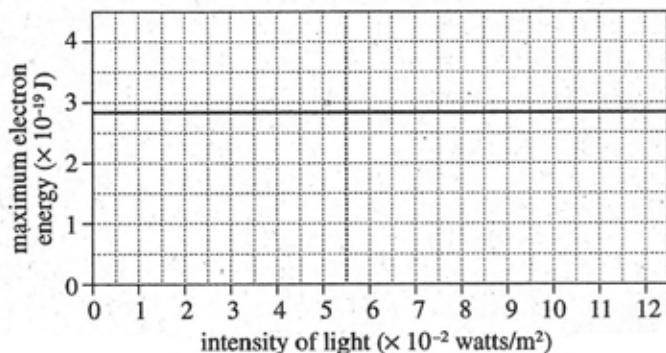


Figure 3

31. Which of the following data is represented on the x-axis of Figure 2?

- F. Frequency
- G. Intensity of light
- H. Number of electrons emitted per second
- J. Maximum energy of emitted electrons

32. The hypothesis that turning on more light will increase the number of electrons emitted per second is supported by which figure(s)?

(Note: Assume the additional light also has adequate energy to eject electrons from metals.)

- A. Figure 1 only
- B. Figure 2 only
- C. Figure 3 only
- D. Figures 2 and 3 only

33. Is the statement "The maximum energy of electrons increases with intensity" supported by the data in Figure 3?

- F. Yes, because the graph line moves to the right as the value of intensity increases.
- G. Yes, because the maximum energy of electrons increases as the value of intensity increases.
- H. No, because the same value for maximum energy is indicated for all values of intensity.
- J. No, because the line does not slope downward from left to right.

34. If the data in Figure 3 was produced by a light with a frequency of  $6.5 \times 10^{14}$  Hz, which metal was most likely used?

- A. Metal A
- B. Metal B
- C. Metal C
- D. Metal E

35. According to the data, which of the following statements best compares the frequencies of light required for both Metals A and D to produce an electron with a maximum electron energy of  $2 \times 10^{-19}$  J?

- F. The frequency required for Metal D is approximately one-quarter of that required for Metal A.
- G. The frequency required for Metal D is approximately half of that required for Metal A.
- H. The frequency required for Metal D is the same as that required for Metal A.
- J. The frequency required for Metal D is approximately twice that required for Metal A.

## Science - 5 question passage 8

Transient luminous events (TLEs) are brief flashes of light that appear above large thunderstorm clouds. A TLE is produced by a positive cloud-to-ground (+CG) lightning stroke. However, not every +CG lightning stroke is followed by a TLE. Figure 1 shows the typical shape, width, and altitudes of 3 types of TLEs—red sprites, blue jets, and elves. Table 1 shows the typical duration (in milliseconds, msec) and brightness (in kiloRayleighs, kR) of each type of TLE. Figure 2 shows the number of +CG lightning strokes of a given peak electrical current (in kiloamperes, kA) from 6 thunderstorms and the percent of those +CG lightning strokes that produced a TLE.

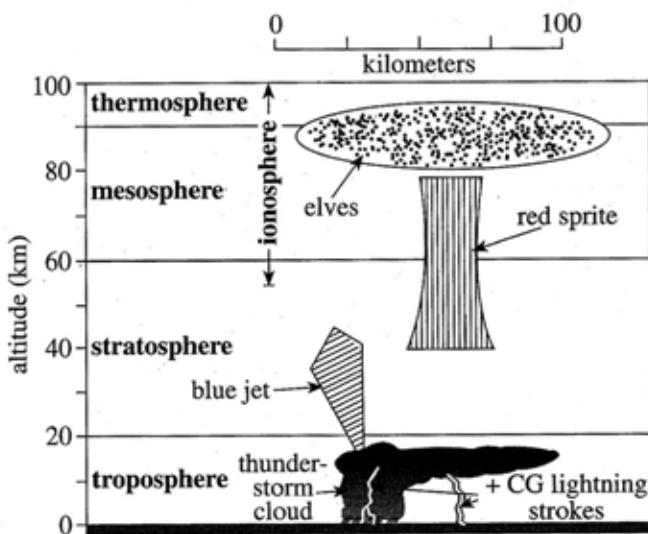


Figure 1

Table 1		
Type of TLE	Duration (msec)	Average brightness (kR)
Red sprite	10–100	10
Blue jet	100–300	800
Elves	< 1	1,000

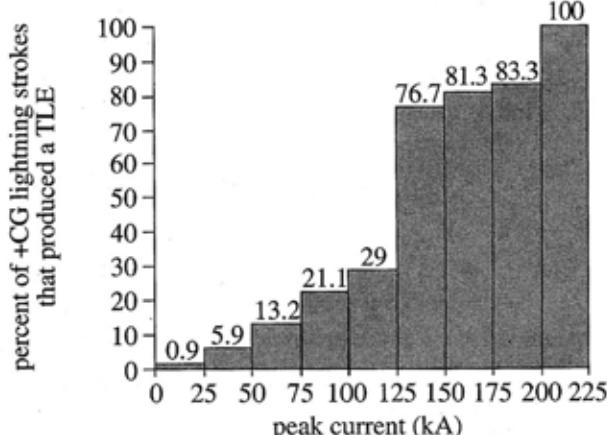
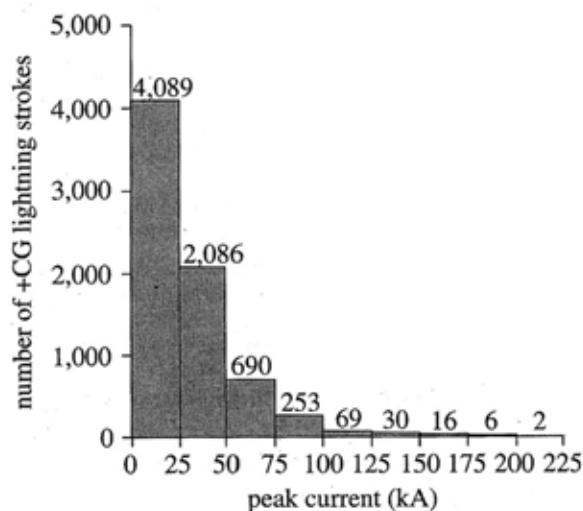


Figure 2

Figure 1 adapted from W. Lyons, R. J. Vavrek, and R. Holle, "Mysterious Flashes: Red Sprites—Blue Jets—Elves." ©2000 by the National Earth Science Teachers Association.

Figure 2 adapted from W. Lyons et al., "Characteristics of Thunderstorms and Lightning Flashes Which Produce Mesospheric Transient Luminous Events." ©1999 by the National Aeronautics and Space Administration.

36. Figure 1 defines the ionosphere as a region of the atmosphere that overlaps which of the following atmospheric layers?
- I. Mesosphere
  - II. Stratosphere
  - III. Troposphere
- A. II only  
B. III only  
C. I and II only  
D. II and III only
37. A flash was observed above a large thunderstorm cloud. The flash had a duration of 100 msec and an altitude between 50 km and 80 km. Based on Figure 1 and Table 1, that flash was most likely which of the following?
- F. A red sprite  
G. A blue jet  
H. Elves  
J. A +CG lightning stroke
38. According to Figure 2, the percent of +CG lightning strokes that produced a TLE more than doubled between which of the following 2 peak current ranges?
- A. Between 75–100 kA and 100–125 kA  
B. Between 100–125 kA and 125–150 kA  
C. Between 125–150 kA and 150–175 kA  
D. Between 175–200 kA and 200–225 kA
39. According to Figure 2, the probability that a TLE will follow a +CG lightning stroke is highest for which of the following ranges of peak currents?
- F. 25 kA to 50 kA  
G. 75 kA to 100 kA  
H. 125 kA to 150 kA  
J. 175 kA to 200 kA
40. Based on Figure 2, TLEs were produced by approximately what fraction of +CG lightning strokes with peak currents between 75 kA and 100 kA ?
- A.  $\frac{1}{2}$   
B.  $\frac{1}{3}$   
C.  $\frac{1}{4}$   
D.  $\frac{1}{5}$

## Science - 6 question passage 1

Color images of the surface of Io, one of Jupiter's moons, show plumes of gas that resemble Earth's geysers and active volcanoes that emit flows of molten material. The materials ejected from Io's volcanoes and plumes rapidly solidify at Io's cold surface temperatures. Scientists believe that these materials may be one of several allotropes (forms) of sulfur (S), or a sulfur compound. The following studies were performed to determine the composition of these materials.

### Study 1

In a laboratory, scientists measured the reflectances (the fraction of light striking a surface that is reflected by that surface) of 4 allotropes of S (red, white, orange, and brown) and of a sulfur compound (sulfur dioxide [ $\text{SO}_2$ ]). Reflectances were measured at visible-light wavelengths between  $0.35 \mu\text{m}$  (micrometers) and  $0.60 \mu\text{m}$ . Figure 1 shows the data for the various S allotropes and for  $\text{SO}_2$ .

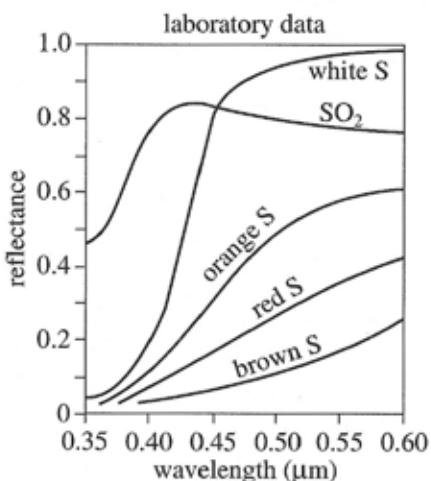


Figure 1

Io's whole-disk reflectance (the reflectance of Io's entire visible surface measured all at once) was measured at 2 different times. Figure 2 shows these data along with reflectance data calculated using a computer model. This model shows what combination of materials from Figure 1 would produce the closest match to the measured reflectance data. According to the model, the overall composition of Io's surface is 15%  $\text{SO}_2$ , 50% orange S, 20% red S, and 15% white S.

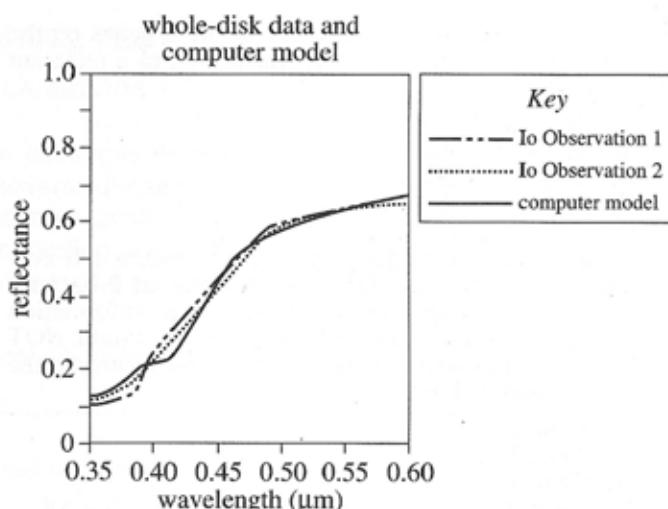


Figure 2

### Study 2

At 2 different times, reflectances were measured of the crater floors of 2 volcanoes on Io: Pele and Surt. Figure 3 shows the reflectance data.

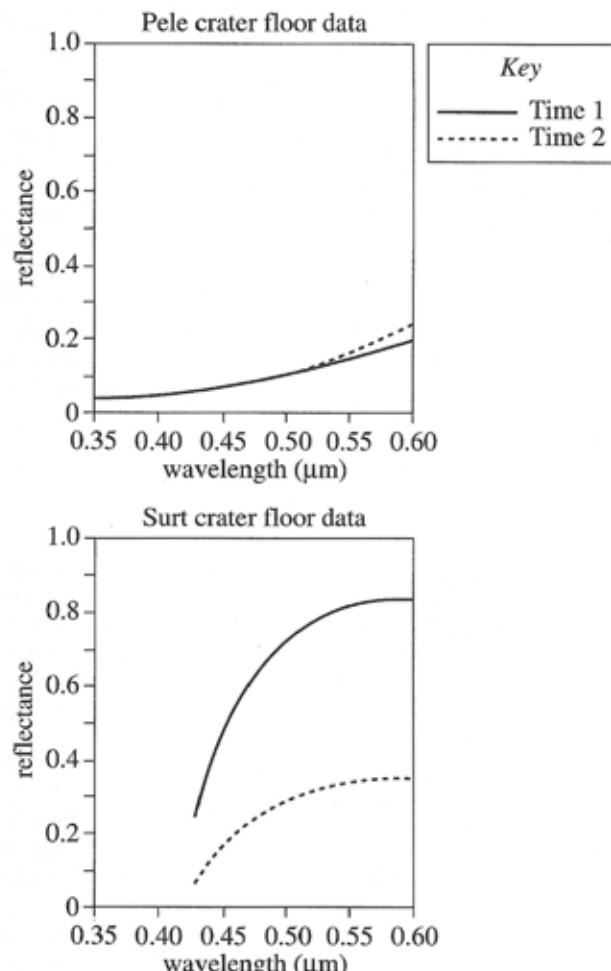


Figure 3

***Study 3***

Reflectance data were taken from several large plumes and several small plumes on Io. The averaged data are in Figure 4.

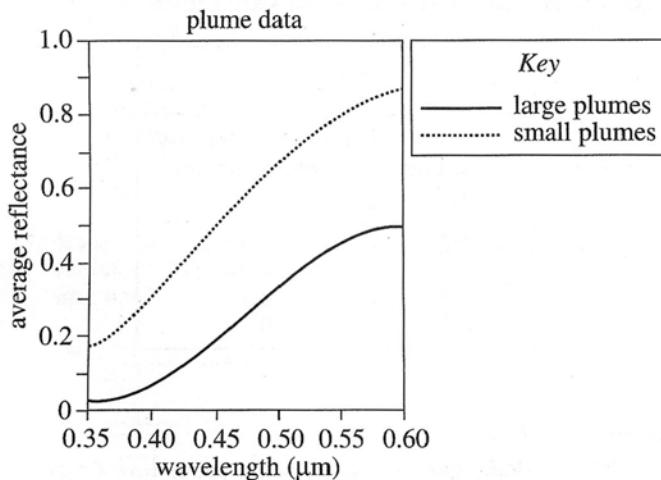


Figure 4

Figures 1, 3, and 4 adapted from Alfred McEwen and Laurence Soderblom, "Two Classes of Volcanic Plumes on Io." ©1983 by Academic Press, Inc.

Figure 2 adapted from Julianne Moses and Douglas Nash, "Phase Transformations and the Spectral Reflectance of Solid Sulfur: Can Metastable Sulfur Allotropes Exist on Io?" ©1991 by Academic Press, Inc.

1. At the wavelengths used in Study 1, as the wavelength of the light increases, the reflectances of the S allotropes and of SO<sub>2</sub> do which of the following?

- |   |   |
|---|---|
| <u>S allotropes</u><br><b>F.</b> Increase only<br><b>G.</b> Increase only<br><b>H.</b> Decrease only<br><b>J.</b> Decrease only | <u>SO<sub>2</sub></u><br>Increase only<br>Increase, then decrease<br>Decrease only<br>Increase, then decrease |
|---|---|

2. According to Study 3, compared with the corresponding average reflectance for small plumes, large plumes on Io have an average reflectance at a given wavelength that is:

- A. always higher.
- B. always the same.
- C. always lower.
- D. sometimes higher and sometimes lower.

3. According to Study 1, the reflectance of white S at a wavelength of 0.40 μm is closest to which of the following?

- F. 0.0
- G. 0.1
- H. 0.2
- J. 0.3

4. According to Study 1 and Study 2, the crater floor of the volcano Pele has reflectances most similar to which of the following S allotropes?

- A. White S
- B. Orange S
- C. Red S
- D. Brown S

5. If the averaged reflectances for large plumes and for small plumes had been measured at a wavelength of 0.61 μm in Study 3, those reflectances would have been closest to which of the following?

	<u>Large plumes</u>	<u>Small plumes</u>
<b>F.</b>	0.2	0.5
<b>G.</b>	0.5	0.2
<b>H.</b>	0.5	0.9
<b>J.</b>	0.9	0.5

6. According to Study 1, white S has a reflectance of 0.98 at a wavelength of 0.60 μm. This means that white S reflects:

- A. 2% of the 0.60 μm wavelength light that strikes its surface.
- B. 98% of the 0.60 μm wavelength light that strikes its surface.
- C. 2% of all the visible light that strikes its surface.
- D. 98% of all the visible light that strikes its surface.

## Science - 6 question passage 2

An electrical circuit contained a 12-volt (V) battery, a *resistor* (a device that resists the flow of electricity), a *capacitor* (a device that stores electrical charge and electrical energy), a *voltmeter* (an instrument for measuring voltage), and a switch, as shown in Figure 1.

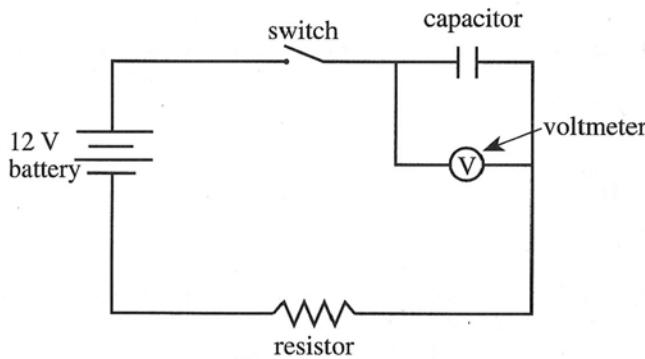


Figure 1

Some students studied the behavior of the circuit.

### Experiment 1

The students used a  $1 \times 10^7$  ohm ( $\Omega$ ) resistor and a capacitor with a *capacitance* of  $1 \times 10^{-6}$  farad (F). (Capacitance is a measure of the maximum amount of electrical charge and electrical energy a capacitor can store.) The capacitor was initially uncharged. At time zero, the students simultaneously closed the switch and started a stopwatch. At time zero and at 12 sec intervals thereafter, they recorded the voltage across the capacitor. Their results are shown in Table 1.

Table 1	
Time (sec)	Voltage across capacitor (V)
0	0.0
12	8.4
24	10.9
36	11.7
48	11.9
60	12.0

### Experiment 2

Using the  $1 \times 10^7 \Omega$  resistor and several different capacitors, the students determined the length of time from when the switch was closed until the voltage across the capacitor reached 6 V. Their results are shown in Table 2.

Table 2	
Capacitance ( $\times 10^{-6}$ F)	Time to reach 6 V across capacitor (sec)
1.2	8.3
0.6	4.2
0.3	2.1
0.1	0.7

### Experiment 3

The students conducted the same procedure described in Experiment 2, except that they used a constant capacitance of  $1 \times 10^{-6}$  F and several different resistors. Their results are shown in Table 3.

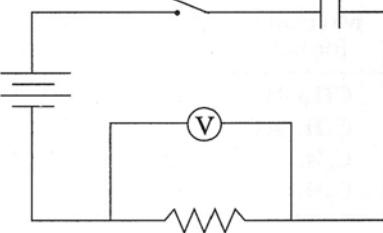
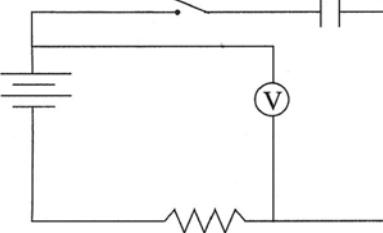
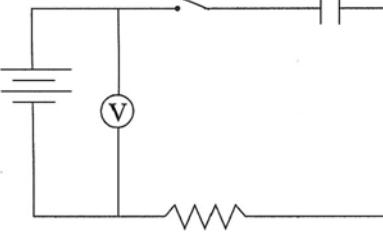
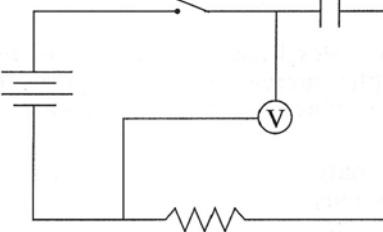
Table 3	
Resistance ( $\times 10^7 \Omega$ )	Time to reach 6 V across capacitor (sec)
0.75	5.2
0.50	3.5
0.25	1.7

7. In Experiment 1, the *time constant* of the circuit was the time required for the voltage across the capacitor to reach approximately 7.6 V. The time constant of the circuit used in Experiment 1 was:

- F. less than 12 sec.
- G. between 12 sec and 24 sec.
- H. between 24 sec and 36 sec.
- J. greater than 36 sec.

8. If, in Experiment 2, a  $1.5 \times 10^{-6}$  F capacitor had been used, the time required for the voltage across the capacitor to reach 6 V would have been closest to:

- A. 4.2 sec.
- B. 7.0 sec.
- C. 10.5 sec.
- D. 15.0 sec.

9. The main purpose of Experiment 3 was to determine how varying the:
- F. battery's voltage affected the resistor's resistance at a given time.
  - G. capacitor's capacitance affected the time required for the voltage across the capacitor to reach a set value.
  - H. capacitor's capacitance affected the voltage across the battery at a given time.
  - J. resistor's resistance affected the time required for the voltage across the capacitor to reach a set value.
10. Based on Figure 1, to measure the voltage across the resistor only, which of the following circuits should one use?
- A. 
  - B. 
  - C. 
  - D. 
11. Consider a circuit like that shown in Figure 1. Based on Experiments 2 and 3, the voltage across the capacitor will reach a given value in the shortest amount of time if the circuit contains which of the following capacitances and resistances, respectively?
- F.  $0.1 \times 10^{-6}$  F,  $0.3 \times 10^7$  Ω
  - G.  $0.1 \times 10^{-6}$  F,  $1.0 \times 10^7$  Ω
  - H.  $1.2 \times 10^{-6}$  F,  $0.3 \times 10^7$  Ω
  - J.  $1.2 \times 10^{-6}$  F,  $1.0 \times 10^7$  Ω
12. Consider the following hypothesis: In a circuit arranged as in Figure 1 containing a battery, a capacitor, and a constant resistance, as capacitance increases, the time required to reach a given voltage across the capacitor increases. Do the experiments support this hypothesis?
- A. Yes; in Experiment 1, as capacitance increased, the time required to reach a given voltage increased.
  - B. Yes; in Experiment 2, as capacitance increased, the time required to reach a given voltage increased.
  - C. No; in Experiment 1, as capacitance increased, the time required to reach a given voltage decreased.
  - D. No; in Experiment 2, as capacitance increased, the time required to reach a given voltage decreased.

## Science - 6 question passage 3

The clearing of rain forests results in *forest fragmentation* (the breakup of large forest tracts into small patches). Researchers predicted that fragmentation would result in a decrease in animal populations and *aboveground tree biomass* (AGTB) in the resulting fragments. They did 4 studies to test this prediction.

### Study 1

The researchers monitored the AGTB of twenty-five 100 m × 100 m forest plots near areas that had recently been cleared of vegetation. The distance from the center of each plot to the nearest clearing was measured. Figure 1 shows the average change per plot in AGTB in metric tons per year (t/yr) over 17 yr.

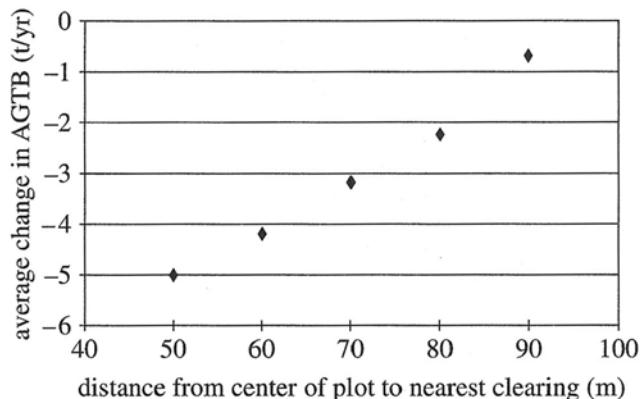


Figure 1

### Study 2

Twenty-five 100 m × 100 m forest plots were monitored as in Study 1. The center of each of these plots was at least 500 m from the nearest clearing. The average change in AGTB over 17 yr for these 25 plots was 0 t/yr.

### Study 3

Researchers monitored sixteen 100 m × 100 m forest plots near areas that had recently been cleared of vegetation. Each plot was bordered on 1 side by a clearing. Figure 2 shows the average cumulative percent change in AGTB at these plots following fragmentation. (Note: Year 0 represents results prior to fragmentation.)

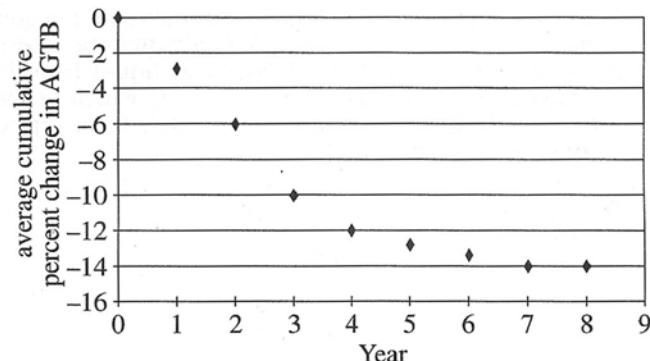


Figure 2

### Study 4

Researchers trapped and released birds in 10 forest fragments adjacent to areas that had recently been cleared of vegetation. Three types of birds were monitored: insectivores, frugivores (fruit eaters), and hummingbirds. Figure 3 shows the number of captures per 1,000 hours (hr) of trapping. (Note: Year 0 represents results prior to fragmentation.)

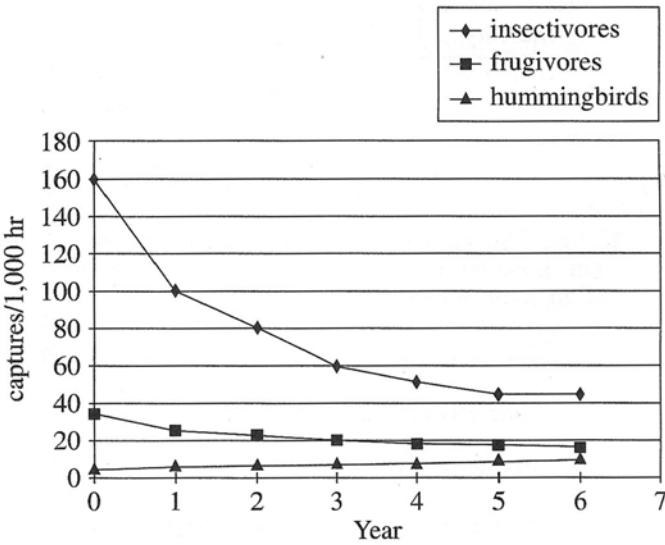


Figure 3

Figures adapted from William F. Laurance et al., "Biomass Collapse in Amazonian Forest Fragments." ©1998 by the American Association for the Advancement of Science.

13. In Study 4, as time increased from Year 0 to Year 6, the captures/1,000 hr of frugivores:
- F. decreased only.
  - G. increased only.
  - H. decreased, then increased.
  - J. increased, then decreased.
14. Based on the results of Study 4, how did fragmentation most likely affect the population sizes of insectivores and hummingbirds in the fragments studied?
- A. Fragmentation increased the population sizes of both insectivores and hummingbirds.
  - B. Fragmentation decreased the population sizes of both insectivores and hummingbirds.
  - C. Fragmentation increased the population size of insectivores and decreased the population size of hummingbirds.
  - D. Fragmentation decreased the population size of insectivores and increased the population size of hummingbirds.
15. Based on the results of Study 1, if the distance from the center of a  $100\text{ m} \times 100\text{ m}$  plot were 75 m from the nearest clearing, the expected average change in AGTB at the plot over 17 yr would be closest to which of the following values?
- F.  $-1.1\text{ t/yr}$
  - G.  $-2.6\text{ t/yr}$
  - H.  $+1.1\text{ t/yr}$
  - J.  $+2.6\text{ t/yr}$
16. After examining the results of Study 2, a student concluded that the AGTB at each of the 25 plots remained constant. Which of the following alternative explanations is also consistent with the results?
- A. The AGTB at all 25 plots increased.
  - B. The AGTB at all 25 plots decreased.
  - C. The AGTB at some of the plots increased and the AGTB at some of the plots decreased.
  - D. The AGTB at plots bounded by forest increased and the AGTB at plots bounded by clearings remained constant.
17. Which of the following sets of results from the studies is *least* consistent with the prediction proposed by the researchers?
- F. The results of Study 1 for AGTB
  - G. The results of Study 3 for AGTB
  - H. The results of Study 4 for frugivores
  - J. The results of Study 4 for hummingbirds
18. In Study 4, the researchers trapped birds for 10,000 hr per year. Thus, how many insectivores were trapped in Year 2?
- A. 80
  - B. 100
  - C. 800
  - D. 1,000

## Science - 6 question passage 4

**Osmosis** is the movement of H<sub>2</sub>O molecules from regions of high H<sub>2</sub>O concentrations to regions of lower H<sub>2</sub>O concentrations through a *semipermeable membrane* (a barrier with pores that allows only H<sub>2</sub>O molecules to pass). See Figure 1. Equal volumes of H<sub>2</sub>O and a sugar-H<sub>2</sub>O solution are separated in a U-shaped tube. Equilibrium is reached when the rate of H<sub>2</sub>O movement is the same in both directions. The *osmotic pressure* is the pressure that, if exerted on the solution, prevents osmosis.

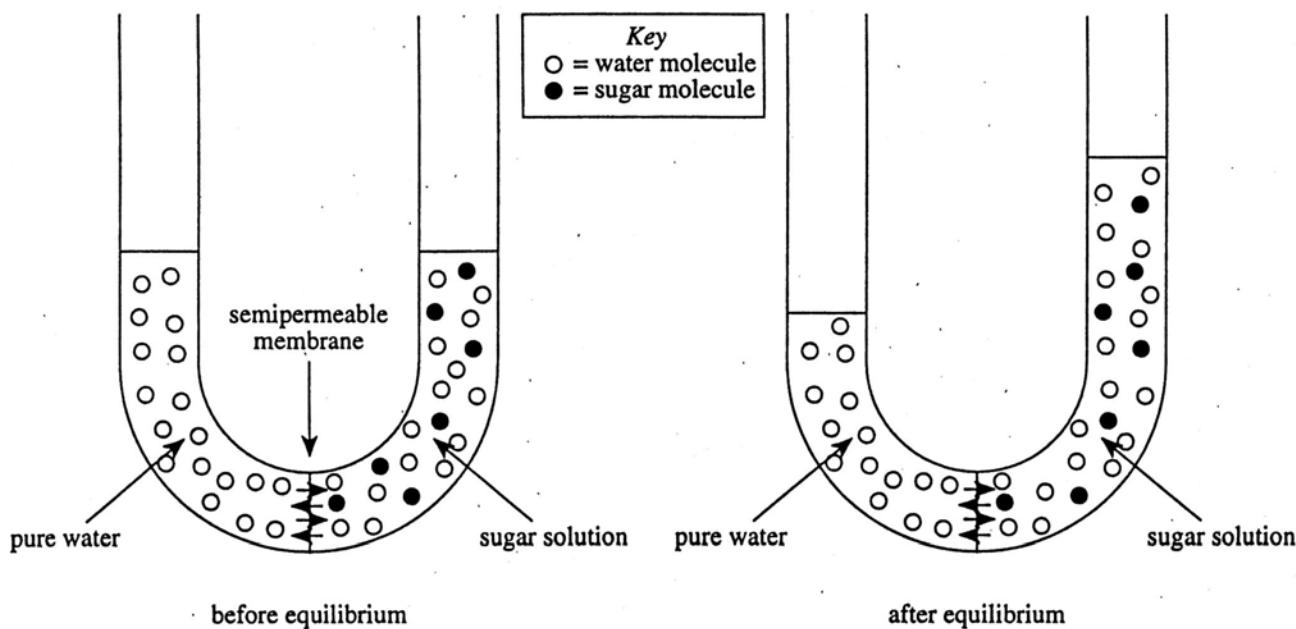


Figure 1

### Experiment 1

The osmotic pressure of sugar solutions was measured at different temperatures with a cellophane membrane. Initial and equilibrium (final) concentrations in moles per liter (mol/L) of the solutions are shown in Table 1.

Table 1

Initial concentration (mol/L)	Osmotic pressure (atm)* of initial solution at:			Final concentration (mol/L)
	0° C	20° C	40° C	
0.1	2.5	2.6	2.7	0.01
0.2	4.7	5.1	5.2	0.02
0.4	9.4	10.4	10.6	0.04
0.6	14.4	15.4	16.1	0.06

\*atm = atmospheres

### Experiment 2

Experiment 1 was repeated with NaCl (salt) solutions instead of sugar solutions. The results are in Table 2.

Table 2

Initial concentration (mol/L)	Osmotic pressure (atm)* of initial solution at:			Final concentration (mol/L)
	0° C	20° C	40° C	
0.1	5.0	5.4	5.4	0.01
0.2	9.3	10.2	10.6	0.02
0.4	17.8	19.6	21.4	0.04
0.6	27.6	29.8	31.7	0.06

Note: NaCl dissociates into Na<sup>+</sup> and Cl<sup>-</sup> ions in solution.

**Experiment 3**

Red blood cells were exposed to solutions of varying salt concentrations at 20° C. The effects on the cells are in Table 3.

Table 3

% salt	Response of cells
0.0	swelled
0.3	swelled
0.6	swelled
0.9	no effect
1.2	shrunk
1.5	shrunk

19. An *isotonic* solution is one that has the same osmotic pressure as the inside of a cell. From the results of Experiment 3, one would expect that which of the following salt solutions was isotonic?

- F. 0.3%
- G. 0.6%
- H. 0.9%
- J. 1.2%

20. In which one of the following ways is the design of Experiments 1 and 2 different?

- A. Osmotic pressure was measured at equilibrium in Experiment 1, but not in Experiment 2.
- B. Temperature was varied in Experiment 1, but not in Experiment 2.
- C. The solutions tested in Experiment 1 were more concentrated than the solutions tested in Experiment 2.
- D. Sugar solutions were tested in Experiment 1 and salt solutions were tested in Experiment 2.

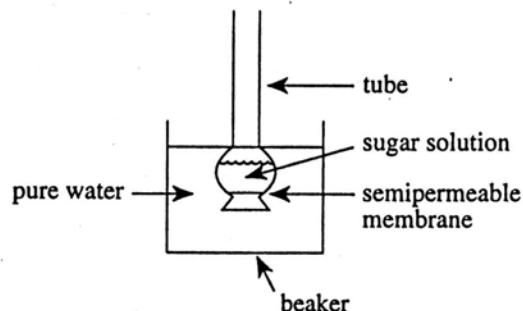
21. If the chemist had repeated Experiment 1 using an initial sugar solution with a concentration of 0.8 mol/L, one would predict that the osmotic pressure at 20° C would be greater than:

- F. 2.6 atm, but less than 5.1 atm.
- G. 5.1 atm, but less than 10.4 atm.
- H. 10.4 atm, but less than 15.4 atm.
- J. 15.4 atm.

22. From the experimental results, one can conclude that which of the following factors affect(s) a solution's osmotic pressure?

- I. Type of solution
  - II. Temperature of solution
  - III. Concentration of solution
- A. III only
  - B. I and II only
  - C. II and III only
  - D. I, II, and III

23. A chemist set up an osmosis experiment as shown in the diagram below. The same type of membrane as in Experiments 1 and 2 was used. How will the liquid levels in the tube and the container be affected?



- F. The level in the tube will fall and the level in the container will rise.
- G. The level in the tube will rise and the level in the container will fall.
- H. Levels in both the tube and the container will rise.
- J. Levels in both the tube and the container will fall.

24. Which of the following hypotheses about the changes in the concentrations of the solutions used in Experiments 1 and 2 is consistent with the experimental results? The concentrations of the solutions:

- A. decreased due to water molecules moving into the solution side of the U-tube.
- B. decreased due to water molecules moving out of the solution side of the U-tube.
- C. decreased due to sugar molecules or salt ions moving out of the solution side of the U-tube.
- D. increased due to water molecules moving into the pure water side of the U-tube.

## Science - 6 question passage 5

Rain causes *sediment runoff* (erosion) of rangelands, which is affected by vegetation (grasses, leaves, and branches) and animal trampling. Scientists conducted 2 experiments using identical-sized plots of soil with slight slopes. Two soils that differed primarily in their sand content were used. Soil 1 contained 60% sand and Soil 2 contained 25% sand. Sprinklers simulated rainfall. It was noted that rain first collected in soil depressions, such as hoofprints, then overflowed and eroded the soil. Sediment runoff was measured at the bases of the plots in grams per square meter ( $\text{g/m}^2$ ), following 1 hour of rain.

### Experiment 1

Vegetation cover was simulated using window screens having various mesh sizes. The larger the number of mesh squares per inch, the greater the simulated vegetation cover. One plot was left uncovered, and screens of various mesh sizes covered the other plots. Table 1 shows the sediment runoff from each plot.

Table 1				
Soil	Sediment runoff ( $\text{g/m}^2$ ) with a simulated vegetation cover of:			
	0%	30%	50%	70%
1	947	751	572	492
2	378	331	291	200

### Experiment 2

Animal trampling was simulated by leading a 500-kilogram (kg) cow back and forth over 2 plots of each soil type until 30% of one and 60% of the other were covered with hoofprints. One additional plot of each soil type was left untrampled. Rainfall was simulated as in Experiment 1. The depth of water stored in hoofprints, in centimeters (cm), is shown in Table 2, and the sediment runoff produced by erosion is shown in Table 3.

Table 2				
Soil	Water stored (cm) in hoofprints on plot that was:			
	0% trampled	30% trampled	60% trampled	
1	0	0.67	0.79	
2	0	0.65	0.52	

Table 3			
Soil	Sediment runoff ( $\text{g/m}^2$ ) from plot that was:		
	0% trampled	30% trampled	60% trampled
1	347	730	801
2	282	307	311

Tables adapted from G. Gifford and M. Savabi, "Effects of Simulated Canopy Cover and Animal Disturbances on Rill and Interrill Erosion." ©1989 by the American Water Resources Association.

25. Which of the following assumptions was made in the design of Experiment 1?

- A. All soils will show the same amount of erosion under the same conditions.
- B. Sprinklers do not adequately simulate actual rainfall.
- C. Grass is more important than trees in preventing sediment runoff.
- D. Simulated plant cover acts like natural plant cover in protecting the soil from erosion by water.

26. According to the results of Experiments 1 and 2, one can minimize soil erosion by:

- F. increasing plant cover, decreasing the amount of trampling, and using land covered with Soil 2.
- G. increasing plant cover, decreasing the amount of trampling, and using land covered with Soil 1.
- H. decreasing plant cover, increasing the amount of trampling, and using land covered with Soil 2.
- J. decreasing plant cover, decreasing the amount of trampling, and using land covered with either soil.

27. If Experiment 2 were repeated using a different soil containing 50% sand, which of the following would be the expected water storage in soil hoofprints and sediment runoff on a plot subjected to 60% trampling?
- A. 0.89 cm water stored; 321 g/m<sup>2</sup> sediment runoff
  - B. 0.86 cm water stored; 932 g/m<sup>2</sup> sediment runoff
  - C. 0.71 cm water stored; 700 g/m<sup>2</sup> sediment runoff
  - D. 0.56 cm water stored; 295 g/m<sup>2</sup> sediment runoff
28. In Experiment 2, after 30% trampling, water stored in the two soil types was similar, but sediment runoff was not. Which of the following statements is the most likely explanation for the difference in sediment runoff?
- F. Water stored in hoofprints has a significant relationship to sediment runoff.
  - G. Water in soil hoofprints evaporates before it can erode the soil.
  - H. A soil with a smaller percent sand is less susceptible to erosion than soil with a higher percent sand.
  - J. Sediment carried from higher areas of the plot is trapped in soil depressions.
29. If Experiment 1 were repeated using a soil containing 50% sand with 70% plant cover, which of the following would be closest to the expected sediment runoff from this soil?
- A. 175 g/m<sup>2</sup>
  - B. 200 g/m<sup>2</sup>
  - C. 425 g/m<sup>2</sup>
  - D. 500 g/m<sup>2</sup>
30. To further investigate the effect of vegetation cover on soil erosion, the scientists should repeat Experiment:
- F. 1, using plots planted with different grasses.
  - G. 1, using no window screen.
  - H. 2, using plots with steeper slopes.
  - J. 2, using a third soil type.

## Science - 6 question passage 6

Marble, which can be used to make buildings, is composed mostly of *calcium carbonate*. Marble is *corroded* (broken down) by air pollutants such as *fly ash*, *nitric acid*, and *sulfuric acid*.

- Fly ash contains corrosive materials.
- Nitric acid, produced when *nitrogen dioxide* reacts with water, reacts with calcium carbonate to form *calcium nitrate*.
- Sulfuric acid, produced when *sulfur dioxide* reacts with air and water, reacts with calcium carbonate to form *calcium sulfate*.

A scientist studied marble corrosion.

### Experiment 1

The scientist measured the *initial mass* of 4 samples from the same piece of marble. Each sample had a surface area of 24 square centimeters ( $\text{cm}^2$ ). The scientist placed each sample in a separate container and added an acid solution (acid and water) with an acid concentration of either 30 parts per million (ppm) or 100 ppm. After 24 hours, the scientist removed each sample, scraped off the calcium nitrate or calcium sulfate, and measured the *final mass* of the sample. The scientist determined the mass of marble lost from each sample, in milligrams (mg), as shown in Table 1.

Table 1			
Marble sample	Acid		Mass of marble lost (mg)
	type	concentration (ppm)	
1	sulfuric acid	30	10.9
2		100	56.2
3	nitric acid	30	4.0
4		100	4.3

### Experiment 2

The scientist obtained marble samples from buildings of different ages. The outer surface of each sample had a gray crust of calcium sulfate, calcium nitrate, and fly ash. The concentrations of calcium sulfate and calcium nitrate in the crust were determined, as shown in Table 2.

Table 2			
Marble sample	Age of building (years)	Calcium sulfate concentration (ppm)	Calcium nitrate concentration (ppm)
5	7	30	3
6	50	200	10
7	100	375	15
8	200	400	16

31. According to the information in the passage, a sample of marble from which of the following buildings would be expected to have the greatest concentration of calcium nitrate on its surface?
- A 10-year-old building in a city with low levels of nitrogen dioxide in the atmosphere
  - A 10-year-old building in a city with high levels of nitrogen dioxide in the atmosphere
  - A 25-year-old building in a city with low levels of nitrogen dioxide in the atmosphere
  - A 25-year-old building in a city with high levels of nitrogen dioxide in the atmosphere

32. In Experiment 1, which of the following factors was the *same* for all 4 marble samples?
- F. Type of acid used  
G. Concentration of acid used  
H. Initial surface area of the sample  
J. Final mass of the sample
33. A comparison of the results for Samples 1 and 3 supports the hypothesis that marble corrodes more quickly when exposed to:
- A. sulfuric acid than when exposed to nitric acid.  
B. nitric acid than when exposed to sulfuric acid.  
C. sulfuric acid with a concentration of 30 ppm than sulfuric acid with a concentration of 100 ppm.  
D. nitric acid with a concentration of 30 ppm than nitric acid with a concentration of 100 ppm.
34. In Experiment 1, if the scientist had added nitric acid with a concentration of 50 ppm to a sample of marble with a surface area of  $24 \text{ cm}^2$ , approximately how much marble would have been lost after 24 hours?
- F. 3.0 mg  
G. 4.1 mg  
H. 4.5 mg  
J. 8.4 mg
35. If the scientist were to repeat Experiment 1, but break every sample of marble into 4 pieces to increase the surface area exposed to the acid, how would the mass of marble lost most likely be affected?
- A. The mass of marble lost would decrease for all 4 samples.  
B. The mass of marble lost would decrease for Samples 1 and 2 and increase for Samples 3 and 4.  
C. The mass of marble lost would stay the same for all 4 samples.  
D. The mass of marble lost would increase for all 4 samples.
36. According to the passage, if a scientist wants to study the effect of nitrogen dioxide on marble corrosion, the scientist should measure the amount of which of the following substances on the surface of the marble?
- F. Fly ash  
G. Sulfuric acid  
H. Calcium sulfate  
J. Calcium nitrate

## Science - 6 question passage 7

Solutions containing the purple permanganate ion ( $MnO_4^-$ ) absorb visible light. The amount of light absorbed can be measured by a spectrometer. White visible light contains light of all colors, and each color is characterized by its *wavelength*. When light passes through a colored solution only certain colors or wavelengths are absorbed. The absorbance measured varies with each wavelength and also depends on the amount of  $MnO_4^-$  present in the solution. Absorbance readings are always adjusted for the absorbance of the *blank* (a solution prepared in the same way as the test solution except it does not contain  $MnO_4^-$ ).

### Experiment 1

Four standard solutions (solutions containing known concentrations of  $MnO_4^-$ ) were prepared by dissolving a permanganate compound in acid. They were analyzed by a spectrometer at a wavelength of 530 nm (nanometers). The results are in Figure 1.

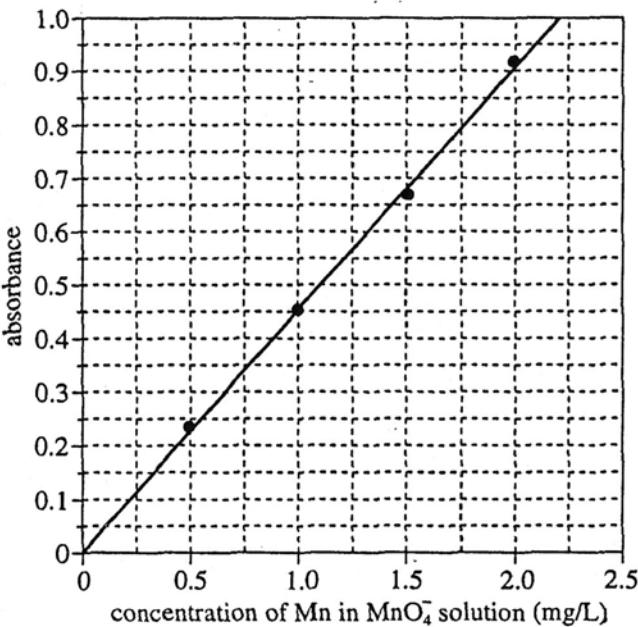


Figure 1

### Experiment 2

Five kinds of steel pipe (A–E), all containing 0.2 to 2.0% of manganese metal (Mn), were obtained. Equal sections of each pipe were cut and their masses determined. The samples were dissolved in acid to react with the metal to form colorless manganese ion ( $Mn^{+2}$ ). An oxidant was added to chemically react with the  $Mn^{+2}$  and convert it to  $MnO_4^-$ . The solutions were then diluted with water to a total volume of 1 liter (L). The resulting test solutions were analyzed at the same wavelength used in Experiment 1. The results are in Table 1. A blank was prepared using a steel pipe containing no Mn and analyzed in the same manner. The blank had an absorbance of 0.015.

Table 1		
Pipe	Mass of steel sample (mg*)	Adjusted absorbance of test solution
A	231	0.850
B	229	0.730
C	235	0.550
D	231	0.500
E	233	0.320

\*milligrams

37. Which of the following is the sequence of steps that was used to produce the test solutions for Experiment 2?

- A. Steel pipe sample + water + acid + oxidant  $\rightarrow$  test solution
- B. Steel pipe sample + acid + water + oxidant  $\rightarrow$  test solution
- C. Steel pipe sample + water + oxidant + acid  $\rightarrow$  test solution
- D. Steel pipe sample + acid + oxidant + water  $\rightarrow$  test solution

38. Why did the chemist treat the test solutions in Experiment 2 with oxidant before the test solutions were analyzed, although the standard solutions prepared in Experiment 1 were treated only with acid?

- F. The Mn in the test solutions would not dissolve in acid.
- G. The Mn in the test solutions could not be compared to the standard solutions unless it was converted to  $MnO_4^-$ .
- H. The Mn in the test solutions could not be compared to the standard solutions unless it was converted to  $Mn^{+2}$ .
- J. The Mn in the standard solutions would dissolve only in acid.

39. If not enough oxidant is added to convert all the  $Mn^{+2}$  to  $MnO_4^-$  in Experiment 2, how would the value of the absorbance be affected? The value of the absorbance would be:

- A. the same as if all the  $Mn^{+2}$  is converted, because the same mass of Mn is present.
- B. the same as if all the  $Mn^{+2}$  is converted, because the wavelength is the same.
- C. less than if all the  $Mn^{+2}$  is converted.
- D. greater than if all the  $Mn^{+2}$  is converted.

40. According to Experiment 2, which steel pipe has the highest content of Mn ?
- F. Pipe A  
G. Pipe B  
H. Pipe C  
J. Pipe D
41. A comparison of the absorbance readings obtained in Experiment 2 with the information in Figure 1 suggests that the concentration of Mn, in mg/L, of Sample D is closest to which of the following values?
- A. 0.50  
B. 0.73  
C. 1.10  
D. 2.25
42. Copper (Cu) forms a blue solution of Cu<sup>+2</sup> ions when dissolved in acid. Blue solutions absorb light at 675 nm. What changes in procedure would be necessary if a metal pipe containing Cu rather than Mn was analyzed using a spectrometer?
- F. The spectrometer would be set at 530 nm for the standard solutions containing Cu<sup>+2</sup> ions and for the metal pipe test solution.  
G. The spectrometer would be set at 530 nm for the standard solutions containing Cu<sup>+2</sup> ions and at 675 nm for the metal pipe test solution.  
H. The spectrometer would be set at 675 nm for the standard solutions containing Cu<sup>+2</sup> ions and at 530 nm for the metal pipe test solution.  
J. The spectrometer would be set at 675 nm for the standard solutions containing Cu<sup>+2</sup> ions and for the metal pipe test solution.

## Science - 6 question passage 8

Polarity is a measure of the separation of charge in a molecule. Molecules are attracted to other molecules based on polarity. In *liquid column chromatography*, a mixture is carried by the flow of solvent through a glass column containing an adsorbent material. If the components of the mixture have different polarities, they will interact differently with the solvent and adsorbent, causing the mixture to separate into its components. When the components *elute* (exit) from the column, they pass through a detector (see Figure 1).

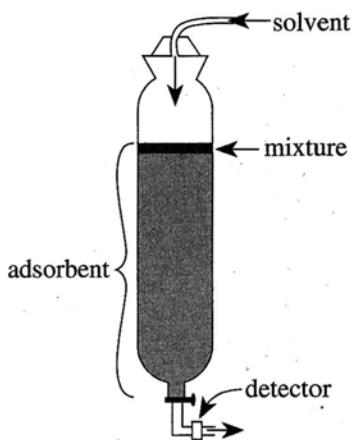


Figure 1

The following experiments were done to study how using solvents and adsorbents of differing polarities affects the separation of a mixture. A component's *elution time* is the time it takes (from the start of the flow) for 100% of the component to be eluted. Table 1 shows the relative polarities (0 being nonpolar and 10 being extremely polar) of the components of the mixture and of the solvents used.

Table 1	
Substance	Polarity
Component	
A	5.6
B	4.2
C	1.1
D	0.4
Solvent	
I	8.2
II	4.1
III	0.2

### Experiment 1

A glass column 50 cm tall and 7 cm in diameter was packed with 3 kg of a *normal-phase* (highly polar) adsorbent. A mixture containing 0.2 g each of Components A–D was dissolved and then added to the top layer of the adsorbent. Solvent I was then allowed to flow through the column at a constant rate. The % *eluted* of each component was measured for 50 min. The procedure was repeated using Solvents II and III (see Figure 2).

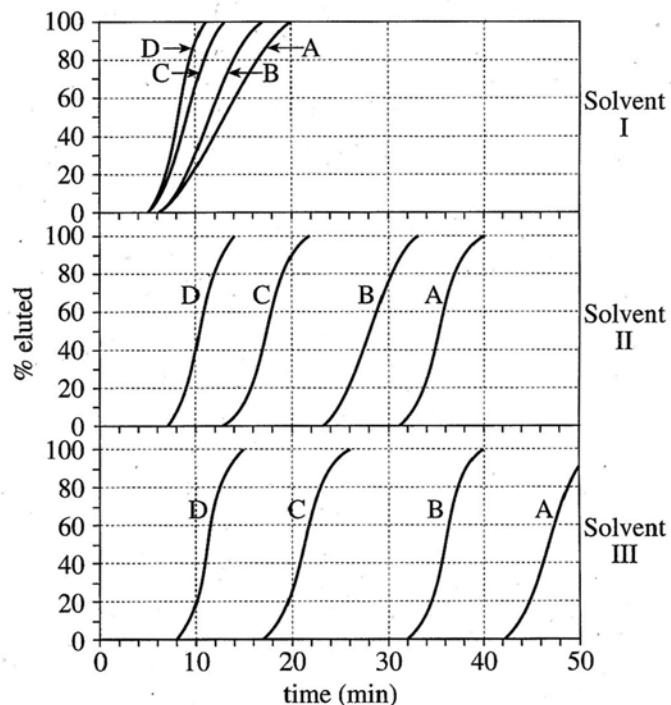


Figure 2

*Experiment 2*

Experiment 1 was repeated, but a *reverse-phase* (non-polar) adsorbent was used in each trial (see Figure 3).

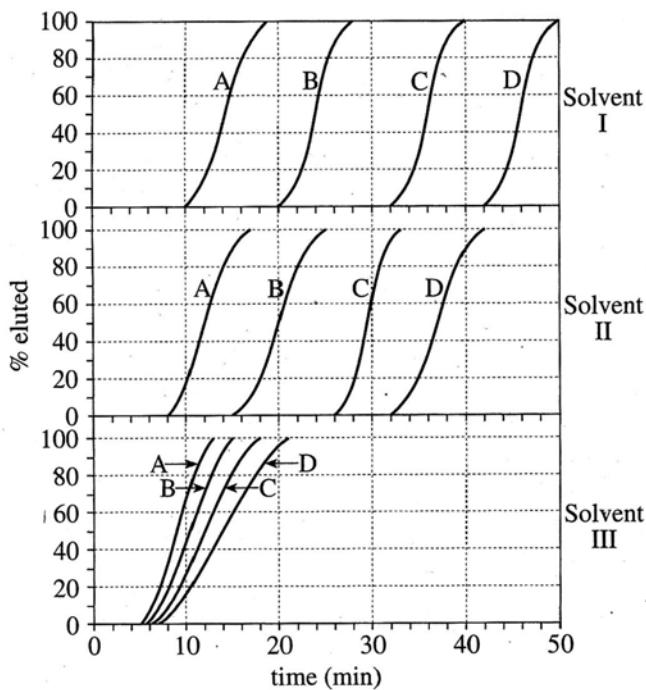


Figure 3

43. In Experiment 1, when Solvent III was used, exactly half the amount of Component B had eluted from the column at a time closest to:
- F. 10 min.  
G. 15 min.  
H. 35 min.  
J. 40 min.

44. Component X has a polarity of 3.9. The results of Experiments 1 and 2 would have been most similar to those shown in Figures 2 and 3 if, in each trial, Component X had been substituted in the mixture for:

- A. Component A.  
B. Component B.  
C. Component C.  
D. Component D.

45. Suppose that Experiment 1 will be repeated using Solvent I, but 0.2 g of Component Z (polarity = 0.7) will be part of the mixture. Which of the following best predicts the order of the elution times of the 5 components, from shortest to longest?

- F. A, B, C, Z, D  
G. A, Z, B, C, D  
H. D, Z, C, B, A  
J. D, C, B, Z, A

46. The *resolution* of a chromatographic separation increases as the amount of time between the elutions of each of the components increases. Based on the results of Experiments 1 and 2, which of the following sets of conditions had the greatest resolution for the separation of the mixture?

- | Normal-phase   | Reverse-phase |
|----------------|---------------|
| A. Solvent I   | Solvent II    |
| B. Solvent I   | Solvent III   |
| C. Solvent II  | Solvent I     |
| D. Solvent III | Solvent I     |

47. In Experiment 1, for Solvent I, at the time when exactly 50% of the amount of Component B had eluted from the column, the percent of Component D that had eluted from the column was closest to:

- F. 10%.  
G. 20%.  
H. 90%.  
J. 100%.

48. Suppose that Experiment 2 was repeated using a solvent with a polarity of 9.3. The elution time of Component D would most likely be:

- A. less than 20 min.  
B. between 20 min and 40 min.  
C. between 40 min and 50 min.  
D. greater than 50 min.

## Science - 7 question passage 1

### Introduction

Students studying a unit on motion and conservation of energy were given the following information:

- Kinetic energy (energy that changes as an object's speed changes) and gravitational potential energy (energy that changes as an object's altitude changes) are forms of mechanical energy.
- An object's total mechanical energy is the sum of its kinetic energy and its gravitational potential energy.
- If an object's total mechanical energy is constant, its total mechanical energy is said to be *conserved*.
- Friction causes some of an object's total mechanical energy to be lost, in which case its total mechanical energy is *not* conserved.

The students' teacher then described the following experiment:

Suppose a student placed a block upon a surface and gave the block a single push. As the block moved along the surface, the student measured the block's speed twice in succession and found that the second measured speed was lower than the first.

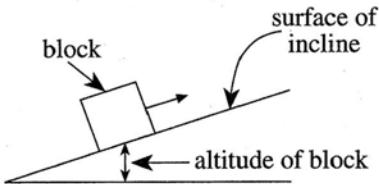
Given no other information, 3 students were asked to explain the results of the 2 measurements and to predict the block's motion after the 2 measurements.

### Student 1

The block was moving on a rough, *horizontal* surface (a surface with no incline). There was a constant frictional force between the block and the surface. This force alone caused the block to slow down at a constant rate and would have caused the block eventually to stop. Once stopped, the block would have remained at rest.

### Student 2

When the 2 measurements were made, the block was moving up a frictionless, inclined surface as shown in the figure, and was slowing down at a constant rate. No air was present.

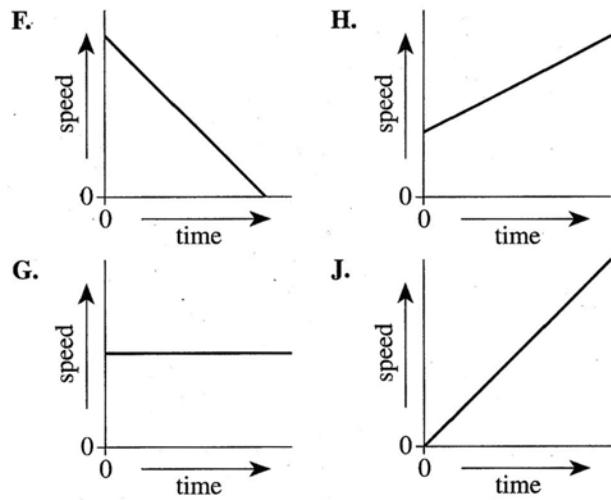


Eventually, the block would have stopped moving up the incline; then gravity alone would have caused the block to accelerate down the incline. At any specified altitude, the block's speed going down the incline would have been the same as its earlier speed going up the incline.

### Student 3

The block moved on a frictionless, horizontal surface. As a result of its motion, the block encountered air resistance. Air resistance alone caused the block to slow down and lose mechanical energy. The rate at which the block slowed down depended upon the amount of air resistance it encountered. As the block's speed decreased, the amount of air resistance decreased.

1. Assume that the block was pushed and then released at time = 0. Student 1's description of the block's speed over time after its release is best illustrated by which of the following graphs?



2. The 3 explanations of the block's motion are similar to each other in that all 3 explanations:
- contradicted the law of conservation of total mechanical energy.
  - were based on 2 measurements.
  - were formulated using the assumption that no friction would exist between the block and the air.
  - were formulated using the assumption that there would be no friction between the block and the surface on which it moved.
3. Based on the explanations of the 3 students, what did the 3 students most likely assume about the block's speed between the times the 2 measurements were made?
- The speed increased only.
  - The speed decreased only.
  - The speed increased, then decreased.
  - The speed changed, but with no general trend.

4. The teacher posed another question: Suppose, in a second experiment, the student placed the block and the surface in an airless chamber. Then the student repeated the procedure from the first experiment, except that he measured the block's speed throughout the experiment. If the block's speed remained constant throughout this second experiment, the explanation(s) of which student(s) for the results of the first experiment would be best supported?
- A. Student 1 only
  - B. Student 3 only
  - C. Students 1 and 2 only
  - D. Students 1 and 3 only
5. Based on Student 2's explanation, the block's gravitational potential energy at the highest point on its path most likely equaled:
- F. the block's kinetic energy one-third of the way up the incline.
  - G. the block's gravitational potential energy two-thirds of the way up the incline.
  - H. the block's total mechanical energy.
  - J. zero.
6. According to Student 1, while the block was moving, did the block's speed affect the frictional force on the block?
- A. Yes; as the block's speed increased, the frictional force on the block decreased only.
  - B. Yes; as the block's speed increased, the frictional force on the block increased, then decreased.
  - C. No; as the block's speed decreased, the frictional force on the block decreased, then increased.
  - D. No; as the block's speed decreased, the frictional force on the block was unaffected.
7. Assuming that Student 1's explanation is correct, while the block moved, was the total mechanical energy of the block conserved?
- F. Yes, because the block's kinetic energy increased and its gravitational potential energy remained constant.
  - G. Yes, because both the block's kinetic energy and its gravitational potential energy increased.
  - H. No, because the block's kinetic energy decreased and its gravitational potential energy remained constant.
  - J. No, because both the block's kinetic energy and its gravitational potential energy decreased.

## Science - 7 question passage 2

Life on Earth contains *organic* compounds (compounds containing carbon and other elements). The earliest compounds on Earth were inorganic. Scientists discuss 2 hypotheses about Earth's first organic compounds.

### Hydrothermal Vent Hypothesis

Organic molecules were first formed several billion years ago in numerous *hydrothermal vents* on the deep seafloor. These vents were openings in the seafloor that spew magma-heated water. Scientists estimated that water temperatures ranged from 700° C in the deepest part of a vent to 10° C at the top of a vent (the seafloor opening). Laboratory experiments have shown that temperature *gradients* (increases or decreases in temperature in relationship to distance) promote chemical reactions. This natural temperature gradient provided the optimum conditions for the following events. Inorganic molecules were heated in the deep part of the vents, creating organic molecules. Seawater circulating through the vents cooled and preserved these organic molecules, which were then deposited onto clay lining the top of the vents. The clay particles provided irregular surfaces where the organic molecules became embedded. The organic molecules eventually combined to first form *polymers* (long chains of organic molecules) and, later, living, self-replicating cells.

### Outer Space Hypothesis

Organic molecules were brought to Earth by bodies from space. Craters on other planets show that the solar system has been bombarded by asteroids, comets, and meteoroids since its formation. A *meteorite* (a meteoroid that strikes Earth) was found to contain *amino acids* (components of protein) and parts of *DNA* (carbon-based molecules found in living cells). Some meteorites are up to 5% organic material. Studies have found that comets contain organic material. Microscopic *interplanetary dust particles* fall to Earth from space in large numbers and are up to 10% organic material. These 3 types of bodies brought organic molecules to Earth. In the deep oceans, several billion years ago, conditions were right for those organic molecules to combine to form polymers and, eventually, living, self-replicating cells.

8. The Hydrothermal Vent Hypothesis would be strengthened by finding that the chemical reactions that produce organic compounds occur most readily at temperatures:
- below 10° C.
  - between 10° C and 700° C.
  - between 700° C and 1,000° C.
  - above 1,000° C.

9. Based on the information in both hypotheses, which of the following was one of the first characteristics exhibited by living things on Earth?
- The ability to move
  - The ability to replicate
  - The ability to digest clay crystals
  - The ability to survive on land
10. The scientists supporting both hypotheses would agree that life on Earth first began:
- in space.
  - in the oceans.
  - on another planet.
  - on land.
11. The Outer Space Hypothesis makes the assumption that, billions of years ago, Earth was:
- the only planet in the solar system with volcanoes.
  - completely covered by oceans.
  - bombarded by bodies from outer space.
  - much colder than it is today.
12. If it was discovered that organic molecules had existed on Earth before oceans existed on Earth, how would this discovery affect the hypotheses, if at all?
- It is consistent with the Outer Space Hypothesis only.
  - It is consistent with the Hydrothermal Vent Hypothesis only.
  - It is consistent with both hypotheses.
  - It would have no effect on either hypothesis.

13. Based on the information in both hypotheses, in order for life to have evolved on Earth, organic compounds had to first form:
- F. RNA.
  - G. DNA.
  - H. polymers.
  - J. clay particles.
14. It is estimated that 100,000 times as much collective mass of interplanetary dust particles landed on Earth as the collective mass of meteorites, comets, and asteroids that landed on Earth. Based on this information, which of the following generalizations would most likely be made by the supporters of the Outer Space Hypothesis?
- A. Only interplanetary dust particles brought organic molecules to Earth.
  - B. Only meteoroids brought organic molecules to Earth.
  - C. Most organic molecules were brought to Earth by interplanetary dust particles.
  - D. Most organic molecules were brought to Earth by asteroids.

## Science - 7 question passage 3

During the seventeenth century, the debate over the nature of light led to two competing theories: the Particle Theory and the Wave Theory.

### Particle Theory

First, light particles could illuminate objects behind an obstruction if the particles could follow curved paths around the edges of the obstruction. Curved light paths could be produced if the particles were attracted to the material making up the edges of the obstruction, like Earth is attracted to the Sun. Second, light particles could undergo *refraction* (a change in light's direction of motion when light passed from one substance to another, such as air and water) if the particles traveled at different speeds in different media. For example, light would change direction and travel faster through water than air because the light particles would be more strongly attracted by the densely packed water molecules. Third, different colors could be produced by the interaction between matter and particles of light having varying sizes and speeds. Finally, particles could move through a *vacuum* (a region containing little or no matter), whereas waves were thought to require a substance like air or water through which to move.

### Wave Theory

First, sound, which is composed of waves, can be heard behind barriers because waves can be *diffracted* (bent) around the edges of the barriers. Similarly, light waves could produce indistinct shadows by being diffracted around the edges of barriers. Second, light waves can combine *constructively* or *destructively*, producing light that is, respectively, visibly brighter or dimmer than any of the waves before they combined. Third, refraction could occur if waves possessed different speeds in different substances. For example, light waves would travel faster in air than in water, and so would change direction as they pass between the different media. Fourth, since light waves would require a substance through which to travel, the existence in outer space of an undetected material called the *ether* was proposed. Finally, the colors red and blue could be produced by interactions between waves and matter. The other colors would be made from mixtures of the various shades of red and blue.

15. Two light sources, one blue and one red, are aimed at the same point on a white screen. According to the Wave Theory, the spot would be:
- red, because in mixtures of red and blue light, red would dominate.
  - a different color, because red and blue would be mixed.
  - black, because light particles would interact with the screen.
  - blue, because a vacuum would transmit blue light more easily.

16. In order to test both theories, one could measure the:

- reduction of sound intensity by an insulator.
- speed of each individual light particle.
- time required for water waves to cross a lake.
- ratio of the speed of light in water to that in air.

17. According to the Particle Theory, the bending of light particles around the edge of an obstacle would be similar to:

- the Moon orbiting the Earth.
- a ping-pong ball hitting a paddle.
- a lamp being turned on and off.
- a flashlight shining on a white wall.

18. Based on the information in the passage, one argument against the Particle Theory is that it:

- restricts the conditions under which particles of light can combine constructively and destructively.
- maintains that particles of light can combine constructively and destructively.
- does not explain whether particles of light combine constructively and destructively.
- explains only how particles of light combine constructively and destructively.

19. Which of the following was a weakness of the Wave Theory of light?

- An undetected ether was required.
- Refraction of waves was not observed.
- Light waves could combine constructively.
- Sound was known to be a wave phenomenon.

20. A point of agreement between the two theories is that light:

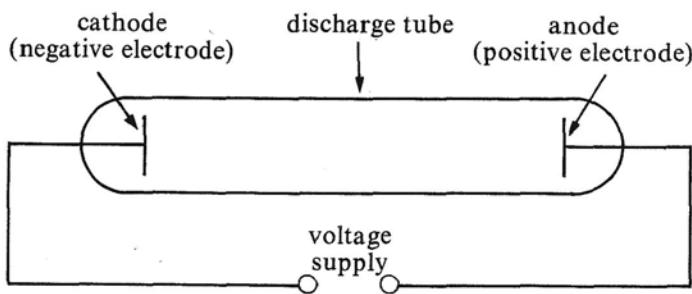
- travels at a higher speed in air than in water.
- travels at a lower speed in air than in water.
- travels at the same speed in air as in water.
- interacts with matter to produce colors.

21. A beam of white light is projected through two small slits onto a screen. The resulting image on the screen is a series of bright and dark bands. According to the Wave Theory, the dark bands are an example of:

- F. destructive combination.
- G. constructive combination.
- H. refraction.
- J. particle interaction.

## Science - 7 question passage 4

*Cathode rays* are invisible beams emitted inside a gas-filled discharge tube in which a voltage difference exists between two electrodes: a cathode and an anode (see figure). These rays cause the glass at the anode end of the tube to glow. No matter what material the cathode is made of, it produces rays with the same properties. The glow is not affected when the type of low-pressure gas (0.01% of normal air pressure) in the tube is changed. Scientists have two theories about the nature and behavior of cathode rays.



### Theory 1

Cathode rays are a stream of high-speed charged particles emitted from the cathode. A previously neutral metal object placed in the path of the rays acquires a negative charge. A platinum disk placed in that same location becomes white-hot as it absorbs energy from the particles striking it. The cathode rays also apply a measurable force on the disk. The glow changes position if a magnetic field is applied across the middle of the tube. This indicates that the particles are deflected by the magnetic field.

### Theory 2

Cathode rays are similar to high-energy light rays. Like light rays, they produce a fluorescent glow seen at the end of the tube. They have no charge and can also heat a disk. The rays travel in straight lines, and if an object is placed between the electrodes, a sharp shadow of that object is created at the anode end of the tube. When a thin metallic window is used to replace the anode end of the tube, the rays appear to penetrate the window, and the air outside the window glows. Cathode rays can produce chemical reactions similar to those produced by light. For example, silver compounds change color when exposed to cathode rays in the same way that these compounds on photographic film change color when exposed to light.

22. As the pressure of the gas in the discharge tube is raised, the glow on the glass disappears and the gas itself gives off light. According to Theory 1, which of the following best explains this observation?

- F. Charged particles collide with the gas and cause it to glow.
- G. The gas reacts chemically with the cathode.
- H. The voltage difference disappears in the higher pressure gas.
- J. Cathode rays travel out of the tube at right angles to their original path.

23. If focusing magnets are used in the discharge tube, the cathode rays can be made to converge at a point between the cathode and the anode. Which theory is supported by this result?

- A. Theory 1, because cathode ray particles are neutral.
- B. Theory 1, because cathode ray particles are charged.
- C. Theory 2, because cathode rays don't produce shadows.
- D. Theory 2, because cathode rays cause light-sensitive chemicals to react.

24. In which of the following ways is Theory 1 different from Theory 2?

- F. The type of gas used in the tube
- G. The acquiring of a charge by a metal object in the tube
- H. The original design of the discharge tube used in the experiment
- J. The voltage difference between the cathode and anode in the discharge tube

25. It is discovered that moving the anode changes the position of the glow. The supporters of Theory 1 would argue that this occurs because which of the following is true?

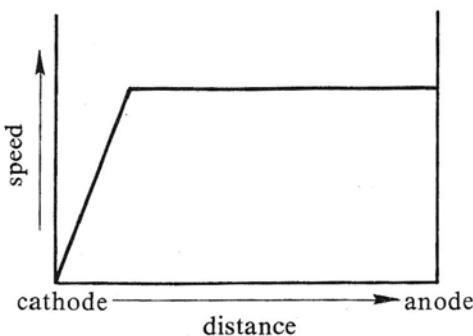
- A. The cathode ray particles are very dense.
- B. The glass attracts the particles.
- C. The particles are attracted by the anode.
- D. The surrounding gas absorbs the particles.

26. According to Theory 2, which of the following best explains why the rays are assumed to originate from the cathode?

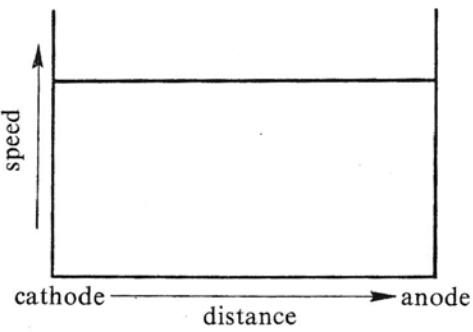
- F. The observed glow does not depend on the gas used.
- G. A metal disk placed between the electrodes becomes charged.
- H. The shadow from the object is seen on the anode side of the tube.
- J. The glow is only seen when a voltage is applied between the anode and the cathode.

27. Theory 1 supporters hypothesize that the particles accelerate rapidly and acquire their maximum speed close to the cathode. Which of the following graphs best illustrates this hypothesis?

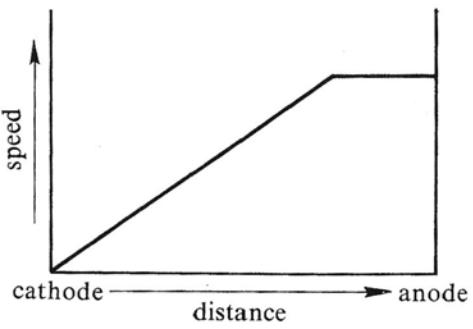
A.



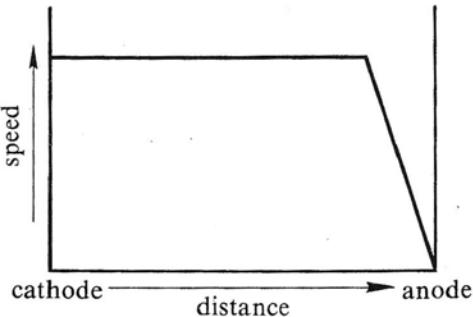
B.



C.



D.



28. Which of the following hypotheses would the scientists of Theory 2 make if no shadow is seen when a piece of thin material not previously tested was placed in the path of the cathode rays?

- F. Cathode rays do not always travel in straight lines.
- G. The material is being heated by the cathode rays.
- H. The material transmits the rays, like glass transmits light.
- J. The material is too dense to cast a shadow.

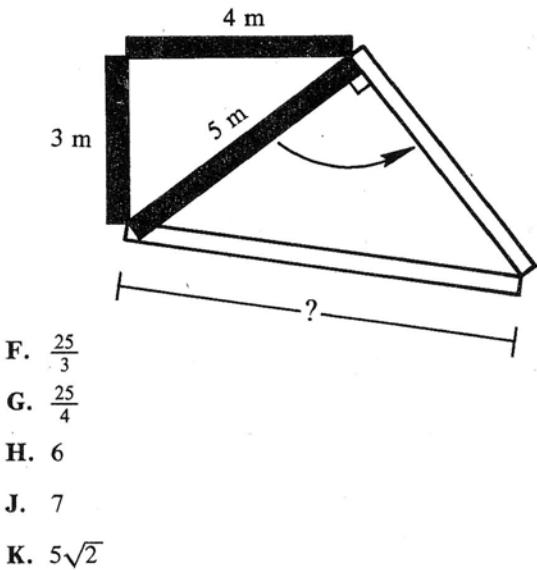
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## Math Practice

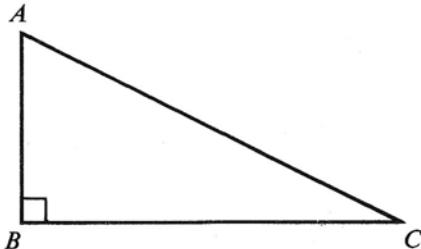
27. In the standard  $(x,y)$  coordinate plane, what is the slope of the line whose equation is  $8x - 2y = 12$ ?

A. -8  
B. -6  
C. -4  
D. 4  
E. 12

28. Wooden beams surround a community garden in City Park, as shown below. The gardeners plan to enlarge this right-triangular garden by digging up the longest wooden beam, swinging it by  $90^\circ$ , and purchasing another beam to complete the 4-sided garden, as illustrated. How many meters (m) long should this new beam be?

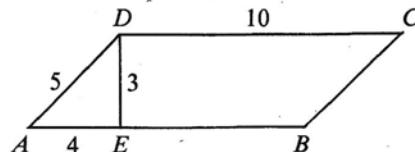


29. In the right triangle below, what is the tangent of  $\angle C$ ? (Note: The notation  $AB$  represents the length of the line segment  $\overline{AB}$ .)



A.  $\frac{AB}{AC}$   
B.  $\frac{AB}{BC}$   
C.  $\frac{BC}{AB}$   
D.  $\frac{BC}{AC}$   
E.  $\frac{AC}{BC}$

30. In parallelogram  $ABCD$  below,  $\overline{AD}$  is 5 centimeters (cm) long,  $\overline{AE}$  is 4 cm long,  $\overline{DC}$  is 10 cm long, and  $\overline{DE}$  is 3 cm long. What is the area of the parallelogram, in square centimeters?

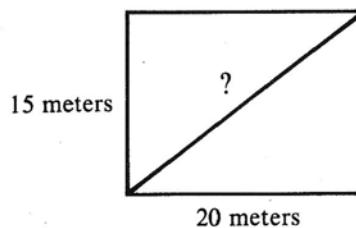


F. 18  
G. 24  
H. 30  
J. 36  
K. 50

31. For all positive integers  $x$  and  $n$ ,  $(2x^{n+2})(3x^3 - n) = 6x^p$ . What is the value of  $p$ ?

A. -2  
B. 0  
C. 3  
D. 5  
E. 6

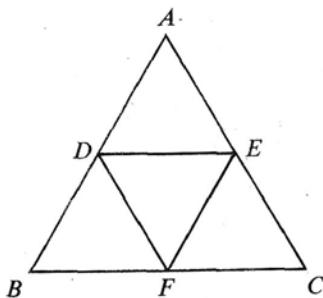
32. To hang decorations for a party, a class wants to run a wire flat across the ceiling from one corner of a rectangular classroom to the opposite corner. If the classroom is 15 meters wide and 20 meters long, how many meters long must the wire be?



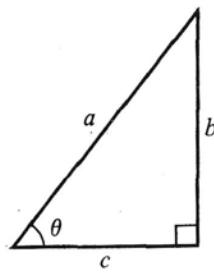
F. 25  
G.  $27\frac{1}{2}$   
H. 30  
J. 35  
K. 70

## Math Practice

33. In the figure below, the vertices of  $\triangle DEF$  are the midpoints of the sides of equilateral triangle  $\triangle ABC$ . If the area of  $\triangle ABC$  is 12 square centimeters, what is the area of  $\triangle DEF$ , in square centimeters?



- A. 2  
B. 3  
C. 4  
D.  $4\sqrt{3}$   
E. 6
34. In the right triangle below, the value of  $\cos \theta$  is equal to which of the following ratios?



- F.  $\frac{a}{b}$   
G.  $\frac{b}{a}$   
H.  $\frac{b}{c}$   
J.  $\frac{c}{a}$   
K.  $\frac{c}{b}$
35. If Voyager II took  $1.0 \times 10^5$  hours to travel  $1.25 \times 10^9$  miles in reaching Saturn, what was its average speed in miles per hour?
- A.  $8.00 \times 10^{-5}$   
B.  $1.25 \times 10^4$   
C.  $8.00 \times 10^4$   
D.  $1.25 \times 10^{14}$   
E.  $8.00 \times 10^{14}$

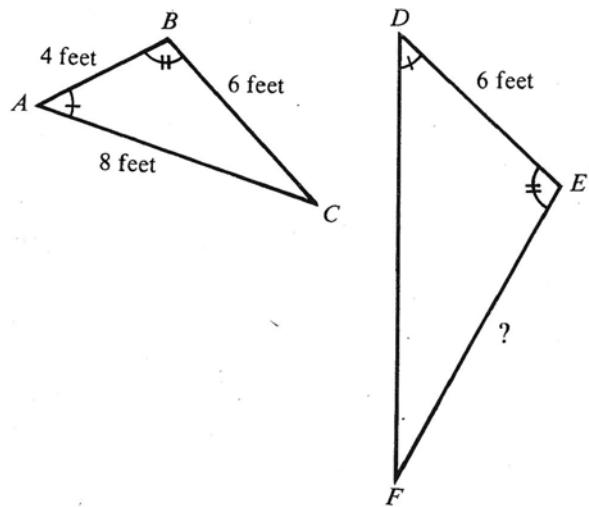
36. What is the distance, in coordinate units, between the points  $(2, 5)$  and  $(-1, 3)$  in the standard coordinate plane?

- F.  $\sqrt{5}$   
G.  $\sqrt{13}$   
H.  $\sqrt{65}$   
J. 5  
K. 13

37. In the standard coordinate plane, what is the number of points where the graphs of  $y = x^2$  and  $x^2 + y^2 = 1$  intersect?

- A. 0  
B. 1  
C. 2  
D. 3  
E. 4

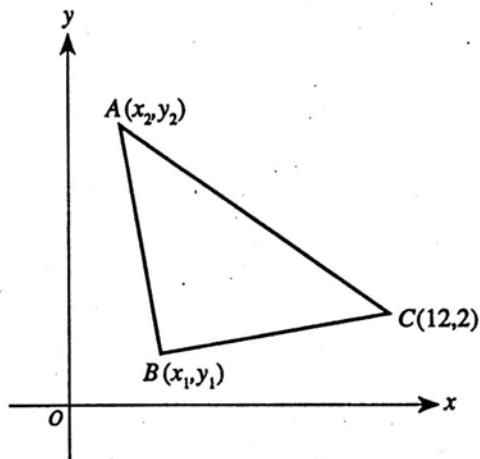
38. For the triangles below,  $\angle A \cong \angle D$ ,  $\angle B \cong \angle E$ , and lengths of the sides are as marked. How many feet long is  $\overline{EF}$ ?



- F. 4  
G.  $\frac{9}{2}$   
H. 8  
J. 9  
K. 12

## Math Practice

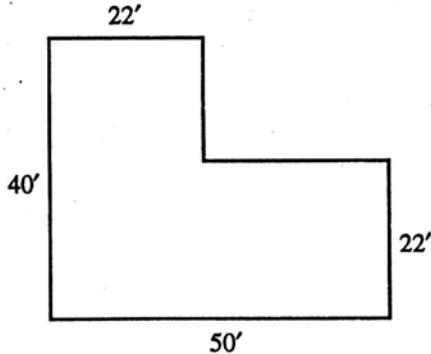
26. Triangle  $\triangle ABC$  is graphed below in the standard coordinate plane. Which of the following is an expression for the slope of  $\overline{BC}$ ?



- F.  $\frac{12-x_1}{2-x_1}$   
 G.  $\frac{2-y_1}{12-x_1}$   
 H.  $\frac{12-x_1}{y_1-2}$   
 J.  $\frac{y_1-2}{12-x_1}$   
 K.  $\frac{y_2-y_1}{x_2-x_1}$

27. The floor plan for an L-shaped storage building is shown below with distances marked in feet. What is the floor area of the building, in square feet?

(Note: Walls in this building meet only at right angles.)

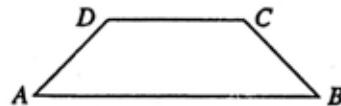


- A. 1,232  
 B. 1,496  
 C. 1,516  
 D. 1,980  
 E. Cannot be determined from the given information

28. For all  $x$ ,  $x^7 + 7x + x^7 + 7x$  equals which of the following expressions?

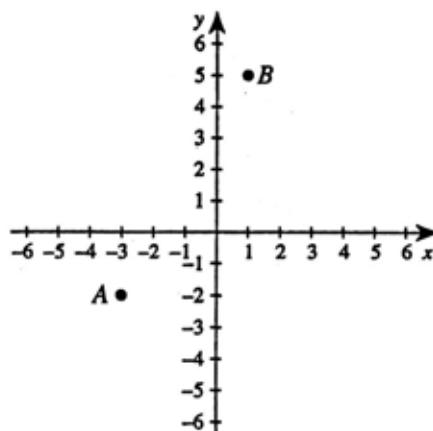
- F.  $14x^{14}$   
 G.  $14x^{16}$   
 H.  $16x^{16}$   
 J.  $2x^7 + 14x$   
 K.  $x^{14} + 14x$

29. In the figure below,  $\overline{DC}$  is parallel to  $\overline{AB}$ , and  $\overline{AD}$  is the same length as  $\overline{BC}$ .  $\overline{AB}$  is 16 units long,  $\overline{CD}$  is 10 units long, and the measure of  $\angle DAB$  is  $45^\circ$ . How many units long is  $\overline{AD}$ ?



- A.  $\frac{3\sqrt{2}}{2}$   
 B.  $3\sqrt{2}$   
 C.  $6\sqrt{2}$   
 D. 3  
 E. 6

30. Points A and B, with  $(x,y)$  coordinates of  $(-3,-2)$  and  $(1,5)$ , respectively, are plotted in the standard coordinate plane shown below. What is the slope of a straight line containing points A and B?



- F.  $-\frac{3}{2}$   
 G.  $-\frac{2}{3}$   
 H.  $\frac{4}{7}$   
 J.  $\frac{7}{4}$   
 K.  $\frac{10}{3}$

## Math Practice

37. If Mark works steadily he can complete a task in  $x$  hours. What portion of the task remains if he works steadily for  $y$  hours, where  $y$  is any value less than  $x$ ?

- A.  $\frac{(x+y)}{x}$
- B.  $\frac{(y-x)}{x}$
- C.  $\frac{(x-y)}{(x+y)}$
- D.  $\frac{(x-y)}{y}$
- E.  $\frac{(x-y)}{x}$

38. If  $a^2 - b^2 = 81$  and  $a - b = 9$ , then  $a = ?$

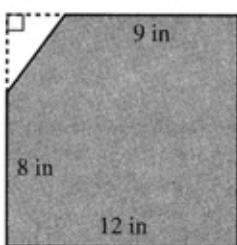
- F. 12
- G. 9
- H. 3
- J. -3
- K. -9

39. For  $y \neq 0$ ,  $\frac{y^9}{y^3}$  is equivalent to:

- A. 1
- B. 4
- C.  $y^3$
- D.  $y^4$
- E.  $y^6$

40. The polygon below was a square with 12-inch sides before a triangle was cut off. What is the perimeter, in inches, of this polygon?

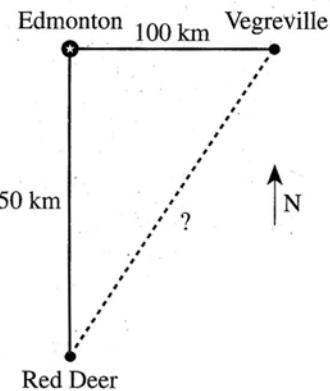
- F. 41
- G. 43
- H. 46
- J. 48
- K. 53



41. A circle in the standard  $(x,y)$  coordinate plane has center  $(2,-3)$  and radius 4 units. Which of the following equations represents this circle?

- A.  $(x-2)^2 + (y+3)^2 = 4$
- B.  $(x+2)^2 - (y-3)^2 = 4$
- C.  $(x+2)^2 + (y-3)^2 = 4$
- D.  $(x-2)^2 + (y+3)^2 = 16$
- E.  $(x+2)^2 - (y-3)^2 = 16$

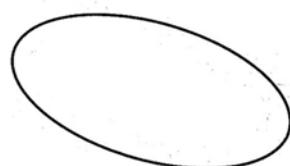
34. One route along flat terrain from Red Deer to Vegreville is to drive north from Red Deer to Edmonton about 150 kilometers, then, at Edmonton, to drive east for about 100 kilometers to Vegreville. If a straight, flat road existed between Red Deer and Vegreville, about how many kilometers long would it be?



- F. 250
- G.  $\sqrt{250}$
- H.  $\sqrt{12,500}$
- J.  $\sqrt{15,000}$
- K.  $\sqrt{32,500}$

35. The ellipse shown below intersects any different ellipse in, at most, how many points?

- A. 1
- B. 2
- C. 3
- D. 4
- E. Infinitely many

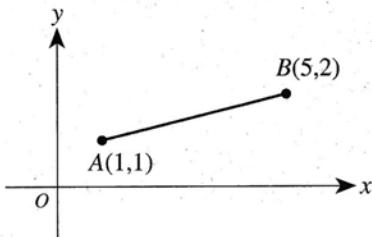


36. The Environmental Club selects its 3 officers by first selecting the president, then the vice president, and finally the secretary. If there are 20 members who are eligible to hold office and no member can hold more than 1 office, which of the following gives the number of different possible results of the election?

- F.  $17^3$
- G.  $19^3$
- H.  $20^3$
- J.  $19 \cdot 18 \cdot 17$
- K.  $20 \cdot 19 \cdot 18$

## Math Practice

37. The points  $A(1,1)$  and  $B(5,2)$  in the standard  $(x,y)$  coordinate plane below are 2 vertices of  $\triangle ABC$ , which has a right angle at  $B$ . Which of the following points could be the third vertex,  $C$ ?



- A.  $(2,-3)$
  - B.  $(3,\frac{3}{2})$
  - C.  $(\frac{7}{2},-\frac{1}{2})$
  - D.  $(4,-2)$
  - E.  $(4,6)$
38. What value of  $n$  will satisfy the equation  $0.1(n + 1,350) = n$ ?
- F. 1,500
  - G. 1,485
  - H. 1,215
  - J. 150
  - K. 135

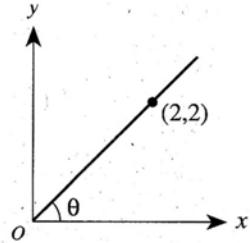
39. If  $0^\circ \leq x^\circ \leq 90^\circ$ , and  $2 \sin^2 x^\circ - 1 = 0$ , then  $x^\circ = ?$
- A.  $0^\circ$
  - B.  $30^\circ$
  - C.  $45^\circ$
  - D.  $60^\circ$
  - E.  $90^\circ$

40. A circular fountain with a diameter of 20 meters is to be placed entirely within a rectangular plaza, 40 by 60 meters. Bricks will be laid on the entire plaza around the fountain (but not under it), making it accessible to pedestrians. What is the approximate area, in square meters, of the plaza that will be brick?
- F. 314
  - G. 1,256
  - H. 2,086
  - J. 2,400
  - K. Cannot be determined without knowing the exact placement of the fountain

41. In the standard  $(x,y)$  coordinate plane, which of the following lines goes through  $(0,2)$  and is parallel to  $y = 3x + 1$ ?

- A.  $y = -\frac{1}{3}x + 2$
- B.  $y = 2x + 3$
- C.  $y = 3x - 6$
- D.  $y = 3x - 2$
- E.  $y = 3x + 2$

42. In the figure below,  $\cos \theta = ?$



- F.  $\frac{1}{2}$
- G.  $\frac{\sqrt{2}}{2}$
- H.  $\frac{\sqrt{3}}{2}$
- J. 1
- K.  $\sqrt{2}$

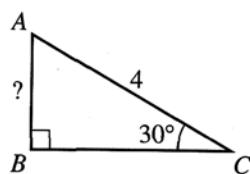
43. Which of the following operations will produce the largest result when substituted for the blank in the expression:  $2 \underline{\hspace{1cm}} - \frac{1}{3}$ ?
- A. averaged with
  - B. divided by
  - C. minus
  - D. plus
  - E. multiplied by

44. The value of  $x$  that will make  $\frac{x}{2} + 1 = \frac{3}{4}$  a true statement lies between which of the following numbers?
- F.  $-3$  and  $-1$
  - G.  $-1$  and  $0$
  - H.  $0$  and  $1$
  - J.  $1$  and  $3$
  - K.  $3$  and  $5$

## Math Practice

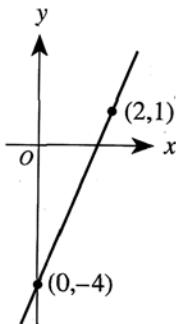
29. In  $\triangle ABC$  below,  $\angle B$  is a right angle, the measure of  $\angle C$  is  $30^\circ$ , and  $\overline{AC}$  is 4 inches long. What is the length, in inches, of  $\overline{AB}$ ?

- A.  $\frac{2}{\sqrt{3}}$
- B.  $\sqrt{3}$
- C. 2
- D.  $\frac{4}{\sqrt{3}}$
- E.  $2\sqrt{3}$



30. What is the slope of a line that is parallel to the line graphed below in the standard  $(x,y)$  coordinate plane?

- F. -4
- G.  $-\frac{3}{2}$
- H.  $\frac{2}{5}$
- J.  $\frac{1}{2}$
- K.  $\frac{5}{2}$



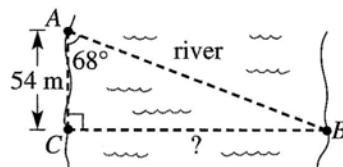
31. The operation  $\otimes$  is defined as “cube the number that is to the left of  $\otimes$  and add the result to the number that is to the right of  $\otimes$ .” What is the value of  $2 \otimes (4 \otimes 5)$ ?

- A. 40
- B. 77
- C. 160
- D. 640
- E. 1,733

32. For which of the following values of  $a$  will  $\left(-\frac{1}{2}\right)^a$  represent a real number between -1 and 0?

- F. -2
- G. -1
- H. 0
- J. 1
- K. 2

33. A surveyor wants to approximate a river's width. As shown in the figure below, points A and C are located on the west bank of a river and point B is located on the east bank of the river such that  $\angle ACB$  is a right angle. She measures and finds that the length of  $\overline{AC}$  is 54 meters and the measure of  $\angle BAC$  is  $68^\circ$ .



Given the trigonometric approximations in the tables below, which of the following is closest to the river's width, in meters, represented by the length of  $\overline{BC}$ ?

$\cos 22^\circ$	0.927
$\sin 22^\circ$	0.375
$\tan 22^\circ$	0.404

$\cos 68^\circ$	0.375
$\sin 68^\circ$	0.927
$\tan 68^\circ$	2.475

- A. 58
- B. 108
- C. 134
- D. 136
- E. 144

34. The first term of an arithmetic sequence is 1. The common difference of the sequence is 2. What is the sum of the first 15 terms of this sequence?

- F. 29
- G. 64
- H. 210
- J. 225
- K. 450

35. A cookbook recommends cooking a certain type of roast at  $325^\circ\text{F}$  for 50 minutes per pound of the roast's weight. According to this recommendation, how long should a 5-pound roast of this type be cooked at  $325^\circ\text{F}$ ?

- A. 2 hours 30 minutes
- B. 2 hours 50 minutes
- C. 4 hours 10 minutes
- D. 4 hours 17 minutes
- E. 6 hours 0 minutes

36. The integer  $a$  is 4 more than the positive integer  $b$ . The integer  $c$  is 4 less than  $b$ . The product of  $a$  and  $c$  is 84. What is the value of  $b$ ?

- F. 6
- G. 8
- H. 10
- J. 14
- K. 42

## Math Practice

37. For what values of  $x$  is it true that  $x - 2 > \frac{x}{2}$  ?

- A. No values
- B. Only values between 0 and 2
- C. Only values between 2 and 4
- D. Only values greater than 4
- E. All values

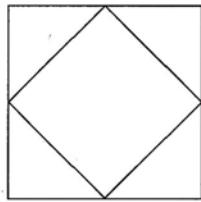
38. For all  $a \geq 0$ ,  $|-a|^3 - (-|3|^2) = ?$

- F.  $a^3 + 9$
- G.  $a^3 + 6$
- H.  $a^3 - 9$
- J.  $-a^3 + 6$
- K.  $-a^3 + 9$

39. If  $x$  and  $y$  are positive integers and  $x - y = 5$ , what is the least possible value of  $x + y$  ?

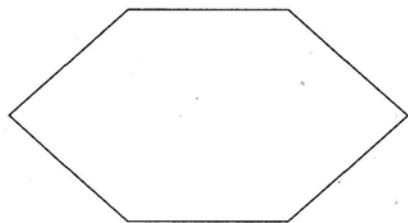
- A. 10
- B. 9
- C. 8
- D. 7
- E. 6

40. The midpoints of the sides of the outer square shown below are the vertices of the inner square. Thus, the outer square is divided into 5 regions (the inner square and 4 right triangles). What is the ratio of the area of the inner square to the total area of the 4 right triangles?



- F. 1:1
- G. 1:2
- H. 2:1
- J. 3:2
- K. 4:1

41. The hexagon shown below has 6 sides of equal length. What is the sum of the measures of the interior angles in this hexagon?



- A.  $900^\circ$
- B.  $720^\circ$
- C.  $540^\circ$
- D.  $360^\circ$
- E.  $120^\circ$

42. What is the least common multiple of 4, 6, and 8 ?

- F. 2
- G. 8
- H. 24
- J. 48
- K. 192

43. What is the distance, in coordinate units, from (3,4) to (6,9) in the standard  $(x,y)$  coordinate plane?

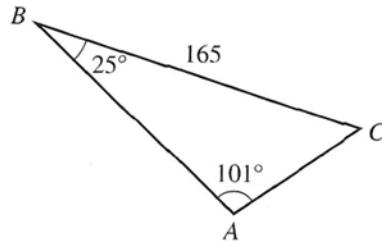
- A.  $\sqrt{4}$
- B.  $\sqrt{8}$
- C.  $\sqrt{10}$
- D.  $\sqrt{34}$
- E.  $\sqrt{40}$

44. Jim makes the statement "If you have visited the White House, then you have been to Washington, D.C." Which of the following statements is logically equivalent to Jim's statement?

- F. You have visited the White House, or you have been to Washington, D.C.
- G. You have visited the White House, and you have been to Washington, D.C.
- H. If you have been to Washington, D.C., then you have visited the White House.
- J. If you have not visited the White House, then you have not been to Washington, D.C.
- K. If you have not been to Washington, D.C., then you have not visited the White House.

45. In  $\triangle ABC$  below,  $\angle A$  measures  $101^\circ$ ,  $\angle B$  measures  $25^\circ$ , and the length of  $\overline{BC}$  is 165 meters. To the nearest meter, what is the length of  $\overline{AC}$  ?

(Note: The law of sines states that the lengths of the sides of a triangle are proportional to the sines of the opposite angles. Note also that  $\sin 101^\circ \approx 0.982$  and  $\sin 25^\circ \approx 0.423$ .)



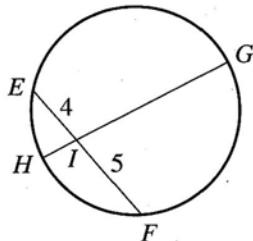
- A. 41
- B. 54
- C. 64
- D. 71
- E. 81

46. Which of the following expressions is equivalent to  $6x^2 - 14x - 12$  ?

- F.  $(2x - 3)(3x + 4)$
- G.  $(2x + 3)(3x - 4)$
- H.  $(6x - 1)(x + 12)$
- J.  $2(3x - 2)(x + 3)$
- K.  $2(3x + 2)(x - 3)$

## Math Practice

47. When 2 chords of a circle intersect inside the circle, the product of the lengths of the 2 segments of one chord is equal to the product of the lengths of the 2 segments of the other chord. In the figure below, chords  $\overline{EF}$  and  $\overline{GH}$  intersect at  $I$ . The length of  $\overline{GH}$  is 12 inches. The length of  $\overline{FI}$  is 5 inches. The length of  $\overline{EI}$  is 4 inches. The length of  $\overline{HI}$  is less than the length of  $\overline{GI}$ . What is the length, in inches, of  $\overline{GI}$ ?



- A. 3  
B. 5  
C. 7  
D. 8  
E. 10

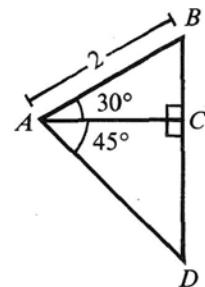
48. Which of the following gives the range of numbers that are within 1.5 of the number  $\frac{2}{3}$ ?

- F.  $-\frac{13}{6}$  to  $\frac{5}{6}$   
G.  $-\frac{13}{6}$  to  $\frac{13}{6}$   
H.  $-\frac{5}{6}$  to  $\frac{5}{6}$   
J.  $-\frac{5}{6}$  to  $\frac{13}{6}$   
K. -1 to 1

49. In the standard  $(x,y)$  coordinate plane,  $\triangle ABC$  is isosceles with  $\overline{AB}$  congruent to  $\overline{AC}$ . Vertex  $B$  has coordinates  $(-3,0)$  and vertex  $C$  has coordinates  $(0,0)$ . What is the  $x$ -coordinate of vertex  $A$ ?

- A. -3  
B.  $-\frac{3}{2}$   
C. 0  
D.  $\frac{3}{2}$   
E. 3

44. In the figure below, what is the length of  $\overline{BD}$ ?



- F.  $\frac{1}{2} + \frac{\sqrt{3}}{2}$   
G.  $\frac{1}{2} + \sqrt{3}$   
H.  $1 + \frac{\sqrt{3}}{2}$   
J.  $1 + \sqrt{3}$   
K. 2

45. If  $2 + i$  is a solution of  $x^2 - 4x + 5 = 0$ , where  $i^2 = -1$ , which of the following must be another solution?

- A.  $2 - i$   
B.  $-2 + i$   
C.  $-2 - i$   
D.  $\frac{1}{2+i}$   
E.  $\frac{1}{2-i}$

46. At work, Tomi heard Elena say, "If my salary were only 4 more dollars per week, I'd be making twice what I made when I started." If  $c$  represents Elena's current weekly salary, in dollars, which expression below represents her starting weekly salary, also in dollars?

- F.  $\frac{1}{2}(c - 4)$   
G.  $\frac{1}{2}(c + 4)$   
H.  $2(c - 4)$   
J.  $2c - 4$   
K.  $2c + 4$

## Math Practice

38. Which of the following is the solution set for the inequality below?

$$|x - 1| > 5$$

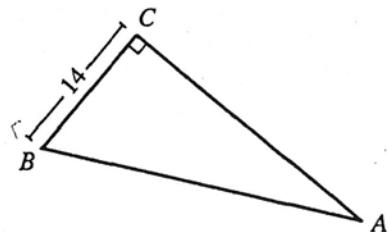
- F.  $x < -4$  or  $x > 6$   
 G.  $x < -5$  or  $x > 5$   
 H.  $x > -1$  and  $x < 1$   
 J.  $x > -4$  and  $x < 6$   
 K.  $x > -5$  and  $x < 5$

39. Saying that  $4 < \sqrt{x} < 9$  is equivalent to saying what about  $x$ ?

- A.  $0 < x < 5$   
 B.  $0 < x < 65$   
 C.  $2 < x < 3$   
 D.  $4 < x < 9$   
 E.  $16 < x < 81$

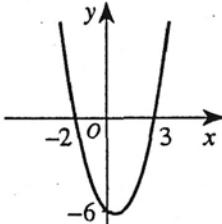
40. In  $\triangle ACB$  shown below,  $\sin A = \frac{3}{7}$  and the measure of  $\overline{CB}$  is 14 inches. What is the measure of  $\overline{AB}$  in inches?

- F. 6  
 G.  $\sqrt{40}$   
 H.  $\sqrt{58}$   
 J.  $\frac{98}{3}$   
 K. 40



41. Which of the following could be the equation for the parabola graphed in the standard  $(x,y)$  coordinate plane below?

- A.  $y = (x + 2)(x - 3)$   
 B.  $y = (x - 2)(x + 3)$   
 C.  $y = -(x - 2)(x + 3)$   
 D.  $y = -(x - 2)(x - 3)$   
 E.  $y = -(x + 2)(x + 3)$



42. The average of a set of 5 integers is 4. If one of the integers in the set is 3, what is the average of the other 4 integers in the set?

- F. 3  
 G.  $3\frac{2}{5}$   
 H. 4  
 J.  $4\frac{1}{4}$   
 K. 5

46. What is the value of  $k$  for which the lines  $y = kx + 1$  and  $y = x - 2$  intersect at the point  $(4,2)$  in the standard  $(x,y)$  coordinate plane?

- F. -1  
 G.  $\frac{1}{4}$   
 H.  $\frac{1}{2}$   
 J. 1  
 K.  $\frac{3}{2}$

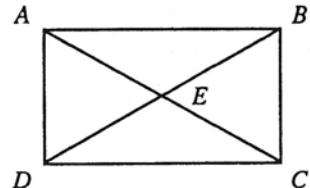
47. The equation of the line containing one side of a rectangle in the standard  $(x,y)$  coordinate plane is  $y = \frac{3}{4}x - 2$ . If one of the following equations is a line containing an adjacent side, which equation must it be?

- A.  $y = -3x + 3$   
 B.  $y = \frac{3}{4}x + 3$   
 C.  $y = -\frac{3}{4}x - 5$   
 D.  $y = \frac{4}{3}x + 1$   
 E.  $y = -\frac{4}{3}x - 4$

48. How many positive integers are factors of 30?

- F. 3  
 G. 5  
 H. 6  
 J. 8  
 K. 10

49. Rectangle ABCD, with diagonals  $\overline{AC}$  and  $\overline{BD}$  intersecting at point E, is shown below. Rectangle ABCD is a square if and only if  $\triangle ABE$  is congruent to which of the triangles in the following list?



- A.  $\triangle ACD$   
 B.  $\triangle ADE$   
 C.  $\triangle BAE$   
 D.  $\triangle BDC$   
 E.  $\triangle CDE$

50. A school supply store sells individual pencils and pens. Two pencils and a pen would cost \$0.55. Two pens and a pencil would cost \$0.95. How much would 1 pencil and 1 pen cost?

- F. \$0.15  
 G. \$0.35  
 H. \$0.50  
 J. \$0.75  
 K. Cannot be determined from the given information

## Math Practice

51. The imaginary number,  $i$ , is defined such that  $i^2 = -1$ . What does  $i + i^2 + i^3 + \dots + i^{49}$  equal?

A.  $i$   
B.  $-i$   
C.  $-1$   
D.  $0$   
E.  $1$

52. For  $0 < x \leq 2\pi$ , if  $\sin x > 0$  and  $\cos x < 0$ , what are the possible values of  $x$ ?

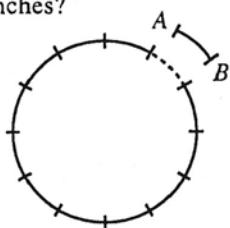
F.  $0 < x < \frac{\pi}{2}$   
G.  $\frac{\pi}{2} < x < \pi$   
H.  $\pi < x < \frac{3\pi}{2}$   
J.  $\frac{3\pi}{2} < x < 2\pi$   
K.  $x = \pi$  or  $2\pi$

53. What is the area, in square centimeters, of the largest circle that can fit within a rectangle measuring 6 centimeters by 8 centimeters?

A.  $6\pi$   
B.  $8\pi$   
C.  $9\pi$   
D.  $16\pi$   
E.  $48\pi$

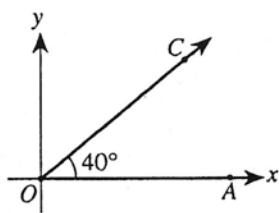
54. A circle with a radius of 6 inches is cut into 12 equal pieces, one of which is arc  $\widehat{AB}$ , as shown below. What is the measure of arc  $\widehat{AB}$  in inches?

F. 1  
G. 2  
H.  $\pi$   
J.  $2\pi$   
K.  $3\pi$



55. When an angle is in standard position in the  $(x,y)$  coordinate plane, its vertex is  $(0,0)$ . One side (called the initial side) is along the positive  $x$ -axis. The other side (called the terminal side) is positioned counter-clockwise from the initial side if the angle's measure is positive and clockwise if the angle's measure is negative. In the figure below,  $\angle AOC$ , which measures  $40^\circ$ , is in standard position. Which of the following gives the measure of an angle in standard position that does NOT have the same terminal side as  $\angle AOC$ ?

A.  $-320^\circ$   
B.  $400^\circ$   
C.  $680^\circ$   
D.  $760^\circ$   
E.  $1,120^\circ$

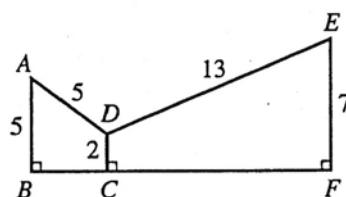


56. An airplane flew for 8 hours at an airspeed of  $x$  miles per hour (mph), and for 7 more hours at 325 mph. If the average airspeed for the entire flight was 350 mph, which of the following equations could be used to find  $x$ ?

F.  $x + 325 = 2(350)$   
G.  $x + 7(325) = 15(350)$   
H.  $8x - 7(325) = 350$   
J.  $8x + 7(325) = 2(350)$   
K.  $8x + 7(325) = 15(350)$

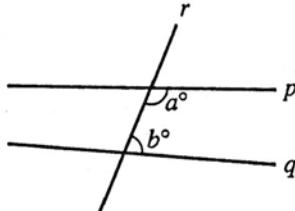
57. In the figure below,  $\overline{BCF}$  is a straight line and all distances are given in centimeters. What is the ratio of the area of quadrilateral  $ABCD$  to the area of quadrilateral  $DCFE$ ?

A. 5:7  
B. 7:5  
C. 7:9  
D. 7:27  
E. 7:34



58. In the figure below, transversal  $r$  crosses both  $p$  and  $q$ , and  $a^\circ$  and  $b^\circ$  are measures of the indicated angles, both between  $0^\circ$  and  $180^\circ$ . Lines  $p$  and  $q$  will cross somewhere to the left of transversal  $r$  (that is, on the side opposite the indicated angles). Which of the following statements best expresses a true relationship between  $a$  and  $b$  for all possible positions of transversal  $r$ ?

F.  $a < b$   
G.  $a = b$   
H.  $a + b < 180$   
J.  $a + b = 180$   
K.  $a + b > 180$



59. For what value of  $a$  will a circle centered at  $(2,-3)$  pass through points  $(1,a)$  and  $(a,3)$  in the standard  $(x,y)$  coordinate plane?

A.  $-3$   
B.  $-0.4$   
C.  $1.4$   
D.  $2$   
E.  $3$

60. If  $a$  and  $b$  are real numbers such that  $a^2 \neq b^2$ , then for what value(s) of  $x$ , if any, is the equation  $|ax + b| = |bx + a|$  true?

F. 1 only  
G.  $\pm 1$  only  
H.  $\frac{a-b}{a+b}$  only  
J. All real numbers  
K. No real numbers

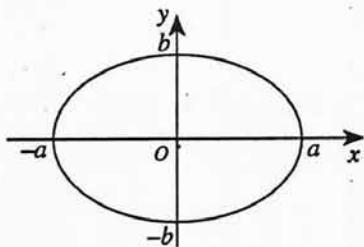
## Math Practice

50. Three sides of a triangle are 5, 13, and  $x$  inches long, respectively. Which of the following must be true of  $x$ ?

- F.  $x = 12$  only
- G.  $x = \sqrt{194}$  only
- H.  $x < 8$
- J.  $8 < x < 18$
- K.  $x$  can have any positive value

51. The area of an ellipse centered on the origin, as in the figure below, is  $\pi ab$ . A lake in the shape of an ellipse has an area of  $6\pi$  square miles. If the lake is 6 miles across at its widest point, then how many miles long is the shortest line that goes across the lake and through its center?

- A. 1
- B. 2
- C. 3
- D. 4
- E. 6

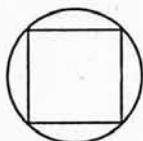


52. The formula  $(p - q)(p + q) = p^2 - q^2$  can sometimes make mental multiplication easier. For example,  $29 \cdot 31$  can be done as  $(30 - 1)(30 + 1) = 30^2 - 1^2 = 899$ . Which of the following multiplication problems could be done in this way with  $p$  a multiple of 10?

- F.  $56 \cdot 74$
- G.  $66 \cdot 74$
- H.  $76 \cdot 74$
- J.  $84 \cdot 74$
- K.  $96 \cdot 74$

53. The circle in the figure below has a radius of 1 centimeter. What is the area, in square centimeters, of the inscribed square?

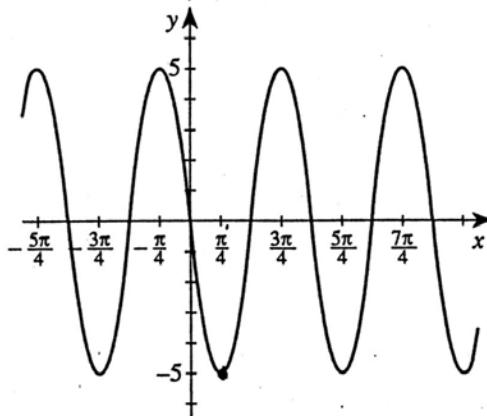
- A. 1
- B.  $\sqrt{2}$
- C. 2
- D.  $\pi$
- E. 4



54. Let  $x = |a - b|$ , where  $1 \leq a \leq 3$  and  $-1 \leq b \leq 1$ . What is the range of all possible values for  $x$ ?

- F.  $-4 \leq x \leq 4$
- G.  $-1 \leq x \leq 3$
- H.  $0 \leq x \leq 2$
- J.  $0 \leq x \leq 4$
- K.  $1 \leq x \leq 3$

55. One of the following functions is graphed below. Which one?



- A.  $y = -5 \cos x$
- B.  $y = -5 \sin x$
- C.  $y = -5 \cos 2x$
- D.  $y = -5 \sin 2x$
- E.  $y = -5 \cos \frac{1}{2}x$

56. Consider all combinations of pairs of different parabolas in the standard  $(x,y)$  coordinate plane. Which of the following lists gives the number of points of intersection that are possible for 2 different parabolas?

- F. 0 and 1 only
- G. 0, 1, and 2 only
- H. 0, 1, 2, and 3 only
- J. 0, 1, 2, and 4 only
- K. 0, 1, 2, 3, and 4

57. On a real number line, which of the following is the coordinate of the midpoint of  $\frac{2}{a}$  and  $\frac{5}{2a}$ , where  $a \neq 0$ ?

- A.  $\frac{1}{4a}$
- B.  $\frac{1}{2a}$
- C.  $\frac{3}{4a}$
- D.  $\frac{9}{4a}$
- E.  $\frac{9}{2a}$

**Math Practice**

58. In an office of 75 employees, 60 are female. Of the 75 employees, there are 30 clerical workers, 10 of whom are male. If an employee is selected at random, what is the probability of selecting a female clerical worker?

- F.  $\frac{1}{3}$   
 G.  $\frac{2}{3}$   
 H.  $\frac{2}{5}$   
 J.  $\frac{2}{15}$   
 K.  $\frac{4}{15}$

59. If  $\cos^2 x + \cos x - 2 = 0$ , and  $0^\circ \leq x \leq 90^\circ$ , then  $x = ?$

- A.  $0^\circ$   
 B.  $26^\circ$   
 C.  $35^\circ$   
 D.  $45^\circ$   
 E.  $60^\circ$

60. How many distinct solutions [ordered  $(x,y)$  pairs] are there for the following system of equations?

$$\begin{aligned} |x| &= 2 \\ |x+y| &= 5 \end{aligned}$$

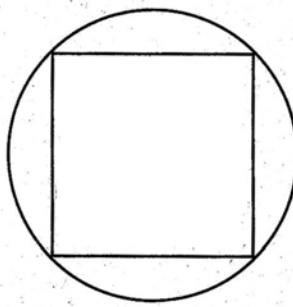
- F. 0  
 G. 1  
 H. 2  
 J. 3  
 K. 4

50. A wheel 29 inches in diameter rolls along a line without slipping. How many inches does the wheel roll along its path in 25 revolutions?

- F. 362.5  
 G. 725  
 H. 1,450  
 J.  $210.25\pi$   
 K.  $725\pi$

51. In the figure below, a square is inscribed in a circle of radius  $r$ . What is the perpendicular distance from the center of the circle to a side of the square, in terms of  $r$ ?

- A.  $\frac{r}{2}$   
 B.  $\frac{r\sqrt{2}}{2}$   
 C.  $r$   
 D.  $r\sqrt{2}$   
 E. Cannot be determined from the given information.



52. The operation  $\Delta$  is defined by the following:

$$a \Delta b = 3 + a + b - a \times b$$

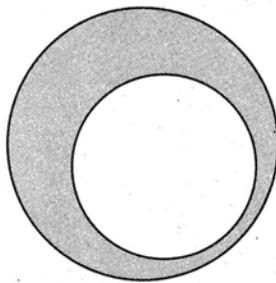
For example,  $4 \Delta 6 = 3 + 4 + 6 - 4 \times 6 = -11$ . If  $a \Delta b = b \Delta a$ , then which of the following describes all the possible values of  $a$  and  $b$ ?

- F. They are both negative.  
 G. They are both positive.  
 H. They have opposite signs.  
 J. They are equal.  
 K. They can have any values.

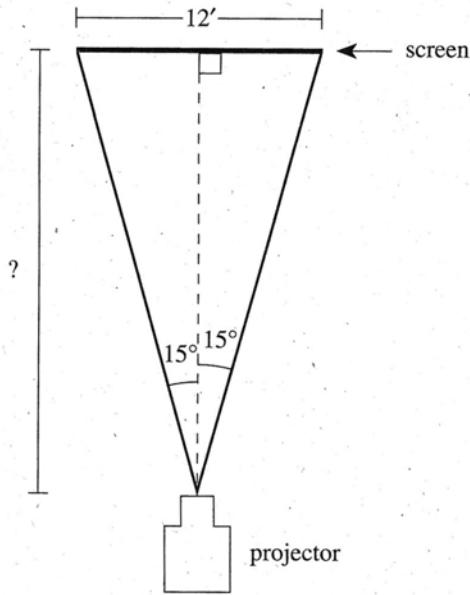
## Math Practice

53. To make a piece of jewelry, Aaron cuts out a circular piece of metal from a larger circular piece, as shown below. The radius of the larger circle is 2 inches. If the area of the cutout is to be the same as the area of the piece that remains, what should be the radius, in inches, of the inner circle?

- A. 1
- B.  $\pi$
- C.  $\sqrt{2}$
- D.  $2\sqrt{2}$
- E.  $\pi\sqrt{2}$



54. A movie projector emits light as shown in the top-view diagram below. To make the light projection cover the full width of a 12-foot screen without extending beyond the screen, the projector must be placed a certain distance from the screen. Assuming the screen is positioned directly in front of the projector as shown, which of the following expressions could be used to calculate the distance, in feet, from the projector to the screen?



- F.  $\frac{6}{\tan 15^\circ}$
- G.  $\frac{6}{\tan 30^\circ}$
- H.  $6 \tan 15^\circ$
- J.  $6 \tan 30^\circ$
- K.  $12 \tan 15^\circ$

58. The Recreation Department wants to build a circular wading pool in the city park. The area available for the pool is a fenced-in rectangular region 12 meters by 18 meters. If the Recreation Department wants the wading pool to be as large as possible, and the edge of the pool must be at least 2 meters from the fence all around, how many meters long should the radius of the pool be?

- F. 4
- G. 5
- H. 7
- J. 10
- K. 14

59. Three distinct lines, all contained in a plane, separate the plane into distinct regions. What are all of the possible numbers of distinct regions of the plane that may be separated by any 3 such lines?

(Note: Do NOT include any of the points on the 3 lines in your count of distinct regions.)

- A. 3, 4, 7
- B. 3, 6, 7
- C. 4, 5, 6
- D. 4, 5, 7
- E. 4, 6, 7

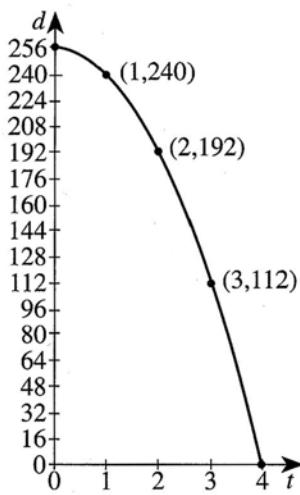
60. For any real number  $a$ , the equation  $|x - a| = 7$  can be thought of as meaning “the distance on the real number line from  $x$  to  $a$  is 7 units.” How far apart are the 2 solutions for  $x$ ?

- F.  $a$
- G.  $2a$
- H.  $7 + a$
- J.  $\sqrt{7^2 + a^2}$
- K. 14

## Math Practice

50. A flowerpot fell from a windowsill. The graph below shows the distance,  $d$  feet, the flowerpot was above the ground  $t$  seconds after it fell. The graph shows that the flowerpot fell 16 feet (from  $d = 256$  to  $d = 240$ ) during the 1st second of its fall and 48 feet (from  $d = 240$  to  $d = 192$ ) during the 2nd second of its fall. During which second of its fall, if any, was the average speed of the flowerpot, in feet per second, the greatest?

(Note: The average speed of an object over a given interval of time is the distance it traveled during the interval divided by the length of the interval.)



- F. 4th
- G. 3rd
- H. 2nd
- J. 1st
- K. None; the speed of the flowerpot was constant during its fall.

51. Each of 6 historical events occurred in a different year. You are asked to arrange the 6 events in ascending order by the years they occurred. You know the earliest and the latest. You randomly order the other events. What is the probability that you order the 6 events correctly?

- A.  $\frac{1}{720}$
- B.  $\frac{1}{120}$
- C.  $\frac{1}{24}$
- D.  $\frac{1}{6}$
- E.  $\frac{1}{4}$

52. Which of the following number line graphs shows the solution set for  $x$  of  $x^2 > 25$  ?

- F.
- G.
- H.
- J.
- K.

53. Rectangle  $ABCD$ , shown below, is reflected over  $\overline{DC}$  and then rotated  $180^\circ$  clockwise around  $C$ . Which of the following shows the final orientation of  $ABCD$  ?

- A.
- B.
- C.
- D.
- E.

## Math Practice

54. The table below shows data from the 1990 U.S. Census.

Highest level of education attained	Percent of adults 25 or older
8th grade or less	10.4
Some high school	14.4
High school diploma	30.0
Some college, no degree	18.7
Associate degree	6.2
Bachelor's degree	13.1
Graduate or professional degree	7.2

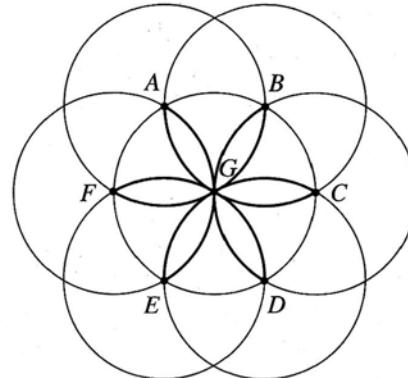
If this information were presented as a circle graph, what would be the measure of the central angle of the sector representing those for whom the highest level of education attained is a high school diploma?

- F.  $120^\circ$   
 G.  $108^\circ$   
 H.  $60^\circ$   
 J.  $54^\circ$   
 K.  $30^\circ$
55. How many  $(x,y)$  pairs of real numbers satisfy  $xy = 3$  and  $(x+y)^2 = 10$ ?
- A. 0  
 B. 1  
 C. 2  
 D. 4  
 E. Infinitely many

56. In the standard  $(x,y)$  coordinate plane, what is the range of the function defined by the equation  $y = 3 \sin(2x)$ ?
- F.  $-\pi \leq y \leq \pi$   
 G.  $-2\pi \leq y \leq 2\pi$   
 H.  $-2 \leq y \leq 2$   
 J.  $-3 \leq y \leq 3$   
 K.  $-6 \leq y \leq 6$

57. The Leaning Tower of Proville creates an  $85^\circ$  angle between itself and the level ground around the tower. The tower's shadow is 100 feet long. If it can be determined, which of the following expressions gives the distance, in feet, from the top of the tower to the ground?
- A.  $100 \cos 85^\circ$   
 B.  $100 \sin 85^\circ$   
 C.  $100 \tan 85^\circ$   
 D.  $100 \cot 85^\circ$   
 E. Cannot be determined from the given information

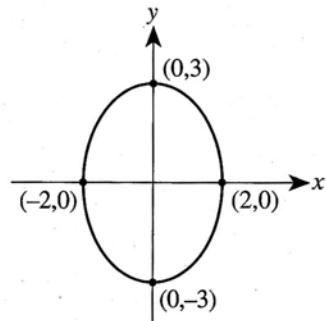
58. The 7 congruent circles shown in the figure below are centered at points A through G, and each circle has a circumference of  $24\pi$  cm. Points A through F are equally spaced on the circumference of the circle centered at G. What is the sum of the lengths, in centimeters, of the 6 thicker arcs ( $\widehat{AGC}$ ,  $\widehat{BGD}$ ,  $\widehat{CGE}$ ,  $\widehat{DGF}$ ,  $\widehat{EGA}$ , and  $\widehat{FGB}$ )?



- F.  $48\pi$   
 G.  $72\pi$   
 H.  $96\pi$   
 J.  $144\pi$   
 K.  $288\pi$

59. Which of the following is an equation of the ellipse graphed below?

- A.  $x^2 + y^2 = -6$   
 B.  $\frac{x^2}{2} + \frac{y^2}{3} = 0$   
 C.  $\frac{x^2}{2} + \frac{y^2}{3} = 1$   
 D.  $\frac{x^2}{4} + \frac{y^2}{9} = 0$   
 E.  $\frac{x^2}{4} + \frac{y^2}{9} = 1$



60. If  $x$  and  $y$  are real numbers such that  $4 \leq x \leq 12$  and  $2 \leq y \leq 4$ , then the minimum value for  $\frac{x}{y}$  is:

- F. 0  
 G. 1  
 H. 2  
 J. 3  
 K. 6

## Math Practice

49. For all positive integers  $n$ , which of the following is a correct ordering of the terms  $n^n$ ,  $(n!)^n$ , and  $(n!)^{n!}$ ?

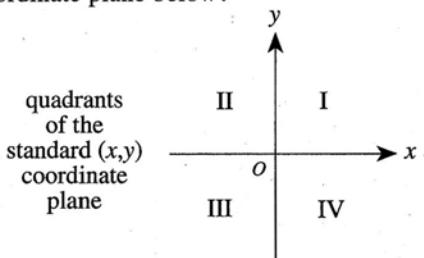
(Note:  $n! = (n)(n - 1)(n - 2) \cdots (2)(1)$ )

- A.  $n^n \geq (n!)^n \geq (n!)^{n!}$
- B.  $(n!)^n \geq n^n \geq (n!)^{n!}$
- C.  $(n!)^n \geq (n!)^{n!} \geq n^n$
- D.  $(n!)^{n!} \geq (n!)^n \geq n^n$
- E.  $(n!)^{n!} \geq n^n \geq (n!)^n$

50. What is the perimeter of quadrilateral  $ABCD$  if it has vertices with  $(x,y)$  coordinates  $A(0,0)$ ,  $B(1,3)$ ,  $C(4,4)$ ,  $D(3,1)$ ?

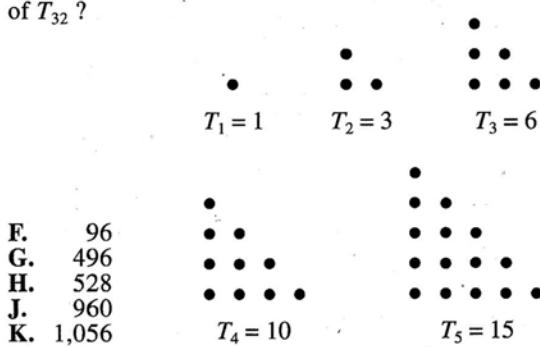
- F.  $2\sqrt{10}$
- G.  $4\sqrt{10}$
- H.  $6\sqrt{2} + 2\sqrt{10}$
- J. 40
- K. 100

51. The graph of the line with equation  $3x - 4y = 24$  does NOT have points in what quadrant(s) of the standard  $(x,y)$  coordinate plane below?



- A. Quadrant I only
- B. Quadrant II only
- C. Quadrant III only
- D. Quadrant IV only
- E. Quadrants I and II only

52. The figure below shows representations of the first 5 triangular numbers,  $T_1$  through  $T_5$ . What is the value of  $T_{32}$ ?



53. Four distinct points are chosen at random on a circle. Line segments are then drawn connecting every possible pair of these points. These line segments divide the interior of the circle into how many individual, nonoverlapping regions of nonzero area?

- A. 2
- B. 4
- C. 6
- D. 8
- E. 24

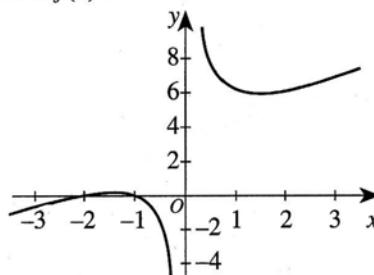
54. The radius of a circle is  $\frac{20}{\pi}$  inches. How many inches long is its circumference?

- F.  $\frac{40}{\pi}$
- G.  $\frac{400}{\pi}$
- H. 20
- J. 40
- K. 80

55. In the  $(x,y)$  coordinate plane, what is the radius of the circle having the points  $(0,-2)$  and  $(-6,6)$  as endpoints of a diameter?

- A. 5
- B. 10
- C. 14
- D. 25
- E. 100

56. The graph of the function  $f(x) = \frac{x^2 + 3x + 2}{x}$  is shown in the standard  $(x,y)$  coordinate plane below. Which of the following, if any, is a list of each of the *vertical asymptotes* of  $f(x)$ ?



- F.  $x = 0$
- G.  $x = -1$  and  $x = -2$
- H.  $y = x + 3$
- J.  $y = 3x + 2$
- K. This function has no vertical asymptote.

## Math Practice

57. The sum of 2 positive prime numbers is a prime number, and 3 times that sum is an odd number. Which of the following prime numbers *must* be one of the original prime numbers?

A. 2  
B. 3  
C. 5  
D. 7  
E. 11

58. The set of points created by the midpoints of all chords of length 4 centimeters in a circle of radius 8 centimeters is a:

F. point.  
G. line segment.  
H. line.  
J. semicircle.  
K. circle.

59. If  $h(x) = f(x) - g(x)$ , where  $f(x) = 5x^2 + 15x - 25$  and  $g(x) = 5x^2 - 6x - 11$ , then  $h(x)$  is *always* divisible by which of the following?

A. 3  
B. 5  
C. 7  
D. 9  
E. 17

60. A square,  $S_1$ , has a perimeter of 40 inches. The vertices of a second square,  $S_2$ , are the midpoints of the sides of  $S_1$ . The vertices of a third square,  $S_3$ , are the midpoints of the sides of  $S_2$ . Assume the process continues indefinitely, with the vertices of  $S_{k+1}$  being the midpoints of the sides of  $S_k$  for every positive integer  $k$ . What is the sum of the *areas*, in square inches, of  $S_1, S_2, S_3, \dots$ ?

F.  $\frac{40}{3}$   
G. 20  
H. 70  
J.  $\frac{400}{3}$   
K. 200

50. In a science class experiment, Charles measured the length of a spring after hanging each of several different weights from it. His data is recorded in the chart below.

Weight hung from spring, in grams <i>x</i>	Length of spring, in centimeters <i>y</i>
50	23
85	33.5
110	41

Based on Charles's experiment, which of the following equations best represents the linear relationship between the weight hung from the spring and the length of the spring?

F.  $y = 0.3x + 8$   
G.  $y = 0.3x - 8$   
H.  $y = 0.3x - 27$   
J.  $y = 0.5x + 2$   
K.  $y = 0.5x - 2$

51. If  $k$  and  $n$  are integers greater than 1, and  $k!$  is divisible by  $n!$ , then which of the following *must* be true?

(Note:  $k! = 1 \cdot 2 \cdot 3 \cdot 4 \cdots \cdot k$ )

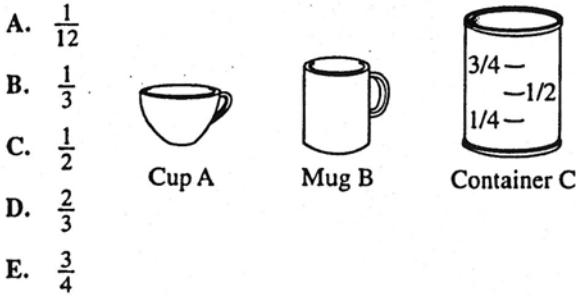
A.  $k \geq n$   
B.  $k < n$   
C.  $k$  is divisible by  $n$   
D.  $k$  and  $n$  have 1 as their only common factor  
E.  $k$  and  $n$  have 1 and 2 as their only common factors

52. An equal number of nickels, dimes, and quarters in a cash register have a value of  $T$  cents. Which of the following is NOT always a divisor of  $T$ ?

F. 40  
G. 25  
H. 20  
J. 10  
K. 5

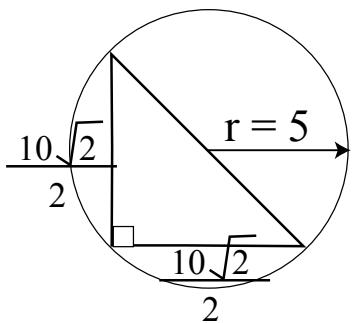
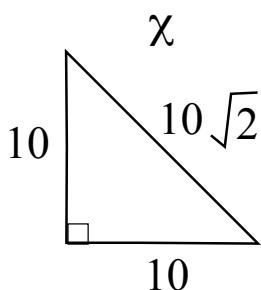
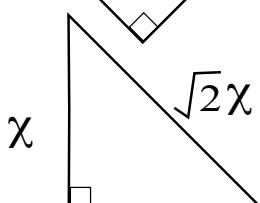
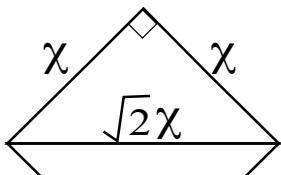
53. The figure below shows Cup A, Mug B, and Container C. Container C has marks on its side to indicate various fractional capacities. Using Cup A, it takes 3 cupfuls of water to fill Container C to the  $\frac{1}{2}$  mark. Then adding 1 mugful of water using Mug B raises the water level to the  $\frac{3}{4}$  mark. Cup A can hold what fraction of the water that Mug B can hold?

A.  $\frac{1}{12}$   
B.  $\frac{1}{3}$   
C.  $\frac{1}{2}$   
D.  $\frac{2}{3}$   
E.  $\frac{3}{4}$

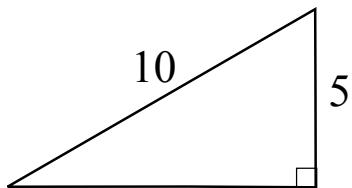
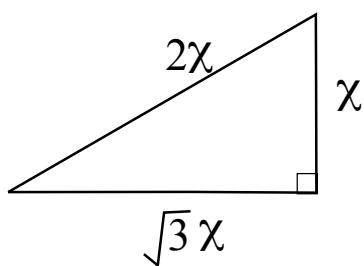
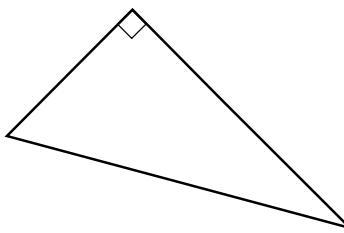




## 45-45-90 Triangles



## 30-60-90 Triangles

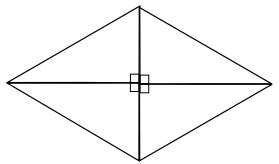


$$\frac{6\sqrt{3}}{3} = 2\sqrt{3}$$

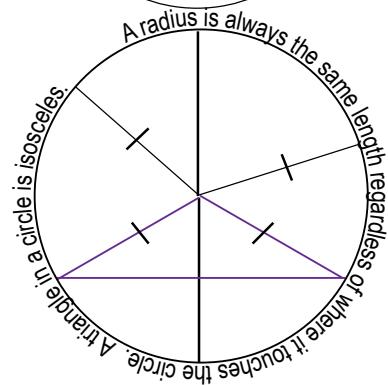
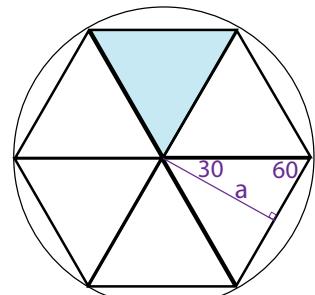
A right triangle with legs of  $2\sqrt{3}$  and  $6$ , and a hypotenuse of  $4\sqrt{3}$ .

## 3 - 4 - 5 Triangle 5 - 12 - 13 Triangle

rhombus  
square  
rectangle  
parallelogram



Watch for other shapes that can be broken into triangles  
A Regular Hexagon  $\rightarrow$  6 equilateral triangles  
1 equilateral triangle  $\rightarrow$  two 30-60-90 triangles



Watch for circle segments that can be broken into triangles

Circumference of a Circle-  $2\pi r$

## Area

Circle -  $\pi r^2$

Triangle -  $\frac{1}{2}bh$

Rectangle -  $LW$

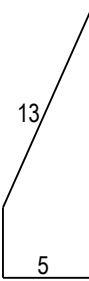
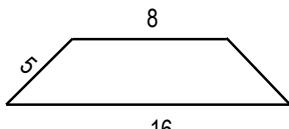
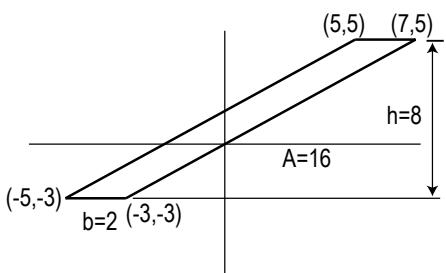
Parallelogram -  $bh$

Trapezoid -  $\frac{b_1+b_2}{2} h$

## Volume

Sphere  $\frac{4}{3}\pi r^3$

Cylinder  $\pi r^2 L$

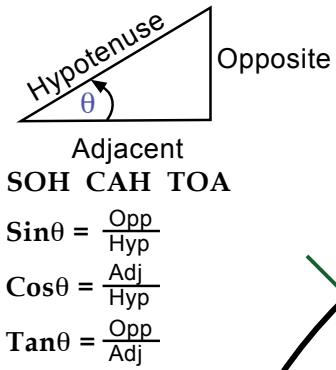


Total Degrees in a polygon =  $(N - 2) \times 180$

Degrees per angle in a regular polygon =

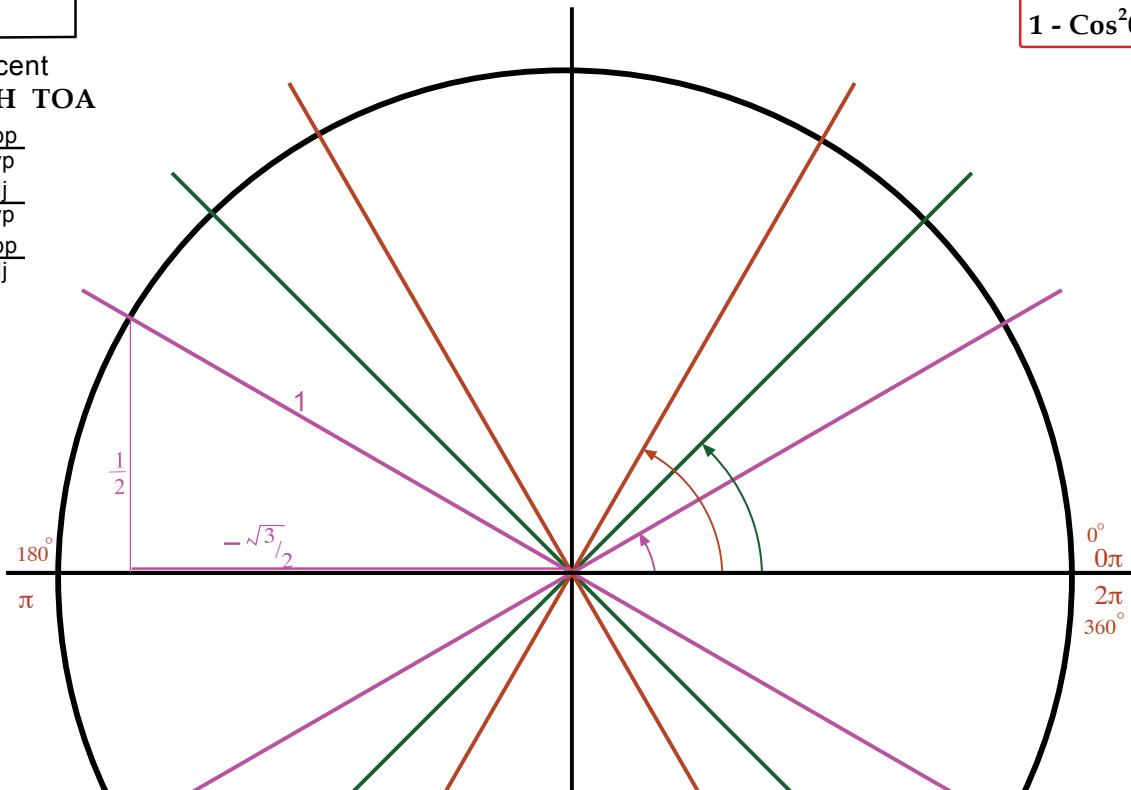
$$\frac{(N - 2) \times 180}{N}$$





# The Unit Circle and Trig Functions

$$\begin{aligned}\sin^2\theta + \cos^2\theta &= 1 \\ 1 - \sin^2\theta &= \cos^2\theta \\ 1 - \cos^2\theta &= \sin^2\theta\end{aligned}$$



$\alpha$	0	30	45	60	90	120	135	150	180	210	225	240	270	300	315	330	360
Radians	0					$\frac{2\pi}{3}$	$\frac{3\pi}{4}$	$\frac{5\pi}{6}$	$\pi$	$\frac{7\pi}{6}$	$\frac{5\pi}{4}$	$\frac{4\pi}{3}$	$\frac{3\pi}{2}$	$\frac{5\pi}{3}$	$\frac{7\pi}{4}$	$\frac{11\pi}{6}$	$2\pi$
Sin	0					$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{1}{2}$	0	$-\frac{1}{2}$	$-\frac{\sqrt{2}}{2}$	$-\frac{\sqrt{3}}{2}$	-1	$-\frac{\sqrt{3}}{2}$	$-\frac{\sqrt{2}}{2}$	$-\frac{1}{2}$	0
Cos	1					$-\frac{1}{2}$	$-\frac{\sqrt{2}}{2}$	$-\frac{\sqrt{3}}{2}$	-1	$-\frac{\sqrt{3}}{2}$	$-\frac{\sqrt{2}}{2}$	$-\frac{1}{2}$	0	$\frac{1}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	1
Tan	0					$-\sqrt{3}$	-1	$-\frac{\sqrt{3}}{3}$	0	$\frac{\sqrt{3}}{3}$	1	$\sqrt{3}$		$-\sqrt{3}$	-1	$-\frac{\sqrt{3}}{3}$	0

Answers to Science Practice problems

<b>Page 29</b>	1	C
	2	G
	3	A
	4	G
	5	C
<b>Page 31</b>	6	H
	7	D
	8	G
	9	A
	10	F
<b>Page 33</b>	11	B
	12	J
	13	C
	14	G
	15	C
<b>Page 35</b>	16	G
	17	A
	18	F
	19	D
	20	J
<b>Page 37</b>	21	G
	22	D
	23	H
	24	A
	25	J
<b>Page 38</b>	26	D
	27	J
	28	A
	29	F
	30	D
<b>Page 39</b>	31	G
	32	B
	33	H
	34	A
	35	J
<b>Page 41</b>	36	C
	37	F
	38	B
	39	J
	40	D

<b>Page 43</b>	1	G
	2	C
	3	H
	4	D
	5	H
	6	B
<b>Page 44</b>	7	F
	8	C
<b>Page 45</b>	9	J
	10	A
	11	F
	12	B
<b>Page 47</b>	13	F
	14	D
	15	G
	16	C
	17	J
	18	C
<b>Page 49</b>	19	H
	20	D
	21	J
	22	D
	23	G
	24	A
<b>Page 50</b>	25	D
	26	F
<b>Page 51</b>	27	C
	28	H
	29	C
	30	F
<b>Page 52</b>	31	D
<b>Page 53</b>	32	H
	33	A
	34	G
	35	D
	36	J
<b>Page 54</b>	37	D
	38	G
	39	C
<b>Page 55</b>	40	F
	41	C
	42	J
<b>Page 57</b>	43	H
	44	B
	45	H
	46	D
	47	J
	48	D

<b>Page 58</b>	1	F
	2	B
	3	G
<b>Page 60</b>	8	B
	9	G
	10	B
	11	H
	12	A
<b>Page 61</b>	13	H
	14	C
<b>Page 62</b>	15	G
	16	D
	17	F
	18	C
	19	F
	20	D
<b>Page 63</b>	21	F
<b>Page 64</b>	22	F
	23	B
	24	G
	25	C
	26	H
<b>Page 65</b>	27	A
	28	H

**Answers to Math Practice Problems**

<b>Page 67</b>	<b>27</b>	<b>D</b>
	<b>28</b>	<b>K</b>
	<b>29</b>	<b>B</b>
	<b>30</b>	<b>H</b>
	<b>31</b>	<b>D</b>
	<b>32</b>	<b>F</b>
<b>Page 68</b>	<b>33</b>	<b>B</b>
	<b>34</b>	<b>J</b>
	<b>35</b>	<b>B</b>
	<b>36</b>	<b>G</b>
	<b>37</b>	<b>C</b>
	<b>38</b>	<b>J</b>
<b>Page 69</b>	<b>26</b>	<b>G</b>
	<b>27</b>	<b>B</b>
	<b>28</b>	<b>J</b>
	<b>29</b>	<b>B</b>
	<b>30</b>	<b>J</b>
<b>Page 70</b>	<b>31</b>	<b>E</b>
	<b>32</b>	<b>F</b>
	<b>33</b>	<b>A</b>
	<b>34</b>	<b>F</b>
	<b>35</b>	<b>A</b>
	<b>36</b>	<b>K</b>
<b>Page 71</b>	<b>37</b>	<b>E</b>
	<b>38</b>	<b>J</b>
	<b>39</b>	<b>C</b>
	<b>40</b>	<b>H</b>
	<b>41</b>	<b>E</b>
	<b>42</b>	<b>G</b>
	<b>43</b>	<b>C</b>
	<b>44</b>	<b>G</b>
<b>Page 72</b>	<b>29</b>	<b>C</b>
	<b>30</b>	<b>K</b>
	<b>31</b>	<b>B</b>
	<b>32</b>	<b>J</b>
	<b>33</b>	<b>C</b>
	<b>34</b>	<b>J</b>
	<b>35</b>	<b>C</b>
	<b>36</b>	<b>H</b>

<b>Page 73</b>	<b>37</b>	<b>D</b>
	<b>38</b>	<b>F</b>
	<b>39</b>	<b>D</b>
	<b>40</b>	<b>F</b>
	<b>41</b>	<b>B</b>
	<b>42</b>	<b>H</b>
	<b>43</b>	<b>D</b>
	<b>44</b>	<b>K</b>
	<b>45</b>	<b>D</b>
	<b>46</b>	<b>K</b>
<b>Page 74</b>	<b>47</b>	<b>E</b>
	<b>48</b>	<b>J</b>
	<b>49</b>	<b>B</b>
	<b>44</b>	<b>J</b>
	<b>45</b>	<b>A</b>
	<b>46</b>	<b>G</b>
<b>Page 75</b>	<b>38</b>	<b>F</b>
	<b>39</b>	<b>E</b>
	<b>40</b>	<b>J</b>
	<b>41</b>	<b>A</b>
	<b>42</b>	<b>J</b>
	<b>46</b>	<b>G</b>
	<b>47</b>	<b>E</b>
	<b>48</b>	<b>J</b>
	<b>49</b>	<b>B</b>
	<b>50</b>	<b>H</b>
<b>Page 76</b>	<b>51</b>	<b>A</b>
	<b>52</b>	<b>G</b>
	<b>53</b>	<b>C</b>
	<b>54</b>	<b>H</b>
	<b>55</b>	<b>C</b>
	<b>56</b>	<b>K</b>
	<b>57</b>	<b>D</b>
	<b>58</b>	<b>K</b>
	<b>59</b>	<b>E</b>
	<b>60</b>	<b>G</b>
<b>Page 77</b>	<b>50</b>	<b>J</b>
	<b>51</b>	<b>D</b>
	<b>52</b>	<b>G</b>
	<b>53</b>	<b>C</b>
	<b>54</b>	<b>J</b>
	<b>55</b>	<b>D</b>
	<b>56</b>	<b>K</b>
	<b>57</b>	<b>D</b>

<b>Page 78</b>	<b>58</b>	<b>K</b>
	<b>59</b>	<b>A</b>
	<b>60</b>	<b>K</b>
	<b>50</b>	<b>K</b>
	<b>51</b>	<b>B</b>
	<b>52</b>	<b>K</b>
<b>Page 79</b>	<b>53</b>	<b>C</b>
	<b>54</b>	<b>F</b>
	<b>58</b>	<b>F</b>
	<b>59</b>	<b>E</b>
	<b>60</b>	<b>K</b>
<b>Page 80</b>	<b>50</b>	<b>F</b>
	<b>51</b>	<b>C</b>
	<b>52</b>	<b>F</b>
	<b>53</b>	<b>C</b>
<b>Page 81</b>	<b>54</b>	<b>G</b>
	<b>55</b>	<b>A</b>
	<b>56</b>	<b>J</b>
	<b>57</b>	<b>E</b>
	<b>58</b>	<b>F</b>
	<b>59</b>	<b>E</b>
	<b>60</b>	<b>G</b>
<b>Page 82</b>	<b>49</b>	<b>D</b>
	<b>50</b>	<b>G</b>
	<b>51</b>	<b>B</b>
	<b>52</b>	<b>H</b>
	<b>53</b>	<b>D</b>
	<b>54</b>	<b>J</b>
	<b>55</b>	<b>A</b>
	<b>56</b>	<b>F</b>
<b>Page 83</b>	<b>57</b>	<b>A</b>
	<b>58</b>	<b>K</b>
	<b>59</b>	<b>C</b>
	<b>60</b>	<b>K</b>
	<b>50</b>	<b>F</b>
	<b>51</b>	<b>A</b>
	<b>52</b>	<b>G</b>
	<b>53</b>	<b>D</b>

## Usage/Mechanics

### **1. The comma**

The comma with conjunctions

He wanted to go to the store, but he didn't have a car.

(The other possible conjunctions are for, and, nor, or, yet, so)

#### **The comma with items in a series**

I'm going to buy fruit, meat, vegetables, and ice cream.

#### **The comma with coordinate adjectives**

He washed his new, black, shiny pickup.

(If "and" can go between all of the adjectives and the sentence still make sense, then you use commas--if it doesn't make sense, don't use a comma - They all admired the tall, powerful football player)

#### **The comma-with nonrestrictive phrases** (when a dependent clause is introducing an independent clause)

When the composer was finished playing, he exited the building.

#### **The comma with nonessential phrases**

Mary, who is my best friend, is going with me to the mall.

### **2. The semi-colon - It joins two complete sentences**

a. The most common use is when joining two complete sentences that are related.

Ex. Christy is going out tonight; she has a date with David.

b. The second use is joining two sentences with a conjunctive adverb.

Ex. I'm going tonight; however, I can't stay late.

### **3. The colon and the apostrophe**

\*\* Whatever is to the left of a colon must be a complete sentence. The right can be another complete sentence, one word, a list, or just a thought.

### **4. Sentence Fragments and Run-on sentences**

### **5. The dash**

The dash generally signals an abrupt interruption that gives extra information or an interjection of some kind. It creates a stronger pause than the comma. \*\*Dashes, commas, and parentheses around a phrase all function the same way. They all enclose nonessential information.\*\*

### **6. Further/Farther - farther is a distance**

Ex. How much farther is it to the mall?

How much farther down the hall do I have to walk?

Ex. Are you going to further your education by going to college?

We will further this discussion tomorrow when we have more time.

**7. Understanding could've, would've, and should've.**

One cannot use could've or would've to mean "could of" or "would of." The contractions mean "could have" or "would have."

\*Incorrect: She could of come over tonight.

\*Correct: She could have come over tonight.

**8. Affect versus Effect** (Affect is a verb / Effect is a noun)**9. It's Its Its' ← Not a word**

## Commas With Conjunctions

- \_\_\_\_\_ 1. Eurystheus was King of Mycenae but his subject Heracles was much better known and more respected.
- \_\_\_\_\_ 2. Eurystheus grew jealous of Heracles' fame, and ordered him to perform twelve impossibly difficult tasks.
- \_\_\_\_\_ 3. The king hoped that Heracles would be killed performing the dangerous tasks but even these duties proved no match for the great hero.
- \_\_\_\_\_ 4. The tasks Heracles performed have become known as the Twelve Labors of Hercules and any task that seems almost impossibly difficult is today known as "Herculean."
- \_\_\_\_\_ 5. Heracles submitted to the king's command and the first labor he performed was to slay the dreaded lion of Nemea.
- \_\_\_\_\_ 6. The lion could not be killed with weapons but Heracles caught it, and strangled it with his bare hands.
- \_\_\_\_\_ 7. Perhaps Heracles' most wonderful labor was, cleaning the Augean stables.
- \_\_\_\_\_ 8. These stables housed 3000 head of cattle, and had not been cleaned for thirty years but Heracles knocked a hole in the stable wall, and diverted two mighty rivers to rush through, and clean the filthy stables.
- \_\_\_\_\_ 9. The hero performed numerous other fabulous feats but still Eurystheus thought of more to challenge Heracles.
- \_\_\_\_\_ 10. Apples of the Daughters of the Night. by tricking the Titan Ajax.
- \_\_\_\_\_ 11. The final labor was to bring Eurystheus the three-headed dog who guarded the entrance to the Underworld, yet even the forces of the dead proved no match for the hero.
- \_\_\_\_\_ 12. When he had completed all twelve labors, Heracles was more famous and admired than ever and the jealous King Eurystheus was forced to leave the hero alone.

**Commas with Items in a Series and Coordinate Adjectives**

- \_\_\_\_\_ 1. Break the eggs into a bowl, beat them lightly with a fork and then add the melted butter.
- \_\_\_\_\_ 2. The sad, angry, contestant walked slowly off the stage.
- \_\_\_\_\_ 3. Lena and Heather researched, wrote, and presented their analysis of the election of 1994.
- \_\_\_\_\_ 4. Thomas Hardy's Tess of the d'Urbervilles is a poignant hard-hitting novel of life in rural England at the end of the nineteenth century.
- \_\_\_\_\_ 5. Among the different types of lettuce available at our grocery store are iceberg, endive, red leaf, and romaine.
- \_\_\_\_\_ 6. Children are taught to stop look and listen before crossing a street.
- \_\_\_\_\_ 7. A loud, smelly truck pulled into our driveway and turned around.
- \_\_\_\_\_ 8. Dad thinks he lost his wallet at either the office the swimming pool, or the drug store.
- \_\_\_\_\_ 9. The piece began with a clash of cymbals then the trumpets played a fanfare and the violins introduced the main theme.
- \_\_\_\_\_ 10. The smoke from the campfire curled upward, mingled with the leaves on the trees and disappeared.
- \_\_\_\_\_ 11. The gardener dug the hole placed the tulip bulb at the proper depth and covered it with a mixture of dirt and compost.

## Commas with Nonessential Phrases

1. Maria caught a bass a popular kind of fish and was very excited.
  2. Sir Richard Burton, an English explorer, tried unsuccessfully to discover the sources of the Nile River.
  3. Volleyball players, who can spike as accurately as she can, are few and far between.
  4. Meet the Beatles the Beatles' first U.S. album was one of the most popular and fastest-selling albums ever recorded.
  5. Pete's mom ordered a cappuccino a kind of coffee that has steamed milk after the meal.
  6. Hikers, who are not prepared for weather changes, pay the price by getting cold, hot, or sick.
  7. That cat, climbing on the fence, has been meowing all night!
- 

## Run-on Sentences

1. Garnet owned several first-edition books she bought one of them in a yard sale.
2. A severe financial panic has hit the U.S. which is reminding people of the Great Depression.
3. Do you think rust protection is worth the added expense since we don't experience much ice and snow in the South?
4. I think we should do something about the overgrown playground on First Avenue North it is becoming a danger to the community.
5. Have you ever tried floating in the ocean on a raft you can't stay in the same place for long because the current pulls you in one direction or another?
6. I'm going to advise the students to return to their classrooms it's getting too loud in the hallway.

## Semi-colons

- \_\_\_\_\_ 1. Brick is a longtime favorite as a building material because of its good looks and sturdiness; moreover, it can be virtually free of maintenance.
- \_\_\_\_\_ 2. The sphinx is a fascinating creature from ancient mythology its body was that of lion, while its head was portrayed as that of a man or woman, ram, or hawk.
- \_\_\_\_\_ 3. The silver-haired senator was considered the eminence grise of his party that is, he was its senior statesman, or “gray eminence.”
- \_\_\_\_\_ 4. The list of performers for tonight’s talent show includes Marty Allerdyece, who will play the piano Jason McPherson, who will do a tumbling routine and the Chang twins, who will juggle items the audience donates.
- \_\_\_\_\_ 5. We will not go along with your plan to disrupt the shareholders’ meeting; furthermore, we will oppose it with all our strength.
- \_\_\_\_\_ 6. Self-portraits are among the most powerful of all paintings the self-portraits of Rembrandt and Van Gogh stand out for their revealing intensity.
- \_\_\_\_\_ 7. Sonya watched a video the night before the math exam instead of studying consequently, she received a D on the test.
- \_\_\_\_\_ 8. The bald eagle faces a raft of serious challenges to is continues survival nevertheless, in many areas it is beginning to make a comeback.
- \_\_\_\_\_ 9. The mid-nineteenth century saw the rise of nursing as a modern profession; both Florence Nightingale and Clara Barton are pioneers of the field.

## Pronoun Agreement

Lesson 59

### Agreement with Indefinite Pronoun Antecedents

Use a singular personal pronoun when the antecedent is a singular indefinite pronoun, and use a plural personal pronoun when the antecedent is a plural indefinite pronoun.

**Each** of the girls on the team has her own shin pads,

**Both** of the dogs lost their collars.

Note in the first sentence, with the prepositional phrase *of the girls*, that even though the object of the preposition *of* is plural, *girls*, you use the personal pronoun that agrees with the indefinite pronoun *each*.

Traditionally, the indefinite antecedent has taken a masculine pronoun. Today, you may use a variety of forms.

#### SINGULAR INDEFINITE PRONOUNS

anybody	anyone	anything	each	either	everybody
everyone	everything	much	neither	nobody	no one
nothing	one	other	somebody	someone	something

#### PLURAL INDEFINITE PRONOUNS

Several	Both	Few	Many		
---------	------	-----	------	--	--

#### SINGULAR OR PLURAL INDEFINITE PRONOUNS

Some	All	Any	Most	none	
------	-----	-----	------	------	--

**Exercise 1** Underline the antecedent in each sentence. In the blank, write a personal pronoun that agrees with the antecedent. In some cases, you may write more than one pronoun

Each one must bring his or her own art materials.

1. Few of the gardeners abandon \_\_\_\_\_ gardens in the summer.
2. Everyone will be required to turn in \_\_\_\_\_ science report next week.
3. Many of the videos were not in \_\_\_\_\_ correct jackets.
4. Each of the sopranos has learned \_\_\_\_\_ part for the oratorio.
5. If anyone has a different idea, I'd like to hear \_\_\_\_\_ express it.
6. One of the photos has \_\_\_\_\_ own separate cellophane cover.
7. Each of the fathers took \_\_\_\_\_ daughter to the banquet.
8. Neither of the women gave \_\_\_\_\_ testimony at the trial.

## Pronoun Agreement

1. No one at the game wanted \_\_\_\_\_ team to lose.
2. Suddenly, all of the computers flashed errors messages on \_\_\_\_\_ screens.
3. Both of the brothers took \_\_\_\_\_ astronomy lessons seriously.
4. Either of the sisters can recite \_\_\_\_\_ original poems.
5. Somebody has left \_\_\_\_\_ history project in the art room.
6. Everything in the museum had \_\_\_\_\_ name correctly labeled.
7. Both of the semifinalist brought \_\_\_\_\_ supporters to the tournament.
8. Everybody wants to show \_\_\_\_\_ courage in a crisis.
9. Does anyone know the combination to \_\_\_\_\_ lock?
10. Many of the travelers lost \_\_\_\_\_ luggage in the crash.
11. A few of the books are harder to read than \_\_\_\_\_ covers would suggest.
12. Several took \_\_\_\_\_ tests later than the other students.
13. Nobody in the room wants to give \_\_\_\_\_ opinion.
14. One of the flowers has dropped \_\_\_\_\_ petals
15. Many of our friends have painted \_\_\_\_\_ homes recently.
16. Each of the brothers has \_\_\_\_\_ own area of expertise.
17. More of their relatives came to \_\_\_\_\_ family reunion this year.
18. Several of the birds ate \_\_\_\_\_ fill at the feeder.
19. Everyone must declare \_\_\_\_\_ major by junior year.
20. One of the sisters rode \_\_\_\_\_ bicycle to school every day.
21. Each of the garden tools has \_\_\_\_\_ own place in the garage.
22. Does anyone know the exact time of \_\_\_\_\_ birth?
23. Few of the tributaries have had \_\_\_\_\_ water quality improved recently.
24. Several of the skiers broke \_\_\_\_\_ legs on the slopes.
25. One of the cars had \_\_\_\_\_ tires stolen.
26. Both of the actors got \_\_\_\_\_ awards on the same night.
27. Everything in nature has \_\_\_\_\_ own place.
28. Has anyone lost \_\_\_\_\_ ring?
29. Another of those storms has left \_\_\_\_\_ mark on our region.
30. Someone has left \_\_\_\_\_ band instrument on the bus.

## Colons

1. The members of the Rock and Roll Hall of Fame include: Chuck Berry, Buddy Holly, and Sam Cooke.
  2. The petition began with this statement “Because of our concern for our public sanitation, we are calling for a community clean-up day on November 10.”
  3. Among the ingredients found on pizza were: pepperoni, olives, and pineapple.
  4. While coffee is very popular in most countries: tea is the beverage of choice in the southern United States.
  5. It took a long time before I realized where the strange, fretful noises were coming from the mule was making.
  6. The boss’s orders left the employees with two choices do all the requirements of the job or experience termination from the job.
  7. One question was uppermost in the mind of everyone in the room: how much longer was this meeting going to last?
- 

## Apostrophes

1. Franciscan father Marcos de Niza and an enslaved person name Estavan entered the area in 1539, and their (explorations’/exploration’s) goal was finding goods like gold or silver that would bring them great fortune.
2. The (Europeans’/European’s) settlement in the United States has more impact on our culture and language than many people realize.
3. (Kristy’s/Kristys’) backpack is on the table.
4. (Wes’s/Wes’) car needs to be washed and waxed.
5. Beginning in the early (1800s/1800’s), settlers from the East began to arrive in New Mexico.
6. The dog chased (it’s/its/its’) tail and entertained the people for hours.
7. The (People’s/Peoples’) Choice Awards is just another excuse for celebrities to dress up and spend thousands of dollars in one night.

**ENGLISH TEST****45 Minutes—75 Questions**

**DIRECTIONS:** In the five passages that follow, certain words and phrases are underlined and numbered. In the right-hand column, you will find alternatives for the underlined part. In most cases, you are to choose the one that best expresses the idea, makes the statement appropriate for standard written English, or is worded most consistently with the style and tone of the passage as a whole. If you think the original version is best, choose "NO CHANGE." In some cases, you will find in the right-hand column a question about the underlined part. You are to choose the best answer to the question.

You will also find questions about a section of the passage, or about the passage as a whole. These questions do not refer to an underlined portion of the passage, but rather are identified by a number or numbers in a box.

For each question, choose the alternative you consider best and fill in the corresponding oval on your answer document. Read each passage through once before you begin to answer the questions that accompany it. For many of the questions, you must read several sentences beyond the question to determine the answer. Be sure that you have read far enough ahead each time you choose an alternative.

**PASSAGE I****Fragile Contents**

The book arrived in a disappointing package.

It was small and narrow, wrapped in plain brown paper.

My mother's faint handwriting covered the outside.

<sup>1</sup>

*Fragile*, she writes next to my address and along each of

<sup>2</sup>

the sides, I wasn't sure, for a moment, whether she meant  
<sup>3</sup> to warn the postal workers or me. We had waited years

for the publication of this book there were very few copies.

<sup>4</sup>

It had taken months for me to convince my mother to  
send me hers. The contents of this package were indeed

fragile, I thought, but not in any of the expected ways.

<sup>5</sup>

1. A. NO CHANGE  
B. handwriting, which she did right-handed,  
C. right-handed handwriting,  
D. writing, using her right hand,
2. F. NO CHANGE  
G. were to write  
H. had it written  
J. had written
3. A. NO CHANGE  
B. sides  
C. sides as  
D. sides.
4. F. NO CHANGE  
G. book, and  
H. book, which  
J. book, of that
5. A. NO CHANGE  
B. fragile, I thought  
C. fragile. I thought  
D. fragile; I thought,

It was a handbook of the Miami language. Published by the Miami Nation of Oklahoma.  
<sup>6</sup>

It seemed too small, too light, to contain the building blocks of an entire language, one that had lain dormant for me for over thirty years. In fact, only a few of the oldest members of the tribe remember speaking the language at all. I had expected something larger and heavier, as

substantial as my *Webster's Dictionary*. A folded note from my mother was tucked between the pages.  
<sup>8</sup>

I glanced and looked through the pages. Then I read about the different parts of speech, about Miami vowels and consonants. However, it was when I began pronouncing the words to myself; that I felt the true weight of the book. As I spoke, I was immediately overwhelmed with images of my great-grandfather. I remembered the way he is used to read to me when I was very young. He  
<sup>11</sup>

would point to the pictures in my storybooks, and giving things their Miami names. I remembered him pointing to a tree, a cloud, a dog, and naming them in the Miami language, giving them back to me in the language of his own childhood.  
<sup>13</sup>

6. F. NO CHANGE  
G. language; published  
H. language, published  
J. language that they published
7. A. NO CHANGE  
B. Too small, too light, it seemed to have lain dormant for me for over thirty years, one that contained the building blocks of an entire language.  
C. Containing the building blocks of an entire language that for me seemed too small, too light, it had lain dormant for over thirty years.  
D. Seemingly lying dormant for me for over thirty years, the building blocks, too light, too small, were of an entire language.
8. Given that all the choices are true, which one would most effectively illustrate the difference between the writer's expectations of the book and its actual appearance?  
F. NO CHANGE  
G. Instead, the Miami handbook rested comfortably in the palm of my hand.  
H. In fact, it lacked a paper jacket to protect the cover.  
J. These pages contained important cultural history.
9. A. NO CHANGE  
B. was looking and glancing,  
C. glanced  
D. glanced, looking
10. F. NO CHANGE  
G. myself  
H. myself—  
J. myself,
11. A. NO CHANGE  
B. used to  
C. use to  
D. used a
12. F. NO CHANGE  
G. storybooks and  
H. storybooks, then  
J. storybooks,
13. At this point in the essay, the writer wants to suggest the significance that the Miami language held for her great-grandfather. Given that all the choices are true, which one would best accomplish that purpose?  
A. NO CHANGE  
B. voice I remembered.  
C. Miami language.  
D. words that were so hard for me to understand.

After he died, it was a language I never heard again—  
nonetheless, until I heard myself struggling with the words

14

he would use so easily all those years ago, his voice  
<sup>15</sup> coming back as vividly as if he were next to me once again, pointing to the page, guiding me.

**PASSAGE II****The Geese of Horicon Marsh**

One Sunday morning in September, I convinced several friends to accompany me to a wildlife preserve famous for the remarkable number of Canada geese that stop during their annual migration there. This preserve, <sup>16</sup> Horicon Marsh, is located in southeast Wisconsin, just a three-hour drive from my home.

I hadn't been to Horicon Marsh in a few years, but my memories of visiting the preserve were still vivid. Often, when I feel

17

a need within myself to have a tranquil moment, <sup>18</sup> I try to summon images of the tall grasses and furry cattails and the mallards, herons, and geese whom are found in the 32,000-acre marsh.

19

Thinking about the geese is always especially comforting.

20

- 14.** F. NO CHANGE  
 G. furthermore,  
 H. because,  
 J. that is,

- 15.** A. NO CHANGE  
 B. would  
 C. would of used  
 D. had used

- 16.** The best placement for the underlined phrase would be:

- F. where it is now.  
 G. after the word *preserve*.  
 H. after the word *geese*.  
 J. after the word *there* (ending the sentence with a period).

- 17.** A. NO CHANGE  
 B. vivid up to the present moment.  
 C. vividly stamped on my memory.  
 D. vividly fresh and alive.

- 18.** F. NO CHANGE  
 G. to experience a condition of tranquillity,  
 H. for tranquillity,  
 J. for it,

- 19.** A. NO CHANGE  
 B. whom can be found  
 C. that can be found  
 D. that are finding

- 20.** Given that all the choices are true, which one best supports the point that memories of visiting the wildlife preserve have a personal effect on the narrator?

- F. NO CHANGE  
 G. This is the largest freshwater marsh in the United States.  
 H. It's been designated as a "Globally Important Bird Area."  
 J. It's an extremely large and beautiful place.

Their sheer number—thousands upon thousands of them coming down from Hudson Bay in Canada—are astonishing.

The sound of the distant honking of these majestic birds always makes me look up.

Therefore, I'm moved by the timbre of their voices and the romantic notion that they get the urge to travel when the seasons change. I've always felt that the migration of the Canada geese symbolizes the arrival of fall, which is the favorite season of many people.

As my friends and I drove to Horicon Marsh that cool morning, I suddenly recalled a trip from my childhood. I recalled sitting in the back seat of our station wagon, looking out in awe at all the geese. My mother was saying, "Look how close they are!" and my father was turning his face toward the slate gray sky in wonder. The V-shaped skein of geese was so large that it seemed to stretch across the sky.

That memory was in my mind during the drive to Horicon Marsh. When my friends and I got to the marsh, we wandered around. We trained our binoculars

on the white herons laughed at the frolicking mallards,

21. A. NO CHANGE  
B. have been  
C. were  
D. is
22. F. NO CHANGE  
G. birds,  
H. bird's  
J. birds'
23. A. NO CHANGE  
B. However,  
C. Consequently,  
D. OMIT the underlined portion.
24. Given that all the choices are true, which one most effectively signals the shift in focus that occurs when moving from this paragraph to the next?  
F. NO CHANGE  
G. which is for me a time of remembrance.  
H. a season of brilliantly changing leaf colors.  
J. the time when I must head back to school.
25. Which choice most effectively supports and elaborates on the description in the first part of this sentence?  
A. NO CHANGE  
B. cover the sky like a thin film.  
C. be completely out of control.  
D. hang over us like a dark cloud.
26. Which of the following alternatives to the underlined portion would NOT be acceptable?  
E. around the area.  
G. among the area.  
H. about the area.  
J. about.
27. A. NO CHANGE  
B. heron's  
C. herons,  
D. herons;

and could not get over the huge flocks of geese. [28]

Standing on the edge of the marsh at early evening,  
<sup>29</sup>  
 we watched a perfectly formed V of geese approach,  
 fly low overhead, and then continue to the other side  
 of the marsh. I can hear the beating of their wings and  
 their mournful honking even now.  
<sup>30</sup>

28. At this point, the writer is considering adding the following true statement:

These Canada geese typically weigh seven to ten pounds, live for six to eight years, and mate for life.

Should the writer make this addition here?

- F. Yes, because it provides important background information relevant to the essay.
- G. Yes, because it helps readers to more clearly visualize the flocks of geese.
- H. No, because it disturbs the flow of personal impressions in this paragraph.
- J. No, because it changes the emphasis from the mallards and herons to the geese.

29. Which of the following alternatives to the underlined portion would NOT be acceptable?

- A. While we stood
- B. While standing
- C. As we stood
- D. We stood

30. F. NO CHANGE

- G. even now they make their mournful honking sounds.
- H. even now there is mournful honking.
- J. they honk mournfully even now.

### PASSAGE III

The following paragraphs may or may not be in the most logical order. Each paragraph is numbered in brackets, and question 45 will ask you to choose where Paragraph 3 should most logically be placed.

#### Auntie Ocloo

[1]

Dr. Esther Afua Ocloo: first chairwoman of

<sup>31</sup>

Women's World Banking, preferred to be called Auntie

Ocloo. "Auntie" is a traditional title of respect in the

<sup>32</sup>

African nation of Ghana, her native land. Born in 1919,

she became a highly successful entrepreneur, industrialist, philanthropist, and international leader.

31. A. NO CHANGE

- B. Ocloo;
- C. Ocloo,
- D. Ocloo—

32. F. NO CHANGE

- G. Ocloo
- H. Ocloo but
- J. Ocloo,

[2]

Ocloo knew that her countrywomen would need  
 33

to have a steady source of income. In order to gain  
 34  
 access to education and health care. So, at the 1975  
 Mexico City gathering that opened the United Nations  
 Decade for Women, Ocloo, with like-minded women,  
 will have developed a "microlending" plan. Here's how it  
 35  
 works: A large lending institution lends the initial money  
 to a microlending institution, \$5 million or more. Then the  
 36  
 microlending institution, such as Women's World Banking,

makes a small loan (as little as \$50) to, in contrast, an  
 37

artisan or a food vendor whom would not qualify for a  
 38

loan from a commercial bank. After the business grows  
 39  
 and the loan is repaid, the microlender makes a larger  
 loan available.

[3]

After high school graduation, with ten shillings given  
 40  
 to her by her aunt, she bought oranges and made twelve  
 jars of marmalade, which she then sold on the street at a  
 nice profit. From that beginning, she worked throughout  
 her life to provide two essential opportunities for African  
 women: appropriate training and access to credit so that  
 they could begin their own enterprises.

33. A. NO CHANGE  
 B. her countrywomen who called Ghana their homeland  
 C. the women who lived in and had grown up in Ghana  
 D. her fellow women in the country of Ghana
34. F. NO CHANGE  
 G. income in  
 H. income; in  
 J. income: in
35. A. NO CHANGE  
 B. developed  
 C. will develop  
 D. have developed
36. Assuming that a period will always be placed at the end of the sentence, the best placement for the underlined phrase would be:  
 F. where it is now.  
 G. after the word *initial* (setting the phrase off with commas).  
 H. after the word *money* (setting the phrase off with commas).  
 J. after the word *microlending* (setting the phrase off with commas).
37. A. NO CHANGE  
 B. for example,  
 C. as a result,  
 D. instead,
38. F. NO CHANGE  
 G. whose  
 H. for whom  
 J. who
39. Which of the following alternatives to the underlined portion would be LEAST acceptable?  
 A. Whenever  
 B. When  
 C. Once  
 D. Unless
40. F. NO CHANGE  
 G. were given  
 H. gave  
 J. were gave

[4]

Since 1975, twenty-five million people—three-fourths of them women; in more than forty less-developed nations

41

have received microloans. Likewise, ninety-eight percent of the loans have been repaid.

42

[5]

In 1990, Auntie Ocloo shared the Africa Prize for Leadership with President Olusegun Obasanjo of Nigeria. For their efforts to fight hunger.

43

44 She helped them, for example, learn to calculate costs and profits on the rice and stew they sell on street corners like the one where Auntie Ocloo first sold her marmalade.

41. A. NO CHANGE  
B. women,  
C. women—  
D. women

42. F. NO CHANGE  
G. On the contrary, ninety-eight  
H. Because ninety-eight  
J. Ninety-eight

43. A. NO CHANGE  
B. Nigeria; for  
C. Nigeria for,  
D. Nigeria for

44. Which of the following true statements, if inserted here, would best connect the first part of Paragraph 5 with the last part while also illustrating one of the main points of this essay?  
F. Ocloo always wore bright African clothes and loved to cook.  
G. Ocloo used her half of the \$100,000 prize to establish a program to train women in business.  
H. Ocloo was the first woman recipient of the Africa prize.  
J. Ocloo's company, Nkulenu Industries, produced products like canned tomatoes and soup bases.

Question 45 asks about the preceding passage as a whole.

45. For the sake of the logic and coherence of this essay, the best placement for Paragraph 3 would be:  
A. where it is now.  
B. before Paragraph 1.  
C. between Paragraphs 1 and 2.  
D. between Paragraphs 4 and 5.

## PASSAGE IV

The following paragraphs may or may not be in the most logical order. Each paragraph is numbered in brackets, and question 59 will ask you to choose where Paragraph 5 should most logically be placed.

## Free Jazz

[1]

In November 1959, when jazz musician Ornette Coleman arrived in New York City with saxophone in hand, the civil rights movement was about to shift into high gear. For many African Americans, the word, freedom<sup>46</sup> would serve as a goal, a guiding principle, and a rallying cry.

[2]

Ornette Coleman had something new to offer. He had lonely developed an unorthodox approach over <sup>47</sup> years of effort, first in his home state of Texas and then in Los Angeles, where he was routinely snubbed by older musicians <sup>48</sup>. Coleman's approach

involved improvisation guided by a personal <sup>49</sup> expression of emotions and a freedom from fixed harmonic chord structures and tempos.

[3]

Eventually, his style caught the attention of other <sup>50</sup> adventurous young players. In 1958, Coleman was given the opportunity to record, and the resulting album—*Something Else!*—served notice that a true innovator was on the scene.

46. F. NO CHANGE  
G. word, *freedom*,  
H. word *freedom*,  
J. word *freedom*

47. The best placement for the underlined word would be:

- A. where it is now.  
B. after the word *approach*.  
C. after the word *years*.  
D. before the word *effort*.

48. Given that all the following are true, which one, if added here, would provide the clearest and most effective explanation for why the older musicians snubbed Coleman?

- F. such as Dexter Gordon and Miles Davis  
G. disturbed by his experimental sound  
H. who happened to hear him play  
J. who also played jazz

49. A. NO CHANGE  
B. involved,  
C. involved;  
D. involved:

50. Which of the following alternatives to the underlined portion would be LEAST acceptable?

- F. attracted  
G. captured  
H. trapped  
J. grabbed

[4]

Next came Coleman's controversial, but successful  
<sup>51</sup>  
 1959 debut with his quartet at a New York club called the

Five Spot. This engagement—coupled for the release of  
<sup>52</sup>  
 two more albums (*The Shape of Jazz to Come* and *The*

*Change of the Century*)—which reversed Coleman's  
<sup>53</sup>

fortunes. Some musicians were concerned that his  
<sup>54</sup>  
influence would ruin jazz.

<sup>54</sup>

[5]

As a uniquely African American  
 musical form, jazz seemed poised to play  
<sup>55</sup>

in the struggle a role for freedom and equality. But  
<sup>56</sup>  
 many people felt that jazz was stagnating. Rock 'n' roll  
 had become the most popular music of the era, and no  
 major wave of inspiration had swept through jazz since  
 the bebop revolution of the early forties.

[6]

Free jazz, as Coleman's style came to be known,  
<sup>57</sup>  
 provided an unconstrained sound to match the intensity  
 and conviction of the times. This fusion of a new sound  
 with a new activist spirit can be heard in many recordings  
 of the early sixties, notably those of Sonny Rollins,  
 Abbey Lincoln, and Charles Mingus. Yet, it was Ornette  
 Coleman, through his determination and uncompromising

51. A. NO CHANGE  
 B. controversial; but successful  
 C. controversial but successful,  
 D. controversial but successful
52. F. NO CHANGE  
 G. with  
 H. up  
 J. DELETE the underlined portion.
53. A. NO CHANGE  
 B. reversing  
 C. reversed  
 D. reverses
54. Given that all the choices are true, which one best supports the point that this engagement and these albums signaled a turning point in Coleman's musical career?  
 E. NO CHANGE  
 G. Veteran players were now competing for the chance to sit in with his band.  
 H. He had already won the approval of John Lewis of the Modern Jazz Quartet.  
 J. The alto sax player from Texas was twenty-nine years old at the time.
55. Which of the following alternatives to the underlined portion would NOT be acceptable?  
 A. appeared to be  
 B. seemed to be  
 C. appeared  
 D. seems
56. The best placement for the underlined phrase would be:  
 F. where it is now.  
 G. after the word *poised*.  
 H. after the word *role*.  
 J. after the word *equality* (ending the sentence with a period).

57. A. NO CHANGE  
 B. jazz, as Coleman's style came to be known  
 C. jazz as Coleman's style came to be known,  
 D. jazz as Coleman's style came to be known

individuality, who spearheaded this.  
58

58. F. NO CHANGE  
G. this musical movement.  
H. this one.  
J. it.

Questions 59 and 60 ask about the preceding passage as a whole.

59. For the sake of the logic and coherence of this essay, Paragraph 5 should be placed:
- where it is now.
  - after Paragraph 1.
  - after Paragraph 2.
  - after Paragraph 3.
60. Suppose the writer's goal was to draft an essay that would draw connections between artistic movements and social or political movements. Does this essay successfully accomplish that goal?
- Yes, because it links the development of Ornette Coleman's free jazz to the civil rights movement.
  - Yes, because it presents an interesting topic and focuses on a particular aspect of jazz music.
  - No, because it limits its focus to the relationship between the musical styles of bebop and free jazz.
  - No, because it refers to events in the late fifties and early sixties but fails to follow them over time.

PASSAGE V

Honoring Rosie the Riveter

[1]

During World War II, millions of women took industrial jobs in shipyards, aircraft plants, steel mills, and other defense-related enterprises throughout the United States. The labor force that shrank and decreased as men  
61

joined the military forces but grew as women flooded into  
62 jobs newly open to them. Crucial to the war effort, these women were immortalized by a fictional poster character of the era: Rosie the Riveter. Her strong arms, direct gaze, wearing rugged work clothes convey the competence and  
63 determination that so many women brought with them into their new roles. [64]

61. A. NO CHANGE  
B. shrank  
C. decreasingly shrank  
D. DELETE the underlined portion.
62. F. NO CHANGE  
G. though it  
H. and yet it  
J. DELETE the underlined portion.
63. A. NO CHANGE  
B. in  
C. and  
D. her
64. If the writer were to delete the words *strong*, *direct*, and *rugged* from the preceding sentence, it would primarily lose:
- description of what was written on the posters featuring Rosie the Riveter.
  - details that support the claim that Rosie the Riveter looked competent and determined.
  - details that blur the paragraph's focus on the symbolic nature of Rosie the Riveter.
  - description that is provided in more vivid language in Paragraph 2.

[2]

In the year 2000, a Rosie the Riveter memorial was dedicated on a sunny day in California. At the height of the war, the workforce at the shipyards grew to 100,000. More

than one-fourth of the working laborers were women.  
 About 200 of those women were able to attend the dedication ceremonies as the guests of honor.

[3]

The memorial was designed by landscape architect Cheryl Barton and photographer Susan Schatzberg. Its' various features together create a sense of the size and shape of the cargo vessels, called Liberty Ships, that were built in Richmond. A 441-foot-long walkway, representing the keel of a Liberty Ship, has lead to a platform that commands a view of San Francisco Bay. Sculptures inspired by elements of the ships can also be seen. Panels positioned among the sculptures display photographs, letters, welding certificates, and other "Rosie" artifacts.

65. Given that all the choices are true, which one provides the most logical transition to the information presented in the rest of this essay?
- NO CHANGE
  - during a program that featured speeches, a ribbon-cutting ceremony, and live music.
  - at the former site of the Kaiser shipyards in Richmond, California.
  - in a ceremony attended by politicians, interested citizens, and retired women welders.
66. F. NO CHANGE  
 G. the female  
 H. which  
 J. those
67. At this point the writer is considering adding the following true statement:  
 The success of the memorial has provided momentum for other urban revitalization projects planned for Richmond.  
 Should the writer add this sentence here?
- Yes, because it provides a specific measure of the success of the Rosie the Riveter Memorial.
  - Yes, because it contributes to the essay's focus on how World War II events are reflected in modern times.
  - No, because it is not relevant to the essay's focus on the memorial and the women honored by the memorial.
  - No, because it is not written in the style and tone that has already been established in the essay.
68. F. NO CHANGE  
 G. architect Cheryl Barton, and, photographer  
 H. architect, Cheryl Barton and photographer,  
 J. architect, Cheryl Barton, and photographer,
69. A. NO CHANGE  
 B. Its  
 C. It's  
 D. Their
70. F. NO CHANGE  
 G. leads  
 H. has led  
 J. would of led
71. Given that all the choices are true, which one is most relevant to the writer's purpose of helping readers visualize the memorial?
- NO CHANGE
  - line the walkway.
  - add to the memorial's impact.
  - make up part of the design.

[4]

One of the welding certificates on view were

72

72. F. NO CHANGE

G. are  
H. was  
J. have been

donated by Bethena Moore, operating a torch that could  
heat metal to 250°<sup>73</sup>F, she helped make Kaiser one of the  
most productive shipyards of the wartime era. The scars  
on her arms from welding sparks are visible reminders of  
the hard labor she performed.

[5]

At the ceremony, Phyllis McKey Gould, another  
former shipbuilder, described how she moved her torch  
in tiny, circular patterns. "If you did it right, it was  
beautiful," she said at the ceremony. "It was like  
embroidery."<sup>74</sup>

73. A. NO CHANGE

B. Moore operating  
C. Moore, who operated  
D. Moore. Operating

74. F. NO CHANGE

G. said in her descriptive way.  
H. said, by way of description.  
J. said.

Question 75 asks about the preceding passage  
as a whole.

75. Suppose one of the writer's goals had been to describe and personalize the important role women played in the labor force during World War II. Does this essay achieve that goal?

A. Yes, because it offers facts about the role played by millions of women during World War II and provides specific details about two of those women.  
B. Yes, because it explains that Rosie the Riveter established a memorial to the women who worked in factories during World War II.  
C. No, because it does not explain where Rosie the Riveter worked during World War II or if she continued to work after the war.  
D. No, because it focuses on the careers of the two women who designed the Rosie the Riveter Memorial and what they based their design on.

**END OF TEST 1**

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

## READING TEST

35 Minutes—40 Questions

**DIRECTIONS:** There are four 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.

**Passage I**

**PROSE FICTION:** This passage is adapted from the novel *China Boy* by Gus Lee (©1991 by Augustus S. M. S. Lee).

The On-On was a cafeteria. For fifty cents I got a huge caldron of rice overlaid with oyster-sauce beef, finely chopped scallions and onion, and a raw egg. The rice and beef were so hot that stirring the egg with the 5 other ingredients cooked it.

I inhaled food. It was my addiction, my habit, my love. Chinese food brought more than splendid sauces, delightful flavors, wonderful textures, and all of the pleasures of a child's innocent tastes. My mother's 10 spirit lay within the wafting aromas.

I ate quickly, lest it get away, or rude fortune interrupt my work, or a worthier child be found suddenly to receive my unfinished servings. Whether sitting in a restaurant or walking down a street, I could pack away 15 a meal before the others had found their napkins.

Chinatown was like its host city—small and compressed in physical dimensions, boundless and ephemeral in spirit.

Like the old and no-longer-noble Victorian structures in the Handle, the structures of Chinatown were obtuse and complicated, filled with shadowed side alleys, curiously angled doors, hidden fences, gabled attics, brooding and silent second stories, quiet spiritualism, and dark unknowns.

25 I had seen much of the city by the time I was seven. The Mission barrios, the hard, bitter streets of the Western Addition and the Fillmore. The museum-like quiet of St. Francis Woods, and the picture-book neighborhoods in the Sunset and the Richmond.

30 The Handle and Chinatown were neighborhoods that revered customs drawn from continents far distant from North America, whose features were now only memory. Both neighborhoods were filled with people who had arrived en masse—not as single family 35 migrants. Most others had come to the City as economically independent families.

Both neighborhoods had a strong spiritual sense, a different musical culture, and unique foods. Everyone

had black hair, brown eyes, and darker skin than the 40 majority. That is, the majority in San Francisco.

I was energetically drawn to the Flowering Nation Grocery. The place was more zoo than store, more a museum of oddities than a grocery, more a continuum of East Asia than the fading recollections of China in 45 our own home. It was a small, congested three-dimensional picture box of my heritage.

I always thought that being in this shop was akin to reviewing the brown-paged photographs in our family album.

50 Flowering Nation Grocery stood between a modest school-supply store called the Wing-Wing Company and a resplendent antiques and clothing store, The City of Kunming. The Wing-Wing sold calligraphy brushes, plastic pencil boxes with the multiplication table on the 55 top, and cheap school purses, which boys and girls in Chinatown carried on schooldays. The City of Kunming sold the most expensive cheongsam dresses in the world and had photos of famous actresses to prove it.

The Flowering Nation storefront was a bright red-60 tile front acting as a base for a huge plate-glass window. Inserted into the middle of the tile, below the picture window, was a smaller, rectangular window that was the front of an aquarium, in which catfish swam at the height of my knees.

65 Children knelt on the sidewalk. We waggled fingers at the slow, dull fish, circling in the dirty, tepid brownness of their confined world. We would tap on the glass for hours, hoping for a response, for the beginning of communication, receiving as our only 70 answers the swish of an indifferent tail, the streamlining of thick, uneven catfish whiskers.

The Hom family ran the store. Mr. Hom spoke with the rapidity of an excited machine gun. He loved his store, his goods, his customers, and his trade, and it 75 showed. Smiling, shouting, jumping, throwing money and packages, he surrendered his vital essence, his *shigong*, to his enterprise, and never looked back. He made Mrs. Timms look uninterested in her store, the Reliance Market, and she was a hard worker.

80 Mr. Hom was a perfectionist and a micromanager, attending to every detail, imagined or extant, historical

or projected, frowning between his cajoling laughter, pondering problems with likely solutions.

I would edge up to the counter, my face concealed by dangling Chinese celery and bok choy, watching him wrap meats and fish and produce, darting back and forth, shouting and laughing. After waiting in line, I put two pennies on the counter and pointed above to the sausages. Mr. Hom would shout, "Hey, Songhai!" and, without looking, pull down a *lop chong* sausage from above his head, dropping it into my hands, scooping the pennies into a cigar box deep in change, and jabbering to three people behind me as he began to extract and wrap their orders.

1. The point of view from which the passage is told is best described as that of an adult:
  - A. reflecting upon some of the experiences that made his childhood in Chinatown meaningful.
  - B. considering how his childhood would have been different if he had never met Mr. Hom.
  - C. thinking about how much Chinatown has changed since he was a child.
  - D. wondering how his childhood experiences in Chinatown have shaped his adult life.
2. One of the main purposes of the second half of the passage (lines 41–94) is to allow the narrator to:
  - F. explain how he began to love food as a result of Mr. Hom's generous offerings.
  - G. describe several Chinatown storefronts in detail and retell a few of his memorable experiences in each store.
  - H. reveal what Flowering Nation Grocery meant to him through his description of the store and its owner.
  - J. show why being in Flowering Nation Grocery reminded him of eating at the On-On.
3. Based on the narrator's characterization, Mr. Hom would best be described as:
  - A. quiet, carefree, and idealistic.
  - B. energetic, committed, and industrious.
  - C. calm, serious, and courteous.
  - D. sarcastic, jovial, and reckless.
4. Information in the last paragraph most strongly suggests that when he visited Flowering Nation Grocery as a child, the narrator was:
  - F. restless while he waited in line.
  - G. friendly to the adult customers.
  - H. carefully observant of Mr. Hom.
  - J. unsure of how to pay for what he wanted.

5. According to the narrator, within the aroma of Chinese food he sensed:
  - A. his mother's spirit.
  - B. a continuum of East Asia.
  - C. a quiet spiritualism.
  - D. his vital essence.
6. According to the narrator, Chinatown was like the city of San Francisco as a whole in its:
  - F. traditions.
  - G. musical culture.
  - H. architecture.
  - J. spirit.
7. The statement in lines 30–33 most strongly suggests that the people who emigrated to the Handle and Chinatown felt that their customs:
  - A. would evolve and grow in a spiritually positive direction in their new homes.
  - B. would most likely not help invigorate their new neighborhoods.
  - C. were not an essential or meaningful part of their lives in their new homes.
  - D. were important to their lives in their new homes and held deep cultural significance.
8. The narrator compares Flowering Nation Grocery to all of the following EXCEPT a:
  - F. picture box.
  - G. museum.
  - H. school.
  - J. zoo.
9. The passage indicates that one reason the narrator was drawn to Flowering Nation Grocery as a place to feel close to his heritage was that:
  - A. the store offered a more vivid representation of East Asia than his home did.
  - B. he was welcomed in the store even though children did not typically shop there alone.
  - C. being in the store reminded him of shopping with his mother.
  - D. the store reminded him of a store in East Asia that he had seen in photographs.
10. According to the narrator, which of the following activities gave him almost the same feeling as being in Flowering Nation Grocery?
  - F. Playing with neighborhood children
  - G. Shopping at the Reliance Market
  - H. Looking at school supplies at the Wing-Wing Company
  - J. Reviewing his family photo album

**Passage II**

**SOCIAL SCIENCE:** This passage is adapted from the article "Design for Living" by Polly Shulman (©2000 by Scientific American, Inc.).

At 85, Jeanne Calment of Arles, France, took up fencing. She outlived all her descendants. Asked at 115 how she saw her future, she quipped, "Short. Very short." But she was wrong: she lived seven more years, 5 dying on August 4, 1997, at 122 years, the longest verifiable life span of any human being.

Richard M. Suzman, an associate director at the National Institute on Aging, claims the rate of disability in all populations, including the oldest old, has been 10 dropping since 1982. Demographers, geneticists and medical researchers hope that studying "the superstars of longevity" will yield vital clues to how all of us can live longer, healthier lives.

To Leonard W. Poon of the Georgia Centenarian 15 Study, there is no secret to longevity. Poon and his colleagues followed 144 cognitively intact, independently living centenarians. Some were compared with groups of people in their 60s and 80s from similar backgrounds; others were interviewed and tested every six 20 months for what remained of their lives. He believes the most important lesson of the study is the qualities that stood out among the oldest old.

For example, few of the centenarians in the study 25 smoked, were obese or drank heavily. They remained active throughout life, ate breakfast regularly, and consumed plenty of vitamin A and carotenoids by eating fruits and vegetables. "In terms of psychology and attitudes, they've resolved whatever issues they have, they're sure of themselves, and they want to have their 30 way." Learning about the diversity of characteristics that centenarians share, Poon thinks, "isn't a bad result, because anyone can find one factor relevant to their lives, one thing that's possible to change. The diversity gives all of us hope to be able to live longer."

Poon, a psychologist by training, considers motivation and attitude as important as genes. But Thomas T. Perls, director of the New England Centenarian 35 Study, believes some genes can guarantee their lucky recipients a better chance to live a long, healthy life, 40 and he means to find them. Siblings of centenarians in his study have a five times greater chance than average of living to their early 90s and a 15 times greater chance of living to 100. Of course, siblings share environmental factors as well as genes. Could some of these 45 be responsible? "Is it the chicken soup their mom makes?" Perls asks. "No, because their parents also live unusually long."

Nir Barzilai, a gerontologist who collaborates with Perls's group, is looking for longevity genes as well. He 50 and his colleagues study "founder populations"—small, genetically isolated groups that gradually expanded to large numbers, all while marrying within the community. One collaborator hunts through the genes of the

Amish; Barzilai does the same with Ashkenazi Jews. 55 The fact that members of such groups share large amounts of genetic material makes it easier to find relevant genes. The geneticists compare the genes of long-lived group members with those of members with short or normal-length lives. Because these people have so 60 much genetic material in common, any genes found in the long-lived group but not in the short- or normal-lived group have a good chance of being the ones the scientists are looking for.

It's important to Barzilai to find out what functions those genes perform, then develop medicines to mimic them. "If they have to do with oxidation, we'll try to manipulate oxidation. If they increase levels of HDL—that's the beneficial kind of cholesterol—maybe we can increase HDL. I had a 102-year-old who had a 70 very high grade cancer, with a prognosis of two months, but she lived with it for five or six years. Maybe something in her genes protected her from this cancer." If so, understanding how that protection worked could help doctors develop cancer-fighting 75 drugs.

Barzilai and his team have been quizzing their centenarians for shared characteristics and, like Poon, have found a lot of diversity. Barzilai says, "One thing they seemed to have in common was some form of flexibility. Many of them had very hard lives. They rolled with the punches, got up and continued with a good attitude."

One problem is to separate cause from effect. Did 85 Barzilai's and Poon's centenarians live longer because they rolled with the punches, or did 10 decades of experience give them the wisdom to accept experiences that would have thrown them for a loop in their youth? Centenarian researchers would like to go back in time and interview their subjects at 20, 50, 80—but of course, 90 they can't.

11. The passage's focus is primarily on the:

- A. conflicting views of Poon and Perls regarding the influence of genes on longevity.
- B. efforts of geneticists and medical researchers to determine the rate of disability in all populations.
- C. studies conducted by Poon, Perls, and Barzilai relating to longevity.
- D. the study of "founder populations" in the search for longevity genes.

12. Based on the passage, one of the similarities between the subjects in Poon's study and the subjects in Barzilai's study is that both groups were:

- F. devoted to active, healthy lifestyles.
- G. considered genetically isolated.
- H. described as having positive attitudes.
- J. interviewed every six months.

13. Which of the following questions is NOT answered by the passage?
- A. According to Perls's study, what is the likelihood that siblings of centenarians will live exceptionally long lives?
  - B. How have "founder populations" been used in the study of longevity genes?
  - C. To Poon, how important are motivation and attitude in longevity?
  - D. To what extent have Suzman's findings on disability rates directly influenced studies by Poon and Barzilai?
14. The passage most strongly suggests that the ultimate goal of Barzilai's study was to:
- E. compare the genes of the Amish and Ashkenazi Jews to identify shared genetic material.
  - G. develop drugs that would mimic the functions of life-extending genes.
  - H. disprove Poon's theory that genes can guarantee a better chance of living a longer life.
  - J. discover what role diversity plays in helping certain groups live longer lives.
15. Which of the following statements best summarizes Perls's theory, as it is described in the passage?
- A. Genetics, not environment, primarily determines longevity.
  - B. Environment plays just as strong a role as genetics in longevity.
  - C. Siblings of centenarians, but not their parents, have a better chance of living to 100.
  - D. Siblings of centenarians tend to live longer-than-normal lives due to positive environmental influences.
16. If the last paragraph were deleted, the passage would primarily lose details that indicate:
- F. Barzilai and Poon worked with the same group of centenarians in their respective studies.
  - G. subjects in longevity studies are interviewed in their 20s, 50s, and 80s.
  - H. Barzilai's and Poon's studies are relatively inconclusive in determining causes and effects.
  - J. centenarians are more flexible in their later years than they were in their youth.
17. The main purpose of the first paragraph is to:
- A. demonstrate that anticipating the end of life can actually lead a person to live longer.
  - B. point out Calment's resignation to the circumstances of her life.
  - C. suggest that athletes are more likely than non-athletes to live long lives.
  - D. provide an anecdote to introduce the various accounts of longevity studies.
18. According to the passage, the 144 subjects in Poon's study shared all of the following characteristics EXCEPT:
- F. being centenarians.
  - G. being tested regularly.
  - H. being cognitively intact.
  - J. living independently.
19. According to Poon, learning about the diversity of traits centenarians share "isn't a bad result" (line 31) because this means that people:
- A. can overcome the negative effects of an unhealthy lifestyle through positive thinking.
  - B. have a better chance of finding something to change that is relevant to their own lives.
  - C. can guarantee their own longevity by continually changing their behaviors.
  - D. are powerless to change their fates—they either have the traits for longevity or they don't.
20. According to the passage, which of the following pairs of researchers collaborates in the study of longevity genes?
- F. Perls and Barzilai.
  - G. Suzman and Barzilai
  - H. Poon and Perls
  - J. Suzman and Perls

**Passage III**

**HUMANITIES:** This passage is adapted from author Sue Miller's essay "Virtual Reality: The Perils of Seeking a Novelist's Facts in Her Fiction" (©1999 by The New York Times Company).

Before my last, recent book tour, I made myself memorize a quotation from an interview with author John Cheever that began, "It seems to me that any confusion between autobiography and fiction debases fiction." Thus girded, armored, I hoped to silence forever the questioner who sits there in the third row waiting to ask, "How much of your work is autobiographical?"

The question bothers me because I sense in it a kind of potential diminishment—yes, debasing—of the work I do. What the questioner seems to be somehow suggesting is that my writing is possibly no more than the stringing together of episodes lifted directly from my life, or from the lives of fascinating characters I have known.

Every writer has met the guy at the party who says he, too, has always wanted to write a novel, if only he had the time, because he's got such a great story to tell. And it seems to me that it's that same guy asking the question at the reading. Maybe this is why the question rises so often: because the guy really wants to know how to do it, how to make fiction from the interesting or painful or shocking things that have happened to him.

There's a way in which readers are encouraged in this by writers who embrace the cult of experience, the notion that the writer needs to have lived a certain *kind* of bold, engaged life, right out there on the edge of . . . well, something or other, in order to have anything worthwhile to write about. What's worthwhile? Well, war, for instance. Adventure on the high seas, or the highways, or the river. No wonder anyone who has even marginally partaken of any of these feels justified in thinking he must have a book in him. Somewhere.

But if experience were all, we *would* all have a book. As author Flannery O'Connor said, anyone who's survived infancy has enough material for countless stories. The fact is, you can make a story of anything, anything at all. What's hard—and what's interesting—about a story is not so much the *thing* that's in it, but what's made of that thing. And then, of course, the making itself. But there is no necessary life to have lived or scene to have witnessed.

But is the life's shape the shape of the fiction, then? Is it all autobiographical? Do I write as I do because I've lived and worked primarily with children and families? Is it true that we have no choice but to echo what's happened to us and to those we know? Do we writers need to step out of our studies into the bright light of day, find jobs as laborers or executives or physicians or models in order to have something more exciting, something more relevant to contemporary life to write about?

Surely not. Surely the writer's job is to make relevant the world she wishes to write about. How? By writing well and carefully and powerfully. By using humor, or violence, or rue, to make the territory of her imagination compelling and somehow universal. And that holds true whether the territory of the imagination is close to the literal truth of her life or far from it.

Sometimes the distance *is* minimal, minimal enough for the fiction to cause lifelong hard feelings: the use of a fictional alter ego, for example, or of changes so slight that they seem like a kind of cruel joke. Sometimes, family or friends can end up feeling misused, abused. There are certainly writers who seem nearly deliberately provocative in this way: the burning-bridges school of art.

For the true writer, though, however close the events may be to her life, there is some distance, some remove, that allows for the shaping of the work. The shaping, after all, is what it's all about. Every reader can sense the difference between a writer who embodies meaning through the events she describes and the writer who seems simply mired in those events. It is that struggle for meaning that lets the writer escape the tyranny of what really happened and begin to dream her fictional dream.

As to what happens in the dream, in the story, well, we all have the *kinds* of event we prefer, but surely this is a matter of preference, not worth. You find in the story of a quest for a white whale the embodiment of the human struggle for control, for wholeness? Fine. For me everyday life in the hands of a fine writer seems similarly charged with meaning. When I write, I want to bring a sense of that charge, that meaning, to what may fairly be called the domestic. O.K.?

So, come on, really, how much is autobiographical?

All of it. None.

21. The tone of the passage could best be described as:

- A. antagonistic and inhibited.
- B. distinguished and quiet.
- C. humorous and carefree.
- D. spirited and frank.

22. According to the author of the passage, readers gain false ideas about writing fiction from writers who:

- F. "embrace the cult of experience" (line 25).
- G. believe that what is difficult about writing is "the making itself" (line 41).
- H. write "using humor, or violence, or rue" (lines 55–56).
- J. "escape the tyranny of what really happened" (lines 75–76).

23. It can reasonably be inferred that the author of the passage memorized the Cheever quotation so that during a book tour she would be:
- A. able to give her audiences an example of an inventive approach to writing fiction.
  - B. ready to answer questions about the similarities between Cheever's fiction and her own.
  - C. fully prepared to deal with a common issue in a definitive way.
  - D. better able to help her audiences understand Cheever's complex ideas.
24. According to the author of the passage, the questioner referred to in lines 5–7 most likely wants to:
- F. write fiction based on his or her own life.
  - G. change his or her life to make it a bold, engaged one worth writing about.
  - H. find out how the author of the passage manages time in order to have time to write.
  - J. create fiction using episodes from another's life.
25. According to the fourth paragraph (lines 24–33), the author of the passage feels that some writers believe that to write well, it is necessary to:
- A. make sure experiencing life doesn't interfere with writing.
  - B. become marginally involved in many worthwhile events.
  - C. depend on imagination.
  - D. live a bold and adventurous life.
26. As it is used in line 20, the word *rises* most nearly means:
- E. ascends.
  - G. soars.
  - H. swells.
  - J. materializes.
27. It can reasonably be inferred from the passage that "the burning-bridges school of art" (lines 66–67) consists of writers who:
- A. consider their fiction to be most meaningful when it offers a sympathetic portrayal of family or friends.
  - B. believe that a minimal distance between fiction and reality is insufficient.
  - C. do not like basing their writing on their own experiences.
  - D. almost seem to want their writing to hurt the people on whose lives it is based.
28. As it is used in line 77, the word *dream* most nearly means the:
- F. story as conceived by a writer.
  - G. goal of a writer.
  - H. real-life experience the writer wants to have.
  - J. image in the reader's mind.
29. The author of the passage indicates that she seeks to write fiction that:
- A. strings together episodes from her life.
  - B. brings significance to the events of domestic life.
  - C. reveals how to write as a "true writer."
  - D. helps readers understand the painful, shocking events in their lives.
30. If lines 88–89 were omitted from the passage, what would primarily be lost?
- F. Support for the statement made in the passage that writers do not like to share their work.
  - G. Evidence that the writer wants her readers to guess how much of her fiction is autobiographical.
  - H. A return to the passage's opening question in an attempt to portray it as the wrong one to ask.
  - J. An apology from the writer for not answering the question she poses in the beginning of the passage.

**Passage IV**

**NATURAL SCIENCE:** This passage is adapted from the article "How Cicadas Make Their Noise" by Henry C. Bennet-Clark (©1998 by Scientific American, Inc.).

The early dusk of late spring can be quite a noisy time. Every year some of the several thousand species of cicada emerge from underground, and the males begin to sing their raucous, almost deafening, song.  
 5 Among these virtuosos of the insect realm, the males of one species of Australian cicada are distinguished for having the loudest insect call measured so far.

Cicadas are plant-sucking bugs, related most closely to aphids and leafhoppers. They are large—and  
 10 noisy—for insects that feast on sap: the smallest are 10 millimeters (just under half an inch) long, the largest 100 millimeters (four inches). Female cicadas lay their eggs in the stems of plants or in trees. Later, the newly hatched young drop to the ground and burrow in search  
 15 of plant roots to tap. They remain underground throughout their larval life, which can last many years; the 13- and 17-year life cycles of the American periodic cicadas are among the longest. When the larvae emerge, they molt into winged adults and then live for only a  
 20 few weeks. During this time, the males sing to attract mates.

Why the insects' calling song is so loud is not entirely understood. One possibility is that the sound may saturate the ears of predators, making it hard to  
 25 locate the cicada precisely. Or it may be that larger cicadas have a larger home range and need to call louder to attract a mate. We do know that the females are not hard of hearing: they hear just fine with thresholds of 30 to 40 decibels. And it is quite likely that  
 30 female cicadas can discriminate between males on the basis of song quantity and quality, just as female crickets do.

The key to understanding how the males make their powerful noise lies in isolating the different  
 35 aspects of the sound-production mechanism. The primary equipment is a pair of domed tymbals, or drum-like structures, that sit on either side of the abdomen. Each of these elastic, resonant organs has a row of four convex ribs that runs longitudinally up and down its  
 40 surface. These ribs are flexibly connected to one another as well as to a large oval plate at the rear of the tymbal.

Attached to each oval tymbal plate, in turn, is a large, fast muscle. The contraction of these muscles  
 45 distorts the domed tymbals, creating a pulse of sound.

Because they contract so rapidly, the muscles produce enough energy in the first three milliseconds of each contraction to cause two or three of the curved ribs on each tymbal to buckle in sequence. This motion  
 50 causes two or three stepwise inward movements of the oval plate. The stored elastic energy released during these stepwise movements produces a brief, loud click

as the individual ribs buckle. This series of clicks merges to form a train of vibrations at the cicada's song  
 55 frequency.

A click from the rib of a tymbal produces high sound pressures within the cicada's abdomen. In most species of cicada, this region is filled largely by an air sac. The abdomen contains a pair of thin eardrums that  
 60 extend the full width of the ventral surface and serve as acoustic windows, connecting the air sac to the outside world.

The high-pressure sound pulses produced by the tymbals and ribs create a sympathetic resonance in the abdominal air sac. Because the eardrums are larger than  
 65 the tymbals, they serve as an effective means of radiating the sound beyond the body—causing it to be about 20 times louder than if the sound were to emanate simply from the tiny tymbals. Thus, the insect manages  
 70 to broadcast over a far greater range.

Although sound is radiated via the eardrums, the sensory part of the male ear is in a separate capsule, connected to the eardrum by way of a small canal. This separation may protect the males, preventing them from  
 75 going deaf.

The abdomen and eardrums do more, though, than simply throw the sound into the world. They serve to maintain the quality of the all-important mating song. By extending the abdomen and by opening the opercula  
 80 that cover the eardrums, the cicada can tune the abdominal resonator to the frequency of the sound pulses produced by the tymbals. The abdominal structures can therefore increase the purity or the loudness of the song. They act as what is called in musical terminology  
 85 a resonant acoustic load to the tymbals—that is, they correct and balance the sound system.

A similar mechanism seems to occur in many other species of cicada, and related sound-production systems have been described in other loud insects as  
 90 well. Yet to the best of our knowledge, the males of this Australian cicada species remain the noisiest insects around.

31. Compared to the language of the first paragraph, the language of the seventh paragraph (lines 56–62) is more:
- informal.
  - technical.
  - vague.
  - judgmental.

32. Which of the following questions is NOT answered by the passage?
- F. How much time passes between the moment a female cicada lays an egg and when the egg hatches?
  - G. Where do cicadas spend the larval phase of their lives?
  - H. Where in relation to a cicada's abdomen are its domed tymbals and oval plate?
  - J. What causes the ribs on a cicada's tymbal to buckle?
33. It is most reasonable to infer from the passage that cicadas in their larval stage obtain nourishment in the form of:
- A. sap from plant roots.
  - B. nutrients from the stems of plants.
  - C. protein from other insects.
  - D. berries and nectar from plants.
34. The primary purpose of the second paragraph (lines 8–21) is to:
- F. compare the sound-producing mechanism of cicadas to that of leafhoppers.
  - G. establish what distinguishes American cicadas from Australian cicadas.
  - H. provide an overview of the characteristics and life cycle of cicadas.
  - J. explain the role cicadas play in maintaining the various ecosystems they inhabit around the globe.
35. As it is used in line 71, the word *radiated* most nearly means:
- A. purified.
  - B. broadcast.
  - C. rounded.
  - D. detected.
36. Which of the following statements about the noise levels produced by cicadas is supported by the passage?
- F. The longer a cicada stays underground to develop, the more complex its sound-producing mechanism is.
  - G. Compared to Australian cicadas, American cicadas are louder in the spring and quieter in the summer.
  - H. The males of one species of Australian cicada are believed to be the loudest of all insects.
  - J. Female cicadas adjust the volume of their sound to the same level as that of their mates.
37. The passage states that cicadas are most closely related to:
- A. aphids and leafhoppers.
  - B. crickets and leafhoppers.
  - C. crickets and dragonflies.
  - D. dragonflies and aphids.
38. Which of the following ideas is clearly presented in the passage as theory and not fact?
- F. The high-pressure sound pulses produced by the tymbals and ribs create a sympathetic resonance in the abdominal air sac.
  - G. The cicada's abdominal structures can increase the purity or the loudness of the cicada's song.
  - H. The female is not hard of hearing, so it is not because of any deafness on her part that the male sings loudly.
  - J. The calling song of the cicada is so loud that it saturates the ears of predators, making it difficult for the predators to locate the cicada.
39. The term *resonant organs* (line 38) refers to what part of a cicada?
- A. Eardrums
  - B. Tymbals
  - C. Oval plates
  - D. Air sacs
40. Which of the following statements best reflects the information provided in the passage about the size of the cicada's eardrums and tymbals and the effect this has on the sound of a cicada?
- F. The eardrums and the tymbals are the same size, which allows their sounds to be in tune.
  - G. Larger than the tymbals, the eardrums amplify the sound made by the tymbals by about twenty times.
  - H. The eardrums and the tymbals both collapse and expand dramatically as sound-producing muscles force air through them.
  - J. Species of cicadas whose tymbals are as large as their eardrums are louder than species for whom this is not the case.

**END OF TEST 3**

**STOP! DO NOT TURN THE PAGE UNTIL TOLD TO DO SO.  
DO NOT RETURN TO A PREVIOUS TEST.**

**PASSAGE III****A Stormy Ride**

[1] When I moved from New York City to rural Nebraska, I became friends with a rancher, named Amil.

31

[2] For his livelihood, he raised cattle for a living, but he

32

enjoyed most the herd of tall, magnificence horses he kept.

33

[3] I had no experience with horses when I had always been too scared to ride them. [4] I was reluctant but finally

34

agreed to give it a try. [5] One day, though, Amil asked

35

me if I would like to sit in the saddle for a while. [36]

Amil brought Stormy and Morgan, two enormous mares, out of the stable. When all was ready, he told me to get on them. I held the reins, put my foot in the stirrup, and hoisted myself up into the saddle. I sat there, awkwardly holding the saddle horn as if it were a hand brake.

37

31. A. NO CHANGE  
B. rancher; named  
C. rancher named  
D. rancher named,
32. F. NO CHANGE  
G. He had started the raising of  
H. His livelihood was raising  
J. He raised
33. A. NO CHANGE  
B. tall, magnificent  
C. magnificently, tall  
D. tall magnificence
34. F. NO CHANGE  
G. horses, which  
H. horses;  
J. horses, however,
35. A. NO CHANGE  
B. day though:  
C. day, though  
D. day, though:
36. For the sake of the logic and coherence of this paragraph, Sentence 4 should be placed:  
F. where it is now.  
G. before Sentence 1.  
H. after Sentence 2.  
J. after Sentence 5.
37. A. NO CHANGE  
B. her.  
C. Stormy.  
D. the horse.

I had followed Amil's initial instructions only to realize he  
had not told me what to do next. I didn't even know how to  
get Stormy to start moving.

Amil had a good-natured smile on his face, I think,

he could tell how nervous I was. Sitting at the controls of a  
jumbo jet, I might just as well have been flying. I watched

him gently nudge his heels into Morgan's side, which she  
quickly responded and trotted down the path.

Stormy must have sensed that I was a novice.

Suddenly, on her own, she started to walk  
toward a field of flowing grass. At first, I was

alarmed like a distress signal flashing in my mind, but

she was moving slowly, and I realized that I would of been  
able to hang on. Then, after about a minute, she stopped  
walking, bent her head, and calmly started eating.

"Well," Amil said as he rode by, "you've just led  
Stormy to her favorite patch of grass. And I thought you  
said you'd never ridden before."

So there I sat, atop a beautiful, massive horse, and  
watched as she ate her dinner. I wasn't an expert rider,  
but at least I was an easy one to get along with. Although  
I later learned how to really ride a horse, I'll never  
forget my first time, when Stormy took me for  
a short, gentle ride.

38. F. NO CHANGE  
G. Amils' initial instructions,  
H. Amils initial instructions  
J. Amils' initial instructions
39. A. NO CHANGE  
B. face I think,  
C. face. I think  
D. face, however, I think
40. F. NO CHANGE  
G. I might just as well have been sitting at the  
controls of a jumbo jet.  
H. Amil could tell I was nervous as if I was flying,  
sitting at the controls of a jumbo jet.  
J. I might, sitting at the controls of a jumbo jet, have  
been just as nervous as if I was flying.
41. A. NO CHANGE  
B. side, which it  
C. side. She  
D. side, where she
42. Given that all of the choices are true, which one most  
effectively introduces the action in this paragraph  
while suggesting the narrator's inability to control  
Stormy?  
F. NO CHANGE  
G. Amil really knew how to ride!  
H. Though very tall, Stormy was a gentle creature.  
J. Amil had bought Stormy from another rancher  
some years ago.
43. A. NO CHANGE  
B. alarmed with fear and distress,  
C. alarmed by the immediate awareness of danger,  
D. alarmed,
44. F. NO CHANGE  
G. would be  
H. will be  
J. should of been
45. A. NO CHANGE  
B. a rider who rode with great skill or expertise,  
C. a master of the art of horseback riding,  
D. an expert,

**PASSAGE IV****Marine Entomology—The Study of Ocean Insects**

Scientific curiosity is often motivated by observable phenomena. Sometimes though, as with the research of entomologist Dr. Lanna Cheng, that curiosity is fueled by what seem to be absent. Her interest in a curious paradox in nature has stimulated the growth of a new branch of oceanography.

Early in her career, Dr. Cheng became intrigued by the fact that because insects are the earth's most abundant and diverse organisms, they are virtually absent from and nonexistent in the world's largest habitat,

the ocean. To try to solve this riddle, Dr. Cheng began studying the genus *Halobates*, the only known open-ocean

insects. 50 She became the first scientist to capture

these insects alive and bringing them back to the laboratory for study.

- 46.** F. NO CHANGE  
G. seems  
H. seemed  
J. have seemed
- 47.** A. NO CHANGE  
B. though  
C. since  
D. OMIT the underlined portion.
- 48.** E. NO CHANGE  
G. absent from  
H. not only absent from but also nonexistent in  
J. absent and not present in
- 49.** Given that all the choices are true, which one provides the most effective transition from the first part of this paragraph to this sentence?  
A. NO CHANGE  
B. Using her maiden name, not her married name,  
C. As a result of a scientific report,  
D. During a walk on the beach,
- 50.** If the writer were to delete the phrase “the only known open-ocean insects” from the preceding sentence (placing a period after the word *Halobates*), the paragraph would primarily lose:  
F. information that helps suggest why insects are so abundant and diverse.  
G. a description that explains why these insects are being studied.  
H. a reference that acknowledges the many unknown insects.  
J. an unnecessary detail, because this information is provided earlier in the essay.
- 51.** A. NO CHANGE  
B. will bring  
C. bring  
D. is bringing

Through her research on *Halobates* and other insects, Dr. Cheng has considered—and then dismissed—three hypotheses concerning the scarcity of marine insects. The first offering the

<sup>52</sup>

oceans high, salt content as an explanation. But <sup>53</sup> Dr. Cheng has found species of flies that can tolerate more than three times the salt content of the sea. The second hypothesis states that the ocean is too deep and underwater pressure too great for insect larvae to complete its life cycle. Research has found, however, that some <sup>54</sup> fly larvae can survive at greater depths than those of the deepest-diving marine mammals. A third hypothesis asserts that ocean water contains too little oxygen for <sup>55</sup>

insects. Similarly, some fly larvae can survive months <sup>56</sup> without oxygen, while other insect species live in very polluted waters with similarly low oxygen levels.

Dr. Cheng believes that a fourth hypothesis is the likely explanation. She suspects insects are less <sup>57</sup> successful at sea because they so readily adapted to land. While the insects were colonizing land, the crustaceans, their main marine competitors, were effectively adapting to the saltwater environment. As partial evidence, Dr. Cheng cites the fact that *Halobates* spend their lives walking on top of the <sup>58</sup>

water; thus eliminating the need to compete <sup>59</sup> with the crustaceans below.

52. F. NO CHANGE  
G. has been offered  
H. offers  
J. will offer

53. A. NO CHANGE  
B. oceans high  
C. ocean's high  
D. ocean's high,

54. F. NO CHANGE  
G. there  
H. they're  
J. their

55. A. NO CHANGE  
B. too few  
C. lesser  
D. fewer

56. F. NO CHANGE  
G. Therefore,  
H. Yet,  
J. So

57. A. NO CHANGE  
B. in all probability the likely  
C. likely the most probable  
D. very probably the likely

58. Which of the following alternatives to the underlined portion would NOT be acceptable?  
F. upon  
G. top of  
H. atop  
J. on

59. A. NO CHANGE  
B. water and thus  
C. water, thus  
D. water. Thus

Question 60 asks about the preceding passage as a whole.

- 60.** Suppose the writer's goal had been to write a brief essay about how a scientist's curiosity can lead to research studies. Would this essay successfully fulfill that goal?
- F. Yes, because it shows how Dr. Cheng based her research on a question she had about marine insects.
  - G. Yes, because it describes how Dr. Cheng was able to develop and ask various hypothetical questions.
  - H. No, because it offers only partial evidence to support Dr. Cheng's hypotheses.
  - J. No, because it focuses on the species *Halobates* rather than on Dr. Cheng.

#### PASSAGE V

##### A Case for Noise Pollution Controls

[1] Talk to friends and neighbors, and you'll have a hard time finding anyone who claims to be in favor of air and water pollution.  
 [2] Our environment is a common resource, something we all enjoy during exciting weekends in the park.

61

[3] We don't tolerate those who exploit or abuse,  
 62  
 the public lands we use for recreation, the water  
 we drink, or the air we breathe. [4] Yet many  
 people, who feel strongly, about pollution of these  
 63  
 resources are strangely silent about protecting

- 61.** Which choice would most effectively conclude this sentence so that it emphasizes citizens' involvement in preserving the environment?

- A. NO CHANGE
- B. we all have a right to use and a responsibility to protect.
- C. that reminds us of our relationship to the land and its contribution to our peace and well-being.
- D. we all reflect upon and appreciate for the many benefits it provides.

- 62.** F. NO CHANGE  
 G. who exploit, or abuse  
 H. who exploit or abuse  
 J. who, exploit or abuse,

- 63.** A. NO CHANGE  
 B. people who feel strongly about pollution,  
 C. people, who feel strongly about pollution,  
 D. people who feel strongly about pollution

our environment from noise. 64

Advocates supporting noise pollution controls are concerned about the noise from construction equipment and airplanes. They are also targeting the noise of snowmobiles and all-terrain vehicles, of leaf blowers and loud car sound systems. Some of the effects of excessive noise are already known. The most obvious one is premature hearing loss. Studies indicate a fairer clear 67

link between noise and stress, which experts believe 68 there's a connection between noise and violence.

Therefore, there's evidence that noise affects not only 69 humans but animals as well. For these reasons, there's

increasing agreement with the view that "good neighbors 70 keep their noise to themselves."

Of course, many people had insisted that 71 they have a right to make noise on their own property.

64. At this point, the writer is considering adding the following sentence:

These people have yet to understand the scope and effects of noise pollution.

Would this be a relevant addition to make here?

- F. Yes, because it completes the idea expressed in Sentence 4.
- G. Yes, because it identifies those who exploit and abuse the land referred to in Sentence 3.
- H. No, because it contradicts the idea expressed in Sentence 1.
- J. No, because it provides a digression that leads the essay away from its primary focus.

65. A. NO CHANGE

- B. Advocates who are in favor of
- C. Advocates of
- D. People who advocate and support

66. F. NO CHANGE

- G. vehicles;
- H. vehicles and,
- J. vehicles of

67. A. NO CHANGE

- B. fair
- C. more fairly
- D. fairly

68. F. NO CHANGE

- G. stress that
- H. stress, and
- J. stress because

69. A. NO CHANGE

- B. Namely,
- C. On the other hand,
- D. In addition,

70. F. NO CHANGE

- G. agreement increasing with the view
- H. agreement with the view increasing
- J. agreement with the increasing view

71. A. NO CHANGE

- B. insisted
- C. were insisting
- D. will insist

But do they? 72 Do people have a right to dump dangerous chemicals on their land if these chemicals escape into the air or end up in our rivers and reservoirs?

The laws say no. Many municipalities have begun to 73 adopt ordinances that limit levels and kinds of noise.

These noise laws specify times when lawnmowers cannot be used, and they restrict when airplanes can take off and land. 74 They crack down on loud car stereos,

just as they ban motorized watercraft. 75 These steps suggest that even if the debate about noise controls may be loud, we may eventually end up with a quieter environment.

**72.** The writer is considering deleting the preceding sentence from this paragraph. Should the sentence be kept or deleted?

- F.** Kept, because it provides a transition from the opening sentence to the statements at the end of this paragraph.
- G.** Kept, because it is the first in a series of questions that explain the meaning of noise pollution.
- H.** Deleted, because the question it poses is never answered in the paragraph.
- J.** Deleted, because the question is restated in the next sentence and therefore is redundant.

**73.** A. NO CHANGE  
B. began  
C. beginning  
D. begin

**74.** At this point, the writer is considering adding the following sentence:

Today airports can hardly control the number of airline arrivals and departures, and this air traffic congestion creates all sorts of other problems.

Should the writer add this sentence here?

- F.** Yes, because it adds important details that suggest noise is not the only concern with major airports.
- G.** Yes, because it provides additional information suggesting the extent to which noise laws have been enforced.
- H.** No, because it does not mention the other problems that are occurring at major airports.
- J.** No, because it provides a digression that leads the paragraph away from its primary focus.

**75.** The writer is considering adding the following phrase to the end of the preceding sentence:

from many lakes and rivers.

Should the writer add this phrase here?

- A.** Yes, because it adds a specific detail clarifying how motorized watercraft have been restricted.
- B.** Yes, because it supports the idea of public lands being used for recreation, mentioned in the first paragraph.
- C.** No, because it does not specify from which lakes and rivers the watercraft have been banned.
- D.** No, because it is redundant; the essay already implies that lakes and rivers would be the only waterways affected by loud noise.

**END OF TEST 1**

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



**Passage III**

**HUMANITIES:** This passage is adapted from the essay "Erased Edges" by Barbara Hurd (©2001 by Barbara Hurd).

Once, I enrolled in a weeklong seminar to learn how the government delineates wetlands. The government's guide to finding the edge of a swamp is fifty pages long, complete with graphs and soil maps you 5 need a magnifying glass to decipher. But a liquid landscape cannot be nailed down with maps and charts any more than love can be understood as a biochemical reaction of pheromones.

Trying to define the edge of a swamp is like trying 10 to put a neatly folded shadow into a dresser drawer. Our efforts to outline these places arise from a desire for tidiness, a wish that nothing undefined lurk around our own edges. But the truth is, even human boundaries shift. Some mornings, I wake up feeling small and 15 compact. I barrel through those days, teaching, opening mail, and grading papers like a self-propelled lawn mower. Other days, I feel huge, airy, globular. Someone blows through the bubble wand, and I billow out my front door, roll into the garden, into class. I can't grade 20 a thing, but I can see the shadow a poem makes, where it wants to go. On those days, I can live with how the edges of a swamp shift, how its underbelly can sometimes surge in the center and open up into a pond, how the pond can disappear and the woods around the 25 perimeter go soggy overnight.

Once, as children, my twin sister and I fashioned our own seedpod by threading an old rope through the four corner grommets of a tarpaulin and flinging the rope's frayed end over a large limb of a maple in front 30 of the house. We sat cross-legged in the middle of the tarp and pulled on the rope until the four corners rose around us, enclosing us, and the sack began to rise off the ground. We were actually able to hoist ourselves a few feet into the air this way and dangle there, a khaki- 35 green sack of twins, a pod hanging heavy on the vine, its seeds hidden inside, suspended and swaying over the front lawn of a suburban neighborhood.

At that time, my family lived just a half mile or so 40 from a small pond. One spring I spent weeks there imagining my stick was a giant pencil with a pink rubber eraser on the end. I imagined crouching on the bank of the pond and systematically erasing the edge. There was something quite magical about the notion 45 that you could change the ground you stood on by erasing some line.

The gift of ambiguity is that it stretches us. Makes us less rigid. Nudges us out of either/or thinking. One morning when I was forty-two, I stood in my bedroom, changing from a sweat shirt to a T-shirt, and suddenly I 50 couldn't remember whether my twin or I was older. Was I Baby Girl A or Baby Girl B? From the moment of our birth, in spite of our parents' best efforts to differentiate us, we were "the twins," a unit who shared bedrooms and friends and chores and clothes and good-

55 night rituals, a unit others momentarily dissected by asking which of us was older, as if those thirteen minutes were the only distinction between us. So, on the midlife morning when I stood in my bedroom and felt those thirteen minutes utterly dissolve, the realization 60 swept over me that if I didn't know which one of us was older, if that distinction disappeared, then I might very well be my sister, not me. Looking in the mirror didn't help. I recognized the face, knew this body was the writer's and that other one the designer's. But I felt 65 somehow it was quite possible that I had momentarily sloshed into her body and she into mine, that this might not be me now sitting on the bathroom floor, the way if you take a stick and dig a channel between puddles in the dirt, the water from each puddle heads toward the 70 other, and there's nothing to stop the exchange of liquid so that, in just an instant, there's some new, double-bulged body of water, but no recognizable puddle A or puddle B.

Here's what I love about the in-between: its inherent 75 ambiguity, how it invites a swaying of the imagination, a languid hammock swing between two definitions, two identities. The mind, like the body, swings sideways, rises over one bed of possibilities, pauses at the peak, considers, sweeps down and over to 80 the other side. I am one twin, then the other. This swamp is land first, and then water; this turtle in my hand a waddler, and now a swimmer. We are shapeshifters, all of us, liquid mosaics of mutable and transient urges, and we give ourselves headaches when 85 we pretend otherwise, when we stiffen into permanent and separate identities unsullied by the drifting slop, the very real ambiguities of ourselves and the world.

21. In the passage, the author refers to herself as all of the following EXCEPT:
- her twin sister.
  - a shape-shifter.
  - a neatly folded shadow.
  - a self-propelled lawn mower.

22. The author would most likely agree with which of the following statements about the seminar mentioned in the first paragraph?
- F. The organizers were poorly prepared to teach what most of the students expected to learn.  
G. It provided a substantial amount of information about wetlands, but it fell short of satisfying the author's curiosity.  
H. It was an exciting introduction to wetlands management and motivated the author to do graduate work in the field.  
J. It successfully combined scientific information with accounts of personal experiences in wetlands.
23. As it is used in the passage, the phrase "a biochemical reaction of pheromones" (lines 7–8) represents:
- A. a government-sponsored wetland evaluation.  
B. an exchange the narrator observes in swamps.  
C. the focus of the weeklong seminar.  
D. an absurdly insufficient definition of love.
24. The word *seeds* in line 36 refers to the:
- F. author's ideas.  
G. author and her sister.  
H. next generation of wetland grasses.  
J. fragile universe.
25. The passage states that the author's twin sister is by profession a:
- A. designer.  
B. biologist.  
C. writer.  
D. business owner.
26. Which of the following best describes how the author uses the reference to the turtle (line 81)?
- F. She offers the turtle as an image that represents humans' slow progress toward understanding.  
G. She contrasts the turtle with humans who rush thoughtlessly through life.  
H. She uses the turtle as another example of a living thing that has more than one identity.  
J. She compares the turtle's shell to the rigid ideas that people use to protect themselves from uncertainty.
27. Information in the passage indicates that the author's age when she wrote this passage was:
- A. twenty-two or younger.  
B. between twenty-two and thirty.  
C. between thirty and forty.  
D. forty-three or older.
28. Which of the following statements about the author and her twin sister as children is supported by the passage?
- F. They resented being mistaken for one another and attempted to form very distinct identities.  
G. They spent a great deal of time together and shared possessions, activities, and friends.  
H. The author continually imagined that she was herself one minute and her sister the next.  
J. They were constantly reminding others that they were born thirteen minutes apart.
29. When the author uses "we" in line 84, she is most likely referring to:
- A. her twin sister and herself.  
B. all twins.  
C. everyone in her family.  
D. people in general.
30. Which of the following would the author most likely see as an example of what it means to "pretend otherwise" as the phrase is used in line 85?
- F. A twin pretending to be his or her twin sibling  
G. A biologist pretending to be a writer  
H. A human pretending to be a turtle  
J. A singer pretending to be nothing but a singer

## Passage IV

**NATURAL SCIENCE:** This passage is adapted from the book *Biomimicry: Innovation Inspired by Nature* by Janine M. Benyus (©1997 by Janine M. Benyus).

It's a steamy 80 degrees Fahrenheit in Christopher Viney's lab, in deference to a six-inch-long golden orb weaver spider, who is dining on crickets while being silked. A gossamer thread issues from her enormous abdomen at a steady clip, wound by a motor onto a revolving spindle. In this session alone, she will donate about 100 feet of "dragline," a specialty silk designed for rappelling from drop-offs and framing the spokes and perimeter of her web.

Compared ounce to ounce with steel, dragline silk is five times stronger, and compared to Kevlar (found in bulletproof vests), it's much tougher—able to absorb five times the impact force without breaking. Besides being very strong and very tough, spider silk also manages to be highly elastic, a hat trick that is rare in any one material. If you suspend increasingly heavy weights from a steel wire and a silk fiber of the same diameter, their breaking point is about the same. But if a gale force wind blows, the strand of silk (five times lighter in weight) will do something the steel never could—it will stretch 40 percent longer than its original length and bounce back good as new. Up against our stretchiest nylon, spider silk bungees 30 percent farther.

Another characteristic in spider silk's favor is that it has to get very, very cold before it becomes brittle enough to break easily. In the frigid temperatures that parachutes encounter, for instance, spider silk would make ideal lightweight lines. Other uses would be cable for suspension bridges, artificial ligaments, and sutures. But how would we fit so much function into such a small package?

Spider silk begins as a pool of raw liquid protein sloshing around in a gland. Viney hypothesizes that the raw liquid silk leaves the gland and travels through a thin duct just before entering the spinneret. As it squeezes through the duct, water is wrung out of the protein and calcium is added. The globules hook up in a pop-bead necklace, making the solution one thousand times less viscous, because the rodlike assemblies can now slide past one another. It's analogous to putting lanes of traffic on a highway sliding past one another, versus the mess that is a laneless, lawless traffic jam.

Viney's model has a pleasing simplicity and completeness: The globular proteins line up into a pop-bead necklace, which squeezes through the spinneret to become a silk fiber. The final product is partly flexible and partly rigid, like a reinforced Slinky. The amorphous part gives, but the stiff crystalline domains don't give. When the fiber becomes notched, a crack or tear gets interrupted by the crystalline regions and can't propagate.

Some, like silk researcher Randy Lewis, don't agree with Viney's model. Lewis feels he has evidence

that there are actually two proteins rather than just one that make up spider silk. "In the two-protein hypothesis, Viney's pop-bead model doesn't make sense," says Lewis. But other researchers are still not convinced of the existence of two proteins. While the jury is out and the debate is lively, all the investigators in spider silk research encourage one another to keep theorizing. When you think about what it could mean in terms of sustainable fiber manufacture, this research, tough as it is, is definitely worth it.

Consider: The only thing we have that comes close to silk in quality is polyaramid Kevlar, a fiber so tough it can stop bullets. But to make Kevlar, we pour petroleum-derived molecules into a pressurized vat of concentrated sulfuric acid and boil it at several hundred degrees Fahrenheit in order to force it into a liquid crystal form. We then subject it to high pressures to force the fibers into alignment as we draw them out. The energy input is extreme, the toxic by-products odious.

The spider manages to make an equally strong and much tougher fiber at body temperature, without high pressures, heat, or corrosive acids. Best of all, says Viney, spiders don't have to drill offshore for oil to produce the silk. They take flies and crickets at one end and process a high-tech material at the other end.

If we could learn to do what the spider does, we could take a soluble raw material that is infinitely renewable and make a super-strong water-insoluble fiber with negligible energy inputs and no toxic outputs. We could apply that processing strategy to any number of fiber precursors. Imagine what it would do to our fiber industry, which is now heavily dependent on petroleum, both for raw material and processing! To break that dependency, says Viney, we have to become spider's apprentices.

31. Which of the following questions is NOT answered by the passage?
- Why is the pop-bead model unworkable if there are two proteins in spider silk?
  - Does the author have an opinion as to the value of the research done by Viney and Lewis and others like them?
  - What do spiders eat?
  - Can a spider produce silk at body temperature?

32. It is most reasonable to infer that if the apprentices referred to in line 89 were successful, which of the following would occur?
- F. Viney would become a research apprentice to Lewis.  
G. The amount of toxic waste produced by the fiber industry would decrease.  
H. Liquid protein would become more available at supermarkets.  
J. The research into spider silk would come to a halt in all but a few obscure labs.
33. Which of the following best describes how the phrase "laneless, lawless traffic jam" (line 42) functions in the passage?
- A. As an example of what a spider web looks like to the untrained eye.  
B. As an analogy for the heated disagreement between scientists about the process of spider silk manufacture.  
C. As an image for the structure of spider silk were the silk not formed into rodlike assemblies.  
D. As a suggestion of how Viney's office might appear to an outsider.
34. Which of the following statements best describes Kevlar and its significance in relation to spider silk, according to the passage?
- F. Spider silk could replace Kevlar, the tough material in bulletproof vests, but the production process would yield many odious by-products.  
G. Kevlar, the material that makes bulletproof vests possible, has all of the strength but none of the flexibility of spider silk.  
H. Of human-made materials, Kevlar comes closest in quality to spider silk, but its manufacture takes a heavy toll on natural resources.  
J. Kevlar, a material used in bulletproof vests, was what inspired Viney to focus his research on the structure and function of spider silk.
35. As it is used in line 4, the word *issues* most nearly means:
- A. takes.  
B. separates.  
C. stitches.  
D. emerges.
36. The passage states that which of the following combinations of qualities rarely occurs in the same material?
- F. Extreme strength and extreme elasticity  
G. Extreme lightness (in weight) and extreme strength  
H. Extreme water resistance and extreme elasticity  
J. Extreme viscosity and extreme durability
37. What comparison does the author make between spider silk and nylon?
- A. When spider silk is stretched out, its molecular structure resembles that of nylon.  
B. Spider silk is one-third as stretchy as the most stretchy nylon.  
C. Spider silk is as stretchy as the most stretchy nylon.  
D. Spider silk is 30 percent more stretchy than the most stretchy nylon.
38. According to Viney's model as it is presented in the passage, what is the route that molecules travel on their way to becoming spider silk?
- F. Gland, duct, spinneret  
G. Spinneret, gland, duct  
H. Gland, spinneret, duct  
J. Duct, gland, spinneret
39. As it is used in line 78, the word *take* most nearly means:
- A. steal.  
B. acquire.  
C. consume.  
D. choose.
40. According to the passage, the fiber industry is heavily dependent on:
- F. silk.  
G. petroleum.  
H. government subsidies.  
J. rodlike assemblies.

## Answers to additional English work

## Page 118 - 124

31. C                    61. B  
32. J                    62. H  
33. B                    63. D  
34. H                    64. F  
35. A                    65. C  
36. J                    66. F  
37. C                    67. D  
38. F                    68. H  
39. C                    69. D  
40. G                    70. F  
41. C                    71. D  
42. F                    72. F  
43. D                    73. A  
44. G                    74. J  
45. A                    75. A  
46. G  
47. B  
48. G  
49. A  
50. G  
51. C  
52. H  
53. C  
54. J  
55. A  
56. H  
57. A  
58. G  
59. C  
60. F

## Answers to additional Reading work

## Page 126 - 129

21. C  
22. G  
23. D  
24. G  
25. A  
26. H  
27. D  
28. G  
29. D  
30. J  
31. A  
32. G  
33. C  
34. H  
35. D  
36. F  
37. D  
38. F  
39. C  
40. G

