Form 70C

(June 2012)

The ACT® 2011 | 2012

In response to your recent request, for Test Information Release materials, this booklet contains the test questions and conversion tables used in determining your ACT scores. Enclosed with this booklet is a report listing your answers to the ACT multiple-choice tests and the answer key.

If you wish to order a photocopy of your answer document—including, if you took the Writing Test, a copy of your written essay—please use the order form on the inside back cover of this booklet.

We hope that you will find this information helpful.

MATHEMATICS TEST
60 Minutes—60 Questions

DIRECTIONS: Solve each problem, choose the correct answer, and then fill in the corresponding oval on your answer document.

Do not linger over problems that take too much time. Solve as many as you can; then return to the others in the time you have left for this test.

You are permitted to use a calculator on this test. You may use your calculator for any problems you choose, but some of the problems may best be done without using a calculator.

Note: Unless otherwise stated, all of the following should be assumed.

1. Illustrative figures are NOT necessarily drawn to scale.
2. Geometric figures lie in a plane.
3. The word *line* indicates a straight line.
4. The word *average* indicates arithmetic mean.

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1. The table below gives the heart rates, in beats per minute (bpm), for 8 participants in a fitness study after each participant completed 45 minutes of aerobic exercise. What is the mean heart rate of the 8 participants, to the nearest 0.1 bpm ?

Participant	Heart rate (bpm)
1	130
2	155
3	162
4	148
5	177
6	162
7	170
8	156
Sum	1,260

A. 137.3
B. 153.5
C. 157.5
D. 162.0
E. 162.5

2. The top surface of a rectangular table has an area of 144 square feet and a width of 4 feet. What is the length, in feet, of the surface?

F. 12
G. 32
H. 36
J. 140
K. 576

3. The price of a coat decreased from $50 to $40. The price decreased by what percent?

A. 10%
B. 14%
C. 15%
D. 20%
E. 25%

DO YOUR FIGURING HERE.

GO ON TO THE NEXT PAGE.

DO YOUR FIGURING HERE.

4. Chang, a store employee, asked each of 50 customers which 1 of 4 shirt colors the customer preferred. The number of customers who preferred each color is given in the table below.

Color	Number of customers
Red	15
White	22
Blue	5
Gray	8
Total	50

Chang will order 500 shirts in the proportions, by color, in the table. How many gray shirts will he order?

F.   8
G.   16
H.   40
J.   80
K.   125

5. Belinda plans to use landscaping timbers to build a border for her 8-foot-by-12-foot rectangular garden. To determine the number of timbers she needs, she must calculate the perimeter of the garden. What is the perimeter, in feet, of the garden?

A.   20
B.   24
C.   40
D.   48
E.   96

6. At Nikki's Necklaces, the total production cost to produce necklaces consists of an operational cost of $300 per day, plus a material cost of $10 per necklace produced. For a day in which n necklaces are produced, which of the following expressions gives that day's total production cost, in dollars, to produce necklaces?

F. $-10n + 300$
G. $10n - 300$
H. $10n + 300$
J. $300n - 10$
K. $300n + 10$

7. The first question on a 2-question quiz offers 2 answers, and exactly 1 answer must be chosen. The second question offers 5 answers, and exactly 1 answer must be chosen. The quiz has how many possible combinations of answers?

A.   5
B.   10
C.   20
D.   25
E.   100

8. For what value of x is the equation $2(x - 6) + x = 36$ true?

F. 8
G. 10
H. 14
J. 16
K. 24

DO YOUR FIGURING HERE.

9. What value of a will make the equation $\frac{4+a}{9+a} = \frac{2}{3}$ true?

A. −19
B. 3
C. 5
D. 6
E. 30

10. The 1st term in the geometric sequence below is −6. If it can be determined, what is the 6th term?

$$-6, 12, -24, 48, -96, \cdots$$

F. 192
G. 144
H. −144
J. −192
K. Cannot be determined from the given information

11. In the standard (x,y) coordinate plane, A has coordinates $(-4,-9)$. Point A is translated 4 units to the right and 9 units up and labeled A'. What are the coordinates of A'?

A. $(-13,-13)$
B. $(-8,-18)$
C. $(-4,-18)$
D. $(0, 0)$
E. $(8, 18)$

12. A formula used to compute the volume, V, of a rectangular prism is $V = lwh$, where l is the length of the base, w is the width of the base, and h is the height of the prism. What is the height, in centimeters, of a rectangular prism that has a volume of 510 cubic centimeters and a base that measures 5 centimeters by 12 centimeters?

F. 8.5
G. 30
H. 42.5
J. 102
K. 450

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DO YOUR FIGURING HERE.

13. Solar panels that produce 150 amps of electric current each are needed for a proposed space station. If the solar panels are manufactured to produce 0.75 amps per square meter of surface area, the surface area of each solar panel needs to be how many square meters?

   A. 20
   B. 75
   C. 112.5
   D. 150
   E. 200

14. If cantaloupes sell at $1.49 each or 3 for $3.90, how much is saved, to the nearest cent, on each cantaloupe by buying them 3 at a time?

   F. 12¢
   G. 19¢
   H. 31¢
   J. 47¢
   K. 92¢

15. Which of the following expressions is equivalent to $(4ab^2)(3a^4b^3)$?

   A. $7a^4b^6$
   B. $7a^5b^5$
   C. $12a^4b^5$
   D. $12a^4b^6$
   E. $12a^5b^5$

16. In the standard (x,y) coordinate plane, the coordinates of the endpoints of $\overline{DM}$ are (11,3) and (17,15). What is the y-coordinate of the midpoint of $\overline{DM}$?

   F. 7
   G. 9
   H. 14
   J. 16
   K. 18

17. The distance-versus-time graph below represents Barbara Jean's walk to school on Friday.
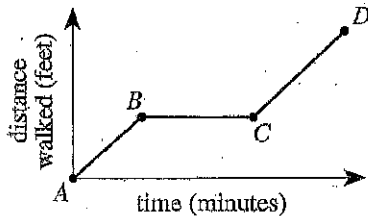
Which of the following statements could describe what Barbara Jean did during the time interval covered by the horizontal line segment $\overline{BC}$?

   A. She walked due east.
   B. She walked up some steps.
   C. She walked on level ground.
   D. She walked at a faster speed.
   E. She stopped to talk to friends.

18. In the diagram below, lines m and n are cut by transversal t. Lines m and n are NOT parallel. Which of the following statements *must* be true?
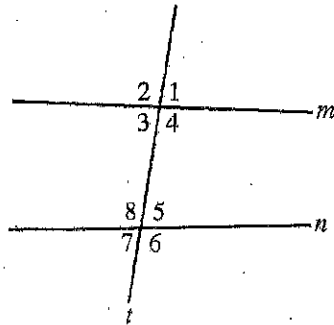
F. $\angle 1 \cong \angle 2$
G. $\angle 1 \cong \angle 3$
H. $\angle 1 \cong \angle 5$
J. $\angle 2 \cong \angle 6$
K. $\angle 3 \cong \angle 5$

19. The expression $5 - 3(2x - 1)$ is equivalent to:

A. $-2 + 4x$
B. $2 - 6x$
C. $8 - 6x$
D. $8 - 5x$
E. $9 - 6x$

20. Which of the following angle measures CANNOT be the measure of any angle in an obtuse triangle?

(Note: An obtuse triangle is a triangle that has 1 angle with a measure greater than 90° but less than 180°.)

F. $30°$
G. $37°$
H. $60°$
J. $90°$
K. $126°$

21. What is the value of $f(-5)$ when $f(x) = \dfrac{-3(x^2 + 3x + 2)}{15x + 15}$?

A. $-\dfrac{19}{10}$

B. $-\dfrac{3}{5}$

C. $\dfrac{3}{5}$

D. $\dfrac{12}{25}$

E. $\dfrac{19}{10}$

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22. In the standard (x,y) coordinate plane, what is the slope of the line with equation $3x + 2y = 6$?

F. -3

G. $-\dfrac{3}{2}$

H. $-\dfrac{2}{3}$

J. $\dfrac{2}{3}$

K. $\dfrac{3}{2}$

23. Which of the following is a simplified form of $\sqrt{20} - \sqrt{45}$?

A. $-\sqrt{5}$

B. -5

C. 5

D. $5\sqrt{5}$

E. $\sqrt{65}$

24. A formula for simple interest is $I = Prt$, where I is the interest in dollars, P is the principal in dollars, r is the annual interest rate expressed as a decimal, and t is the time in years the money is invested. Which of the following expressions gives t when the annual interest rate is 5% ?

F. $\dfrac{I}{0.05P}$

G. $\dfrac{I}{0.5P}$

H. $\dfrac{I}{5P}$

J. $\dfrac{0.5I}{P}$

K. $0.05IP$

25. When $t = 2,005$, the value of the function $f(t)$ is 100 more than twice the value of $f(t)$ when $t = 1,998$. Which of the following equations expresses this relationship?
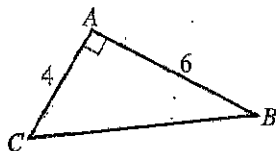
A. $f(2,005) = 2f(1,998) + 100$
B. $f(1,998) = 2f(2,005) + 100$
C. $f(t) = 2f(t) + 100$
D. $f(t + 2,005) = 2f(t + 1,998) + 100$
E. $f(2,005) + 100 = 2f(1,998)$

Use the following information to answer
questions 26–28.

Shown below is right triangle △ABC with the given
dimensions in meters.

26. What is the length, in meters, of $\overline{BC}$?

F. 8
G. 10
H. $\sqrt{10}$
J. $\sqrt{20}$
K. $\sqrt{52}$

27. Which of the following statements about the measures
of the interior angles in △ABC is true?

(Note: $m\angle A$ represents the degree measure of $\angle A$.)

A. $m\angle A = m\angle B$
B. $m\angle B = m\angle C$
C. $m\angle A = m\angle B + m\angle C$
D. $m\angle B + m\angle C = 180°$
E. $m\angle A + m\angle B + m\angle C = 360°$

28. Which of the following expressions represents $\cos B$?

F. $\dfrac{AB}{AC}$

G. $\dfrac{AB}{BC}$

H. $\dfrac{AC}{BC}$

J. $\dfrac{AC}{AB}$

K. $\dfrac{BC}{AB}$

29. Given the functions f and g defined by $f(x) = x + 3$ and
$g(x) = x^2 + 1$, what is the value of $f\big(g(1)\big)$?

A. 2
B. 5
C. 6
D. 8
E. 17

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30. Which of the following expressions is equivalent to $(3x^2)^3$?

    F. $3x^5$
    G. $3x^6$
    H. $9x^5$
    J. $9x^6$
    K. $27x^6$

31. Marsha is making a sail for a model boat. In the figure below, the sail is represented by $\triangle ABC$. Base $\overline{BC}$ is 18 inches long, and legs $\overline{AB}$ and $\overline{AC}$ are each 15 inches long. The mast, represented by $\overline{AD}$, is perpendicular to the base and extends 4 inches below the bottom of the sail. How many inches long is the mast?
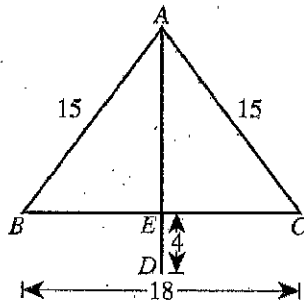
    A. 12
    B. 16
    C. 33
    D. $3\sqrt{11}$
    E. $3\sqrt{11} + 4$

32. Which of the following inequalities orders the numbers below from least to greatest?

$$3\tfrac{3}{7}, -(-3.5), 3\tfrac{2}{5}$$

    F. $-(-3.5) < 3\tfrac{2}{5} < 3\tfrac{3}{7}$
    G. $-(-3.5) < 3\tfrac{3}{7} < 3\tfrac{2}{5}$
    H. $3\tfrac{3}{7} < 3\tfrac{2}{5} < -(-3.5)$
    J. $3\tfrac{2}{5} < -(-3.5) < 3\tfrac{3}{7}$
    K. $3\tfrac{2}{5} < 3\tfrac{3}{7} < -(-3.5)$

DO YOUR FIGURING HERE.

Use the following information to answer questions 33–35.

The table below gives the prices for dog grooming at Pretty Pooches.

Size of dog	Shampoo	Haircut
Small	$20	$30
Large	$35	$55

33. Hoakoa brought 10 dogs to Pretty Pooches and paid $260 to have all 10 shampooed. How many large dogs did Hoakoa have shampooed?

A. 2
B. 4
C. 5
D. 6
E. 7

34. Jim took his large dog to Pretty Pooches for a haircut 3 times. Jim paid full price for the first 2 haircuts, and had a coupon for the 3rd haircut, giving him a 15% discount on the 3rd haircut. How much did Jim pay for the 3 haircuts?

F. $ 99.75
G. $118.25
H. $137.50
J. $150.00
K. $156.75

35. When the owner of Pretty Pooches increases the price to have a small dog shampooed, the number of small dogs shampooed per day decreases. The expression $ax + b$ represents the number of small dogs shampooed in 1 day whenever the price is x dollars per dog. The number of small dogs shampooed per day was 12 when the price in the table was in effect. The number of small dogs shampooed per day decreases by 2 for every $5 increase in price. What are the values of a and b ?

	a	b
A.	$-\frac{5}{2}$	62
B.	$-\frac{2}{5}$	20
C.	$\frac{2}{5}$	4
D.	2	200
E.	5	2

DO YOUR FIGURING HERE.

36. $\dfrac{1}{1+\dfrac{1}{1+\frac{1}{2}}} = ?$

   F. $\dfrac{5}{3}$

   G. $\dfrac{3}{2}$

   H. $\dfrac{3}{4}$

   J. $\dfrac{2}{3}$

   K. $\dfrac{3}{5}$

37. In the standard (x,y) coordinate plane, what is the x-intercept of the line represented by $y = -2x + 8$?

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

38. A toy rocket is launched from the ground. Its height, h feet above the ground, t seconds after it is launched, is given by $h = -16t^2 + 48t$. During the rocket's ascent, at what value of t is the rocket 32 feet above the ground?
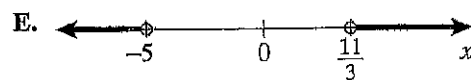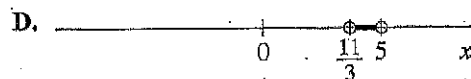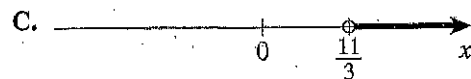
   F. $\dfrac{1}{2}$
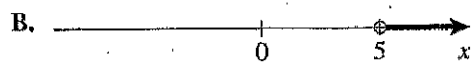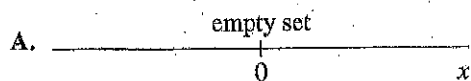
   G. $\dfrac{2}{3}$

   H. 1

   J. 2

   K. 3

39. Which of the following graphs illustrates the solution set for the system of inequalities $3x - 2 > 9$ and $-2x > -10$?

DO YOUR FIGURING HERE.

40. A cab picks up a passenger at a point that is designated on the map as (7,−3) and is 7 miles east and 3 miles south of the cab company's headquarters. From (7,−3), the cab travels 4 miles due north, 5 miles due east, and then 2 miles due west, where the passenger is dropped off. Which of the following is closest to the straight-line distance, in miles, the cab is from the cab company's headquarters?

F. 21
G. 17
H. 14
J. 10
K. 8

41. During a competition, a swimmer will be swimming the width of a river, from X to Y in the figure below. The swimmer wants to know how wide the river is. The right triangle shows the measurements the swimmer obtained by walking 100 feet from X to Z, sighting to Y from both points. From this sighting, it is determined that the measure of $\angle Z$ is 40°. How wide, in feet, is the river?
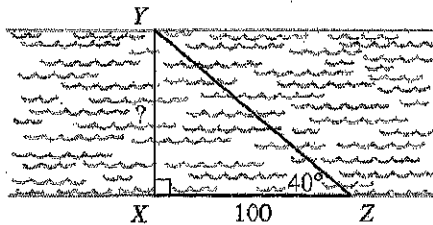
A. $\dfrac{100}{\sin 40°}$

B. $\dfrac{100}{\tan 40°}$

C. $100 \sin 40°$

D. $100 \cos 40°$

E. $100 \tan 40°$

42. The figure below shows a support wire for a television transmission tower. The wire, which is fastened to the tower at a point 125 feet above the level ground, has an angle of elevation of 65°. Which of the following expressions gives the length, in feet, of the wire?

F. $\dfrac{125}{\sin 65°}$

G. $\dfrac{125}{\cos 65°}$

H. $\dfrac{125}{\tan 65°}$

J. $125 \sin 65°$

K. $125 \tan 65°$

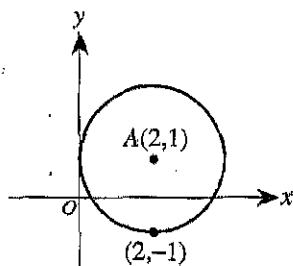125 feet

65°

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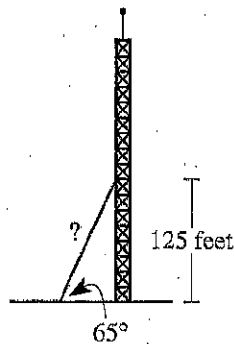
43. A circle is inside a rectangle 6 inches wide and 8 inches long and is tangent to 3 sides of the rectangle. What is the area, in square inches, of the circle?

A. 6π
B. 8π
C. 9π
D. 16π
E. 36π

DO YOUR FIGURING HERE.

44. Which of the following equations represents the circle with center $(2,1)$ shown in the standard (x,y) coordinate plane below?

F. $(x-2)^2 + (y-1)^2 = 2$
G. $(x-2)^2 + (y-1)^2 = 4$
H. $(x-2)^2 + (y+1)^2 = 4$
J. $(x+2)^2 + (y+1)^2 = 2$
K. $(x+2)^2 + (y+1)^2 = 4$

45. One of the following inequalities, where both constants a and b are positive real numbers, is graphed in the standard (x,y) coordinate plane below. Which inequality is it?
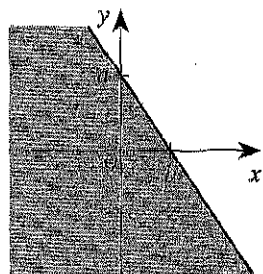
A. $y \geq -\dfrac{a}{b}x + a$

B. $y \leq -\dfrac{a}{b}x + a$

C. $y \leq -\dfrac{b}{a}x + a$

D. $y \leq \dfrac{b}{a}x$

E. $y \leq \dfrac{a}{b}x + a$

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46. Circles A, B, and C have diameters of x inches, $2x$ inches, and $4x$ inches, respectively. What is the ratio of the *radius* of Circle B to the *diameter* of Circle A ?

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

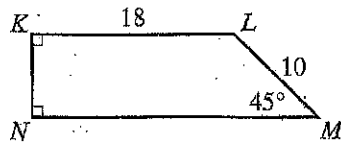**47.** In trapezoid *KLMN* shown below, ∠M measures 45° and ∠K and ∠N are both right angles. The given side lengths are in feet. Which of the following values is closest to the area, in square feet, of *KLMN* ?

   A. 4
   B. 7
   C. 43
   D. 127
   E. 152

48. For the 2 o'clock hour on Milena's grandfather clock (shown below), the bell is struck 2 times. For the 3 o'clock hour, the bell is struck 3 times. For every hour, 2 seconds elapse between consecutive strikes of the bell. For the 9 o'clock hour, how many seconds elapse between the 1st strike of the bell and the 9th strike of the bell?

   F. 8
   G. 9
   H. 11
   J. 16
   K. 18

49. For positive real numbers a, b, and c such that $2a = 3b$ and $\frac{1}{4}b = \frac{1}{2}c$, which of the following inequalities is true?

   A. $c < b < a$
   B. $c < a < b$
   C. $b < c < a$
   D. $b < a < c$
   E. $a < b < c$

50. This month, Malcolm has $100 saved, and his goal is to have a total of $310 saved 12 months from now. After adding to his savings next month, each month he will add $1 more than what he added the previous month. For the next 12 months, Malcolm will not remove any money from what he has already saved. What is the minimum amount of money Malcolm must add to his savings next month so that he reaches his goal?

F. $12
G. $17
H. $18
J. $26
K. $34

DO YOUR FIGURING HERE.

51. For all pairs of nonzero real numbers a and b, the product of the complex number $a + bi$ and which of the following complex numbers is a real number?

A. abi
B. $a + bi$
C. $a - bi$
D. $b + ai$
E. $b - ai$

52. Four congruent semicircles touch only at their corners, as shown in the figure below. If the path from A to B along the diameters of the semicircles is 100 centimeters long, how many centimeters long is the path from B back to A along the arcs of these semicircles?

F. 25π
G. 50π
H. 100π
J. 150π
K. 230π
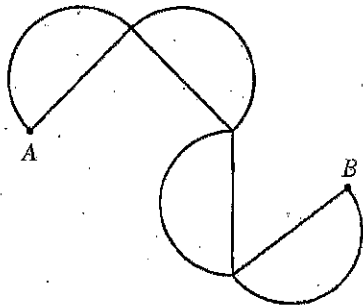
53. For all $a > 1$, which of the following statements describes the function g defined by $g(x) = a^{-x}$?

A. g is constant for all x
B. g is increasing for $x \geq 0$
C. g is decreasing for $x \geq 0$
D. g is increasing for $0 \leq x < 1$ and decreasing for $x \geq 1$
E. g is decreasing for $0 \leq x < 1$ and increasing for $x \geq 1$

54. A magnet attracts a nail with a force that varies inversely with the square of the distance between them. The nail is 12 inches from the magnet. How many inches from the magnet would the nail need to be to have twice as much attractive force on it as it currently has?

F. $\sqrt{2}$

G. 3

H. 6

J. $6\sqrt{2}$

K. $12\sqrt{2}$

55. What is the area, in square meters, of a rhombus (a parallelogram having 4 congruent sides) with side length 4 meters and 2 angles that each measure 60° ?

A. $8\sqrt{3}$

B. $16\sqrt{3}$

C. 8

D. 24

E. 48

56. The right triangle shown below with hypotenuse 13 inches long and vertical leg 5 inches long is rotated 360° around the vertical leg to form a right circular cone. What is the volume of this cone, in cubic inches?

(Note: $V = \frac{1}{3}\pi r^2 h$, where V is the volume, r is the radius, and h is the height.)

F. $\frac{80}{3}\pi$

G. 40π

H. $\frac{320}{3}\pi$

J. 240π

K. 960π
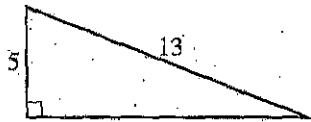
57. Which of the following fractions is equal to $\frac{1}{11^{20}} - \frac{1}{11^{21}}$?

A. $\frac{1}{11^{21}}$

B. $\frac{1}{11^{22}}$

C. $\frac{1}{11^{40}}$

D. $\frac{10}{11^{21}}$

E. $\frac{10}{11^{41}}$

58. Which of the following is equal to $\tan\theta \cos\theta$ when $\sin\theta = \frac{2}{3}$ and $0 < \theta < \frac{\pi}{2}$?

F. $\frac{2}{3}$

G. $\frac{2\sqrt{5}}{9}$

H. $\frac{\sqrt{5}}{3}$

J. $\frac{2\sqrt{5}}{5}$

K. 1

DO YOUR FIGURING HERE.

59. An equilateral triangle is partitioned into 4 smaller congruent equilateral triangles. What is the ratio of the perimeter of 1 of the smaller triangles to the perimeter of the original triangle?

A. $\frac{1}{6}$

B. $\frac{1}{5}$

C. $\frac{1}{4}$

D. $\frac{1}{3}$

E. $\frac{1}{2}$

60. If $|x| = -x$, which of the following statements *must* be true?

F. $x \le 0$
G. $x \ge 0$
H. $x = 0$
J. $x \ne 0$
K. x is not a real number.

END OF TEST 2

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

DO NOT RETURN TO THE PREVIOUS TEST.

SCIENCE TEST

35 Minutes—40 Questions

DIRECTIONS: There are seven passages in this test. Each passage is followed by several questions. After reading a passage, choose the best answer to each question and fill in the corresponding oval on your answer document. You may refer to the passages as often as necessary.

You are NOT permitted to use a calculator on this test.

Passage I

A scientist discovered that cells of a new strain of bacteria, Bacteria X, form colonies when incubated for 72 hr at 37°C on a growth medium having a pH of 7 and an NaCl concentration of 5 g/L. To determine whether these conditions are optimal for the growth of Bacteria X, the scientist conducted an experiment in which incubation temperature, and the pH and the NaCl concentration of the growth medium, were varied. In each trial, Bacteria X cells were incubated for 72 hr, and colony growth was then assayed by determining the average colony diameter (ACD) of the colonies that grew during the incubation (see the table).

| Trial | Incubation temperature (°C) | Growth medium: | | ACD (mm) |
		pH	NaCl concentration (g/L)	
1	25	6	5	1.1
2	37	6	5	1.7
3	42	6	5	0.8
4	25	6	10	1.3
5	37	6	10	1.9
6	42	6	10	0.9
7	25	7	5	1.1
8	37	7	5	1.5
9	42	7	5	1.0
10	25	7	10	1.2
11	37	7	10	2.1
12	42	7	10	1.1

1. To determine whether doubling the NaCl concentration in the growth medium doubles the ACD of Bacteria X, the scientist should compare the results of which of the following 2 trials?
   A. Trial 2 and Trial 3
   B. Trial 2 and Trial 5
   C. Trial 4 and Trial 6
   D. Trial 7 and Trial 8

2. How did increasing the pH of the growth medium from pH 6 to pH 7 affect the ACD when Bacteria X cells were incubated at 42°C on a growth medium having an NaCl concentration of 5 g/L ? When the pH was increased from pH 6 to pH 7, the ACD:
   F. increased; the ACD for Trial 1 was 1.1 mm and the ACD for Trial 2 was 1.7 mm.
   G. increased; the ACD for Trial 3 was 0.8 mm and the ACD for Trial 9 was 1.0 mm.
   H. decreased; the ACD for Trial 1 was 1.7 mm and the ACD for Trial 2 was 1.1 mm.
   J. decreased; the ACD for Trial 3 was 1.0 mm and the ACD for Trial 9 was 0.8 mm.

3. Which of the growth conditions was(were) varied among Trials 10–12 ?
   A. Temperature only
   B. pH only
   C. Temperature and pH only
   D. pH and NaCl concentration only

4. The scientist predicted that the ACD for Bacteria X colonies would be greatest when the bacteria were incubated at a temperature of 37°C on a growth medium having a pH of 7 and an NaCl concentration of 5 g/L. Are the results in the table consistent with this prediction?
   F. Yes; the ACD for Bacteria X colonies was greatest in Trial 8.
   G. Yes; the ACD for Bacteria X colonies was greatest in Trial 11.
   H. No; the ACD for Bacteria X colonies was greatest in Trial 8.
   J. No; the ACD for Bacteria X colonies was greatest in Trial 11.

5. The growth mediums tested in Trial 4 and Trial 10 differed in which of the following ways?
   A. The growth medium in Trial 4 was more acidic than the growth medium in Trial 10.
   B. The growth medium in Trial 10 was more acidic than the growth medium in Trial 4.
   C. The NaCl concentration of the growth medium was greater in Trial 4 than in Trial 10.
   D. The NaCl concentration of the growth medium was greater in Trial 10 than in Trial 4.

Passage II

When a sphere falls through air, the sphere is subjected to a drag force, F, that resists its motion. F depends on the sphere's diameter, D; the air temperature, T; the sphere's speed, V; and atmospheric pressure.

The table below gives F, in newtons (N), on a sphere falling through air near Earth's surface, for various combinations of D, in meters (m); T, in degrees Celsius (°C); and V, in meters per second (m/sec). For each combination, air pressure is 1 atmosphere.

Combination	D (m)	T (°C)	V (m/sec)	F (N)
1	0.050	25.0	20.0	0.93
2	0.100	25.0	20.0	3.71
3	0.150	25.0	20.0	8.34
4	0.200	25.0	20.0	14.9
5	0.200	10.0	20.0	15.8
6	0.200	15.0	20.0	15.5
7	0.200	20.0	20.0	15.1
8	0.200	25.0	20.0	14.9
9	0.200	25.0	10.0	3.72
10	0.200	25.0	20.0	14.9
11	0.200	25.0	30.0	33.5
12	0.200	25.0	40.0	59.5

6. According to Combinations 5–8, as T increases, F:

F. increases only.
G. decreases only.
H. varies, but with no general trend.
J. remains the same.

7. Based on Combinations 9–12, the relationship between F and V is best represented by which of the following graphs?
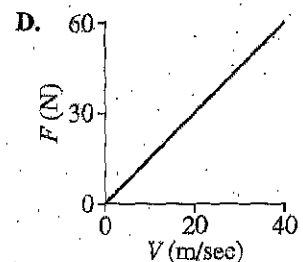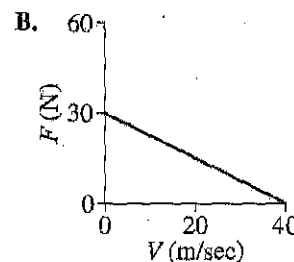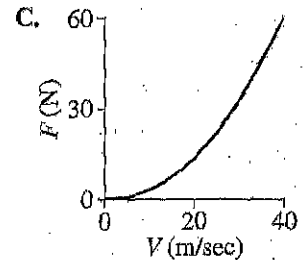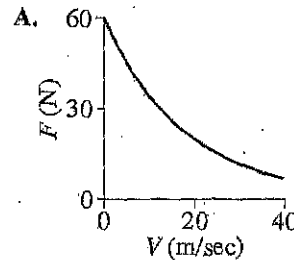
8. Based on the table, F will be greatest for which of the following D, T, and V?

	D (m)	T (°C)	V (m/sec)
F.	0.400	30	100
G.	0.400	60	200
H.	0.800	60	100
J.	0.800	30	200

9. If experimental trials were conducted in which Combinations 1–4 were tested, what would be the independent variable and what would be the dependent variable?

	independent	dependent
A.	V	T
B.	T	V
C.	F	D
D.	D	F

10. As a sphere moves as described in the passage, a transformation of energy takes place involving the sphere's kinetic energy (KE_S), the sphere's potential energy due to Earth's gravity (GPE_S), and heat (Q). Which of the following statements best describes this transformation?

F. Both GPE_S and Q are converted to KE_S.
G. Both KE_S and Q are converted to GPE_S.
H. GPE_S is converted to KE_S and Q.
J. Q is converted to GPE_S and KE_S.

Passage III

When *t*-butyl chloride [(CH$_3$)$_3$CCl] is dissolved in an acetone-H$_2$O solution, it reacts with H$_2$O completely to form *t*-butyl alcohol [(CH$_3$)$_3$COH]:

$$(CH_3)_3CCl + H_2O \xrightarrow{\text{acetone-H}_2\text{O}} (CH_3)_3COH + H^+ + Cl^-$$
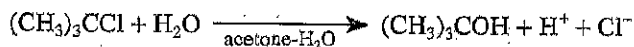
Acetone is less polar than H$_2$O. Thus, increasing the concentration of acetone in H$_2$O *decreases* the polarity of the reaction solution.

Figures 1 and 2 show how the electrical conductivity of each of 5 acetone-H$_2$O solutions varied over time after 1 mg of (CH$_3$)$_3$CCl was dissolved in 100 mL of each solution. The conductivity (which increased as the solution's ion concentration increased) stopped increasing when the reaction had run to completion (indicated by the point labeled "RC").
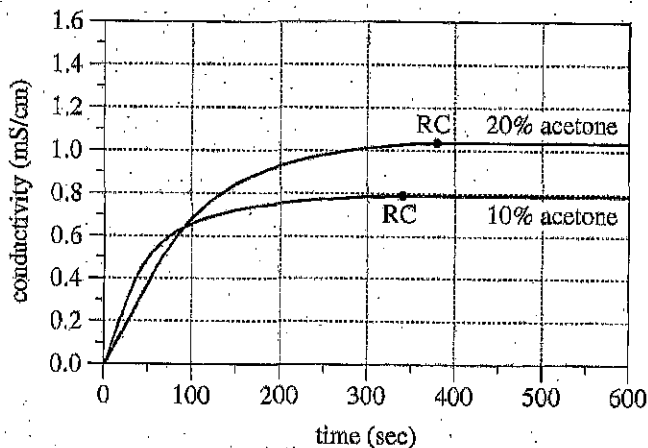
Figure 1
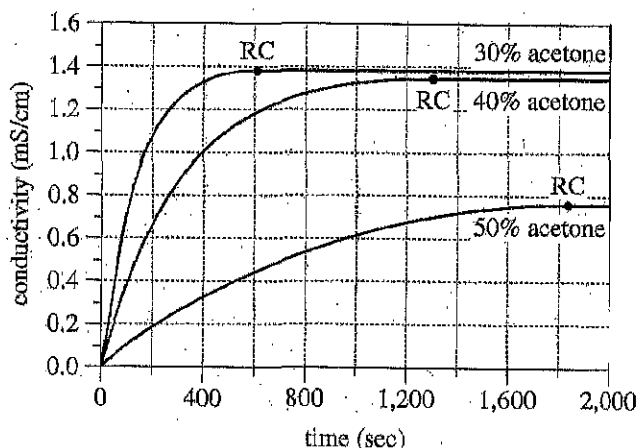
Note: In Figures 1 and 2, concentration is given as the percent by mass of acetone in the solution, and conductivity is given as millisiemens per centimeter, mS/cm.

Figure 2

11. The conductivity of the reaction solution at the end of a reaction is κ_∞. Which of the following graphs best shows how κ_∞ varied with acetone concentration?

A.

B.

C.

D.
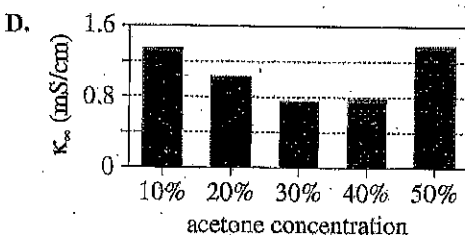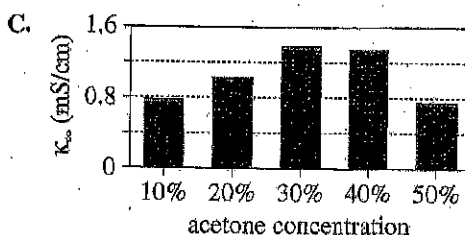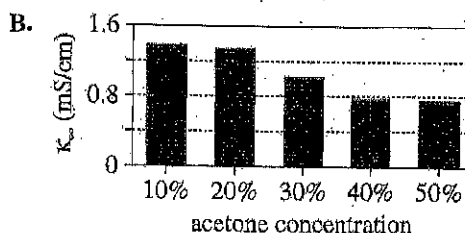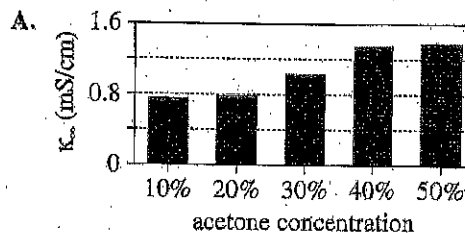
12. Based on Figure 2, if a 45% acetone solution had been tested, the reaction would most likely have reached completion at a time:

F. less than 600 sec.
G. between 600 sec and 1,200 sec.
H. between 1,200 sec and 1,800 sec.
J. greater than 1,800 sec.

13. Based on Figures 1 and 2, the reaction was completed soonest when the acetone concentration was:

  A. 10%.
  B. 20%.
  C. 40%.
  D. 50%.

14. Consider the acetone-H_2O solution that resulted in the greatest maximum conductivity shown in Figures 1 and 2. What masses of acetone and H_2O can be mixed together to make 100 g of this solution?

	acetone	H_2O
F.	20 g	80 g
G.	20 g	100 g
H.	30 g	70 g
J.	30 g	100 g

15. As *resistivity* increases, the ability to conduct electricity *decreases*. Based on Figures 1 and 2, which of the solutions had the highest resistivity at RC ?

  A. 20% acetone
  B. 30% acetone
  C. 40% acetone
  D. 50% acetone

Passage IV

Scientists investigated whether sleep improves *procedural memory* (memory of skilled movements).

Subjects trained to tap their fingers in 1 or 2 sequences: Sequence X only, or Sequence X followed by Sequence Y (see Figure 1). To train for a sequence, the subjects attempted to tap the sequence for 30 sec and then rested for 30 sec, 12 times in succession. During the last 3 of these 12 cycles, the subjects' accuracy was tested.
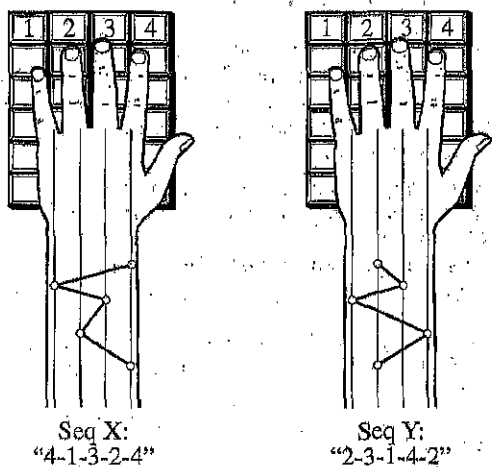

Seq X:
"4-1-3-2-4"

Seq Y:
"2-3-1-4-2"

Figure 1

The subjects' accuracy was *retested*—either immediately after training or after a full night's sleep—as they attempted to tap the sequence during 3 cycles.

Six groups, each consisting of 15 people, were subjected to different protocols:

Group 1 trained for Seq X and was immediately retested.

Group 2 trained for Seq X, slept overnight, and was retested the next day.

Group 3 trained for Seq X, immediately trained for Seq Y, and was immediately retested.

Group 4 trained for Seq X, immediately trained for Seq Y, slept overnight, and was retested the next day.

Group 5 trained for Seq X, waited for 6 hr, trained for Seq Y, slept overnight, and was retested the next day.

Group 6 trained for Seq X, waited for 9 hr, trained for Seq Y, slept overnight, and was retested the next day.

The table shows, for each group, the percent change in the average accuracy of the subjects between their initial testing (during training) and their retesting.

		Time between training sessions (hr)	Sleep before retesting	Percent change in average accuracy for Sequence:	
Group	Sequences taught			X	Y
1	X only	n.a.	no	−4	n.a.
2	X only	n.a.	yes	25	n.a.
3	X and Y	0	no	−9	−10
4	X and Y	0	yes	−1	42
5	X and Y	6	yes	23	40
6	X and Y	9	yes	25	40

Note: n.a. indicates that the conditions are not applicable.

Table 1

Figure 1 and Table 1 adapted from Matthew P. Walker et al., "Dissociable Stages of Human Memory Consolidation and Reconsolidation." ©2003 by Nature Publishing Group.

16. When subjects were *not* trained for Seq Y, did retesting after a full night's sleep result in an increase in the percent change in average accuracy for Seq X ?

F. Yes; the percent change in average accuracy for Group 2 was 25%, compared to −4% for Group 1.
G. Yes; the percent change in average accuracy for Group 3 was −9%, compared to −4% for Group 1.
H. No; the percent change in average accuracy for Group 2 was 25%, compared to −4% for Group 1.
J. No; the percent change in average accuracy for Group 3 was −9%, compared to −4% for Group 1.

17. To consider whether Seq Y was finger-tapped with greater accuracy after a full night's sleep than it was immediately after training, one should compare the results for:

A. Groups 1 and 2.
B. Groups 2 and 3.
C. Groups 3 and 4.
D. Groups 4 and 5.

18. The results of the study are most consistent with which of the following conclusions about the effect of sleep on procedural memory?

F. Sleep before learning can improve procedural memory.
G. Sleep after learning can improve procedural memory.
H. Sleep before learning cannot improve procedural memory.
J. Sleep after learning cannot improve procedural memory.

19. How did the behavior of a subject training for Seq X differ from the behavior of a subject training for Seq Y ? A subject training for Seq X finger-tapped:

A. for 30 sec intervals, whereas a subject training for Seq Y finger-tapped for 1 min intervals.
B. with the right hand, whereas a subject training for Seq Y finger-tapped with the left hand.
C. for a total of 12 intervals, whereas a subject training for Seq Y finger-tapped for a total of 3 intervals.
D. 4-1-3-2-4, whereas a subject training for Seq Y finger-tapped 2-3-1-4-2.

20. Based on the results in the table, when subjects in Group 3 were retested, was their average accuracy for finger-tapping Seq X less than or greater than that during training?

F. Less, because the percent change in average accuracy was less than 0.
G. Less, because the percent change in average accuracy was greater than 0.
H. Greater, because the percent change in average accuracy was less than 0.
J. Greater, because the percent change in average accuracy was greater than 0.

21. One of the scientists predicted that increasing the time between training for Seq X and training for Seq Y from 0 hr to 6 hr would have no effect on the percent change in average accuracy for Seq X. Was the scientist's prediction correct?

A. Yes; the percent change in average accuracy for Seq X was the same for Group 4 as it was for Group 3.
B. Yes; the percent change in average accuracy for Seq X was the same for Group 5 as it was for Group 4.
C. No; the percent change in average accuracy for Seq X was greater for Group 4 than it was for Group 3.
D. No; the percent change in average accuracy for Seq X was greater for Group 5 than it was for Group 4.

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Passage V

Gas-giant planets have a solid core surrounded by a massive envelope of gases. Gas-giant planets form within stellar nebulae—large, flattened clouds of gas and dust that surround newly formed stars. Planet formation begins when some of the solid material within a stellar nebula clumps together to form a spherical body called a planet core. Two scientists discuss how gas-giant planets like Jupiter form from planet cores in stellar nebulae.

Scientist 1

A planet core continuously attracts additional solid particles from the stellar nebula, gradually increasing its mass. If a planet core reaches a minimum mass of 10 times the mass of Earth ($10\ M_E$), its gravity is then strong enough to attract and hold gases from the surrounding stellar nebula. The formation of a $10\ M_E$ planet core takes approximately 1 million years. The time required for a $10\ M_E$ planet core to then attract a minimum $300\ M_E$ of gases and thus become a gas-giant planet like Jupiter is 10 million to 100 million years more. Because it takes so long to form gas-giant planets like Jupiter, they are very rare in our galaxy.

Scientist 2

Gas-giant planets form in a stellar nebula if gravity variations cause the nebula to suddenly fragment into 2 or more massive spherical clumps of gas and dust called gas-giant protoplanets (GGPP), each having a planet core at the center that is no larger than $6\ M_E$. A GGPP forms in less than 1,000 years. After formation, the GGPP contracts to form a gas-giant planet. The entire process from the start of GGPP formation to a new gas-giant planet takes only about 1 million years.

Gas-giant planets like Jupiter would not have time to form as described by Scientist 1. Observations indicate that stellar nebulae around newly formed stars do not remain in existence longer than 7 million years after the stars are formed. Also, planet cores that are not part of a GGPP do not have enough momentum to keep them from spiraling into the star at the center of the nebula within 100,000 years. Gas-giant planets like Jupiter are not rare. At least 130 gas-giant planets as large as or larger than Jupiter have been identified in our galaxy.

22. What are the 2 scientists' estimates of the mass of a planet core that later becomes the center of a gas-giant planet?

	Scientist 1	Scientist 2
F.	exactly $10\ M_E$	exactly $6\ M_E$
G.	exactly $6\ M_E$	exactly $10\ M_E$
H.	at least $10\ M_E$	at most $6\ M_E$
J.	at least $6\ M_E$	at most $10\ M_E$

23. Based on Scientist 1's discussion, which of the following statements gives the most likely reason Earth is not a gas-giant planet? At the time the planets were forming in the Sun's stellar nebula, the:

A. planet core that became Earth was not massive enough to attract and hold a sufficient amount of gases.
B. planet core that became Earth was massive enough to attract and hold a large quantity of gases.
C. nebula did not contain enough gases to form any gas-giant planets.
D. nebula contained only enough gases to form 2 gas-giant planets.

24. The discovery that some stellar nebulae remain in existence for more than 10 million years would contradict a statement made by:

F. Scientist 1 only.
G. Scientist 2 only.
H. both Scientist 1 and Scientist 2.
J. neither Scientist 1 nor Scientist 2.

25. Suppose a planet core in a stellar nebula has, over time, attracted and held $200\ M_E$ of gases from the nebula. Would Scientist 1 be likely to claim that this planet core surrounded by $200\ M_E$ of gases is a gas-giant planet like Jupiter?

A. Yes, because Scientist 1 claims that less than $200\ M_E$ of gases must be attracted and held by a planet core to form such a gas-giant planet.
B. Yes, because Scientist 1 claims that no less than $200\ M_E$ of gases must be attracted and held by a planet core to form such a gas-giant planet.
C. No, because Scientist 1 claims that more than $200\ M_E$ of gases must be attracted and held by a planet core to form such a gas-giant planet.
D. No, because Scientist 1 claims that no more than $200\ M_E$ of gases must be attracted and held by a planet core to form such a gas-giant planet.

26. The discovery of which of the following objects would provide the strongest support for Scientist 2's viewpoint?

F. Several 1-million-year-old stars, none with orbiting gas-giant planets
G. Several 1-million-year-old stars, each with 2 orbiting gas-giant planets
H. Several 100-million-year-old stars, none with orbiting gas-giant planets
J. Several 100-million-year-old stars, each with 2 orbiting gas-giant planets

27. Assume that the gas-giant planets and the non-gas-giant planets (*terrestrial planets*) in another solar system in our galaxy have spatial and size relationships the same as those of the gas-giant planets and the terrestrial planets in our solar system. Given this assumption, in the other solar system, an existing gas-giant planet would most likely be:

A. located at a greater distance from the star than would any of the terrestrial planets.
B. located at a lesser distance from the star than would any of the terrestrial planets.
C. the same diameter as the largest terrestrial planet.
D. a lesser diameter than any of the terrestrial planets.

28. Based on Scientist 2's discussion, in a stellar nebula, a 10 M_E planet core that was NOT part of a GGPP would most likely:

F. form a gas-giant planet in fewer than 10 million years.
G. escape from the central star's gravity and travel out into space.
H. continue to revolve around the central star at a constant distance and speed.
J. move in toward the central star and eventually be destroyed.

45

Passage VI

In a hydrothermal vent, *anaerobic oxidation of methane* (AOM) occurs in the top 20 cm of ocean-floor sediment (see Figure 1). This reaction begins when hot fluid containing methane (CH_4) rises from a source deep beneath the ocean-floor surface and mixes with seawater containing sulfate (SO_4^{2-}).
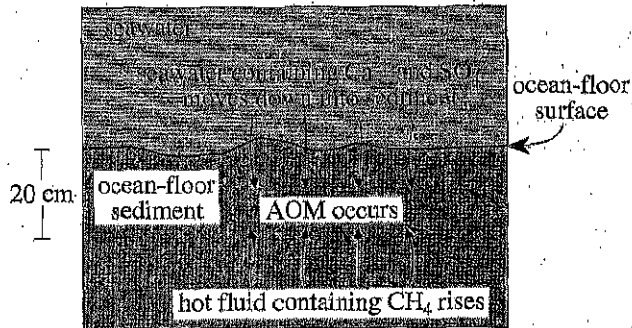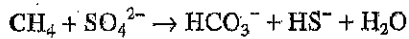

Figure 1

AOM is represented by the following equation:

$$CH_4 + SO_4^{2-} \rightarrow HCO_3^- + HS^- + H_2O$$

One of the 3 direct products of this reaction, HCO_3^-, can then combine with calcium (Ca^{2+}) in the seawater in a second reaction to produce solid calcium carbonate ($CaCO_3$). This $CaCO_3$ exists as *calcite* crystals and/or *aragonite* crystals. Over time, the crystals fill in the pores in the sediment.

At each of 10 locations in a hydrothermal vent, 2 vertical cylindrical cores of the top 20 cm of ocean-floor sediment were collected.

Study 1

One of the 2 cores from each of the 10 locations was cut every 0.5 cm along its length. Each piece of core was squeezed to extract all of the *pore water* (water present in the sediment's pores). The 10 pore water samples from the pieces at the same depth interval in each core were combined and then analyzed for SO_4^{2-} and CH_4. The average SO_4^{2-} and CH_4 concentrations, in millimoles per liter (mmol/L), from 0 cm to 20 cm depth are shown in Figure 2.
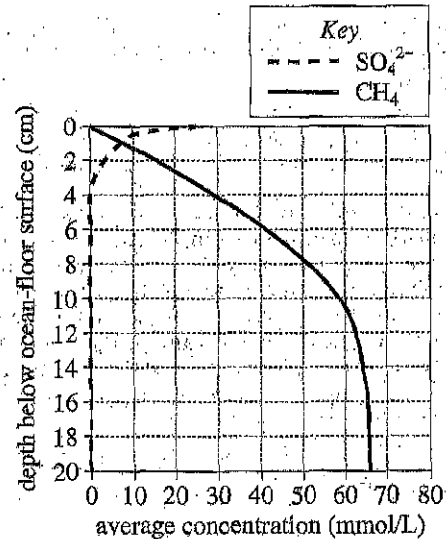
Figure 2

Study 2

The sediment in the other core from each of the 10 locations was sampled at the top of the core (0 cm depth), then every 0.5 cm along the core's length. The 10 samples from the same depth in each core were combined and then analyzed to determine the average percent by mass of calcite and the average percent by mass of aragonite in the sediment from 0 cm to 20 cm depth (see Figure 3).
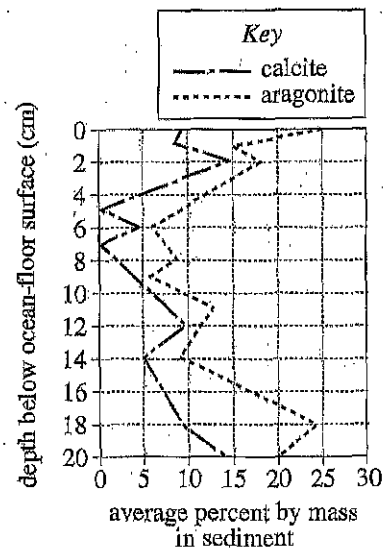
Figure 3

Figures 2 and 3 adapted from Roger Luff et al., "Simulation of Long-Term Feedbacks from Authigenic Carbonate Crust Formation at Cold Vent Sites." ©2004 by Elsevier B.V.

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29. According to the results of Study 2, there was NO calcite found at which of the following depths?

   A. 2 cm
   B. 5 cm
   C. 8 cm
   D. 11 cm

30. Suppose that in Study 1, at the same locations, samples of ocean-floor sediment from 20 cm to 20.5 cm below the ocean-floor surface had been collected and combined. The pore water extracted from those combined samples would most likely have had an average SO_4^{2-} concentration and an average CH_4 concentration, respectively, closest to which of the following?

	SO_4^{2-} (mmol/L)	CH_4 (mmol/L)
F.	0	0
G.	0	65
H.	20	0
J.	20	65

31. Is the statement "Some SO_4^{2-} was found in the pore water from each depth interval in the cores" supported by Figure 2?

   A. Yes, because Figure 2 indicates that the average SO_4^{2-} concentration was zero at depths of 4 cm or greater.
   B. Yes, because Figure 2 indicates that the average SO_4^{2-} concentration was greater than zero at all depths.
   C. No, because Figure 2 indicates that the average SO_4^{2-} concentration was zero at depths of 4 cm or greater.
   D. No, because Figure 2 indicates that the average SO_4^{2-} concentration was greater than zero at all depths.

32. According to the results of Study 2, over the top 20 cm of sediment, how did the average percent by mass of calcite compare to the average percent by mass of aragonite? The average percent by mass of calcite was:

   F. greater at each depth.
   G. less at each depth.
   H. greater at some depths but less at all other depths.
   J. greater at some depths but the same at all other depths.

33. Consider the average percent by mass of aragonite at a depth of 10 cm shown in Figure 3. On average, the mass in grams of aragonite present in a 50 g sample of sediment taken from that depth would be closest to which of the following?

   A. 2.5 g
   B. 5 g
   C. 25 g
   D. 50 g

34. The procedures of Studies 1 and 2 differed in which of the following ways? In Study 1, samples were:

   F. analyzed for the reactants of AOM, whereas in Study 2, samples were not analyzed for the reactants of AOM.
   G. not analyzed for the reactants of AOM, whereas in Study 2, samples were analyzed for the reactants of AOM.
   H. analyzed for the direct products of AOM, whereas in Study 2, samples were not analyzed for the direct products of AOM.
   J. not analyzed for the direct products of AOM, whereas in Study 2, samples were analyzed for the direct products of AOM.

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Passage VII

A physicist tested various sheets for their ability to stop *gamma rays* (γ-rays) that had different energies. Any γ-ray that was not stopped by a sheet struck a detector (see Figure 1), which then registered a detection, or *count*.
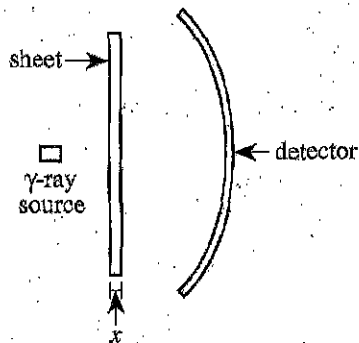

Figure 1

Each sheet was made of either Material 1, Material 2, or Material 3. The thickness, x, of each sheet was uniform, but sheets of the same material had different thicknesses.

I_0 represented the number of counts per minute (cpm) with no sheet between the γ-ray source and the detector, and I represented the cpm with 1 sheet between the source and the detector.

Experiment 1

First, the physicist measured I_0 for a source of γ-rays having an energy of 4 *million electron volts* (MeV). Next, with this same γ-ray source, she measured I for various sheets of Material 1, each having a different thickness x. Then, she plotted a graph of I versus x (in cm) for Material 1. Similarly, she produced graphs of I versus x for Material 2 and Material 3 (see Figure 2).
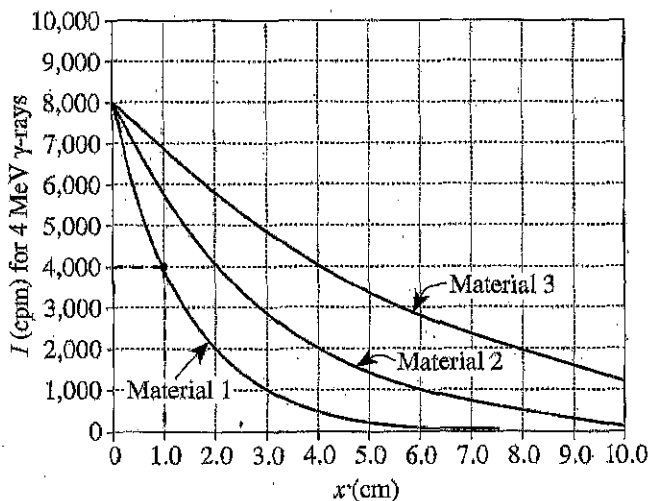
Figure 2

Experiment 2

The physicist repeated the procedures from Experiment 1 with other sources of γ-rays having different energies. For each combination of sheet material and γ-ray energy, she produced a graph of I versus x. These graphs are not shown.

From the graphs of I versus x, she found the *half-value thickness*, x_{half}, for each combination of sheet material and γ-ray energy. A sheet of thickness x_{half} stopped half of the γ-rays striking the sheet; that is, I equaled $\frac{I_0}{2}$. (For example, based on Figure 2, for 4 MeV γ-rays striking sheets of Material 1, x_{half} equaled 1.0 cm.) Finally, the physicist plotted a graph of x_{half} versus γ-ray energy for each material (see Figure 3).
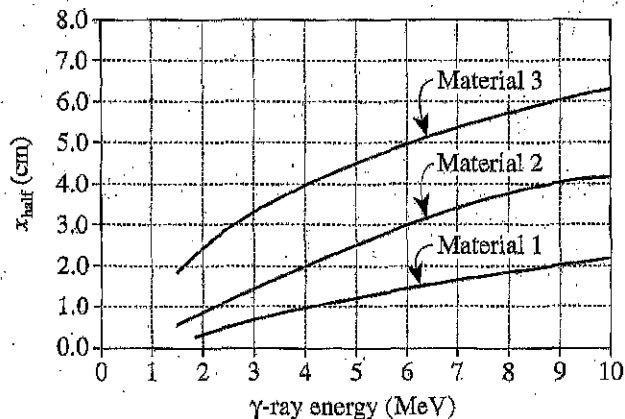
Figure 3

35. Based on the results of Experiment 2, for a given material, as γ-ray energy increased, x_{half}:

A. increased only.
B. decreased only.
C. varied, but with no general trend.
D. remained the same.

36. Based on the results of Experiment 1, x_{half} for Material 3 and a γ-ray energy of 4 MeV was closest to which of the following values?

F. 1.0 cm
G. 2.0 cm
H. 3.0 cm
J. 4.0 cm

GO ON TO THE NEXT PAGE.

37. Based on the results of Experiment 2, to stop a given number of γ-rays of a given energy, which sheet had to be thicker, a sheet made of Material 1 or a sheet made of Material 3 ?

    A. Material 1, because at every energy plotted in Figure 3, x_{half} for Material 1 is greater than x_{half} for Material 3.
    B. Material 1, because at every energy plotted in Figure 3, x_{half} for Material 1 is less than x_{half} for Material 3.
    C. Material 3, because at every energy plotted in Figure 3, x_{half} for Material 3 is greater than x_{half} for Material 1.
   D. Material 3, because at every energy plotted in Figure 3, x_{half} for Material 3 is less than x_{half} for Material 1.

38. Based on the description of the experiments, for γ-rays of a given energy, as the ability of materials to stop γ-rays increased, did I decrease or increase, and why?

    F. Decrease, because the number of γ-rays reaching the detector per minute increased.
    G. Decrease, because the number of γ-rays reaching the detector per minute decreased.
    H. Increase, because the number of γ-rays reaching the detector per minute increased.
    J. Increase, because the number of γ-rays reaching the detector per minute decreased.

39. The physicist must prepare a sheet that will yield a detection rate of 1,000 cpm when the sheet is struck by 4 MeV γ-rays, as in Experiment 1. This sheet can be no thicker than 10.0 cm. Based on the results of Experiment 1, the physicist can satisfy these requirements by constructing the sheet out of which of the materials tested?

    A. Either Material 1 or Material 2
    B. Either Material 1 or Material 3
    C. Either Material 2 or Material 3
    D. Either Material 1, Material 2, or Material 3

40. In Experiment 1, what was the value of I_0 ?

    F. 0 cpm
    G. 1 cpm
    H. 4,000 cpm
    J. 8,000 cpm

END OF TEST 4

STOP! DO NOT RETURN TO ANY OTHER TEST.

Explanation of Procedures Used to Obtain Scale Scores from Raw Scores

On each of the four tests on which you marked any responses, the total number of correct responses yields a raw score. Use the table below to convert your raw scores to scale scores. For each test, locate and circle your raw score or the range of raw scores that includes it in the table below. Then, read across to either outside column of the table and circle the scale score that corresponds to that raw score. As you determine your scale scores, enter them in the blanks provided on the right. The highest possible scale score for each test is 36. The lowest possible scale score for any test on which you marked any responses is 1.

Next, compute the Composite score by averaging the four scale scores. To do this, add your four scale scores and divide the sum by 4. If the resulting number ends in a fraction, round it off to the nearest whole number. (Round down any fraction less than one-half; round up any fraction that is one-half or more.) Enter this number in the blank. This is your Composite score. The highest possible Composite score is 36. The lowest possible Composite score is 1.

ACT Test 70C	Your Scale Score
English	_____
Mathematics	_____
Reading	_____
Science	_____
Sum of scores	_____
Composite score (sum ÷ 4)	_____

NOTE: If you left a test completely blank and marked no items, do not list a scale score for that test. If any test was completely blank, do not calculate a Composite score.

Scale Score	Test 1 English	Test 2 Mathematics	Test 3 Reading	Test 4 Science	Scale Score
36	75	59-60	40	39-40	36
35	74	58	—	38	35
34	73	56-57	39	—	34
33	72	55	38	37	33
32	71	53-54	37	36	32
31	70	52	35-36	35	31
30	69	51	34	34	30
29	68	49-50	33	33	29
28	67	47-48	32	32	28
27	65-66	44-46	31	31	27
26	63-64	42-43	30	29-30	26
25	61-62	39-41	29	27-28	25
24	58-60	36-38	28	25-26	24
23	55-57	34-35	27	24	23
22	53-54	32-33	25-26	22-23	22
21	49-52	30-31	24	20-21	21
20	46-48	29	22-23	18-19	20
19	43-45	27-28	21	16-17	19
18	41-42	25-26	19-20	15	18
17	39-40	22-24	18	14	17
16	36-38	17-21	16-17	12-13	16
15	33-35	13-16	15	11	15
14	31-32	11-12	13-14	10	14
13	29-30	9-10	12	9	13
12	27-28	7-8	10-11	8	12
11	24-26	6	8-9	7	11
10	22-23	5	7	6	10
9	19-21	4	6	5	9
8	16-18	3	5	4	8
7	13-15	—	—	—	7
6	11-12	2	4	3	6
5	8-10	—	3	2	5
4	6-7	1	2	—	4
3	4-5	—	—	1	3
2	3	—	1	—	2
1	0-2	0	0	0	1

Table header: Raw Scores

Explanation of Procedures Used to Obtain Scale Subscores from Raw Scores

For each of the seven subscore areas, the total number of correct responses yields a raw score. Use the table below to convert your raw scores to scale subscores. For each of the seven subscore areas, locate and circle either the raw score or the range of raw scores that includes it in the table below. Then, read across to either outside column of the table and circle the scale subscore that corresponds to that raw score. As you determine your scale subscores, enter them in the blanks provided on the right. The highest possible scale subscore is 18. The lowest possible scale subscore is 1.

If you left a test completely blank and marked no items, do not list any scale subscores for that test.

ACT Test 70C   **Your Scale Subscore**

English

     Usage/Mechanics   _____

     Rhetorical Skills   _____

Mathematics

     Pre-Algebra/Elementary Algebra   _____

     Intermed. Algebra/Coord. Geometry   _____

     Plane Geometry/Trigonometry   _____

Reading

     Social Studies/Sciences   _____

     Arts/Literature   _____

| | Raw Scores | | | | | | | |
| | Test 1 English | | Test 2 Mathematics | | | Test 3 Reading | | |
Scale Subscore	Usage/ Mechanics	Rhetorical Skills	Pre-Algebra/ Elem. Algebra	Inter. Algebra/ Coord. Geometry	Plane Geometry/ Trigonometry	Social Studies/ Sciences	Arts/ Literature	Scale Subscore
18	39-40	35	23-24	18	18	20	20	18
17	38	—	22	17	—	19	19	17
16	37	33-34	21	16	16-17	18	18	16
15	35-36	32	20	14-15	14-15	16-17	17	15
14	34	30-31	19	12-13	13	15	16	14
13	32-33	28-29	18	11	11-12	14	15	13
12	31	25-27	16-17	9-10	9-10	13	14	12
11	28-30	23-24	15	8	8	11-12	13	11
10	25-27	21-22	14	7	7	10	12	10
9	23-24	18-20	12-13	6	5-6	9	11	9
8	20-22	16-17	10-11	4-5	4	7-8	10	8
7	18-19	14-15	7-9	—	—	6	8-9	7
6	16-17	12-13	6	3	3	4-5	7	6
5	13-15	10-11	4-5	—	2	3	6	5
4	11-12	8-9	3	2	—	2	4-5	4
3	9-10	5-7	2	—	1	—	3	3
2	5-8	3-4	1	1	—	1	1-2	2
1	0-4	0-2	0	0	0	0	0	1

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                 ITEM           1 1111111112 2222222223 3333333334 4444444445 5555555556 6666666667 77777
               NUMBER  1234567890 1234567890 1234567890 1234567890 1234567890 1234567890 1234567890 12345

ENGLISH
CORRECT ANSWER         DGAGAHBHAF AJAHDGCFDJ AFDHDGBJAJ BHBGAGDHAF BJBHAHDFBH AHDGCJDHBG DGCJAHAGCF BFCJB
YOUR ANSWER            A++++F++++ ++++++++++ ++++++++++ A+++++++++ +++G++++++ ++++++++F++ +F+++J++++ A++F+
SUBSCORE               URUUUURURR UURRRRUUUU RUUUURUURR RURURURRUR UURRRURUUU RURUURUURR UURURURURR RUURR

MATHEMATICS
CORRECT ANSWER         CHDJCHBJDF DFEGEGEGCJ CGAFAKCGBK BKBKBKDHDJ EFCGBFEJAF CGCJAJDFEF
YOUR ANSWER            +++H+KAK++ +++J++++A+ BJ++++++++ +H++EJ+JB+ DJDJ+GDK+J AHD+D+EJCH
SUBSCORE               ATAATAAAAG GAAAAGATAT GGAAATTTGG TAGAGAGAGG TTTGGTTAAA GTGGTTATTG

READING
CORRECT ANSWER         BGDHCFAJAH BFBHDJBFCJ CJDGAGAFDG CGBFCFDJCG
YOUR ANSWER            D++JD++F+G +G+JB+++D+ A++JDJDJ-- DF++++++B+
SUBSCORE               LLLLLLLLLL SSSSSSSSSS LLLLLLLLLL SSSSSSSSSS

SCIENCE
CORRECT ANSWER         BGAJAGCJDH CHAHDFCGDF DHAGCGAJBG CGBFAJCGAJ
YOUR ANSWER            D+++B+DH+F A++++HDF+J +JDJDHCH++ B+CH++B+DF
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1st Row: Correct responses to the items on the ACT tests.   0000140

2nd Row: Your Responses:
          A plus (+) indicates your response was correct.
          A letter (A through K) is the response you chose,
            if your answer was incorrect.
          A dash (-) indicates you omitted the item.
          An asterisk (*) indicates you gridded more than
            one response.

3rd Row: If the test includes subscores, one of the letters below
         indicates the category to which each item belongs:

         English: U = Usage/Mechanics
                  R = Rhetorical Skills
         Math: A = Pre-Algebra/Elementary Algebra
                  G = Intermediate Algebra/Coordinate Geometry
                  T = Plane Geometry/Trigonometry
         Reading: S = Social Studies/Sciences
                  L = Arts/Language