

MATHEMATICS LEVEL 2 TEST

REFERENCE INFORMATION

THE FOLLOWING INFORMATION IS FOR YOUR REFERENCE IN ANSWERING SOME OF THE QUESTIONS IN THIS TEST.

Volume of a right circular cone with radius r and height h : $V = \frac{1}{3}\pi r^2 h$

Volume of a sphere with radius r : $V = \frac{4}{3}\pi r^3$

Volume of a pyramid with base area B and height h : $V = \frac{1}{3}Bh$

Surface Area of a sphere with radius r : $S = 4\pi r^2$

DO NOT DETACH FROM BOOK.

MATHEMATICS LEVEL 2 TEST

M 17

For each of the following problems, decide which is the BEST of the choices given. If the exact numerical value is not one of the choices, select the choice that best approximates this value. Then fill in the corresponding circle on the answer sheet.

Notes: (1) A scientific or graphing calculator will be necessary for answering some (but not all) of the questions in this test. For each question you will have to decide whether or not you should use a calculator.

(2) For some questions in this test you may have to decide whether your calculator should be in the radian mode or the degree mode.

(3) Figures that accompany problems in this test are intended to provide information useful in solving the problems. They are drawn as accurately as possible EXCEPT when it is stated in a specific problem that its figure is not drawn to scale. All figures lie in a plane unless otherwise indicated.

(4) Unless otherwise specified, the domain of any function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. The range of f is assumed to be the set of all real numbers $f(x)$, where x is in the domain of f .

(5) Reference information that may be useful in answering the questions in this test can be found on the page preceding Question 1.

USE THIS SPACE FOR SCRATCH WORK.

1. What is the greatest common divisor of the three integers 144, 216, and 360?

- (A) 12 (B) 18 (C) 24 (D) 36 (E) 72

2. If the graph of the parabola $y = ax^2 + bx + c$ opens up, which of the following must be true?

- (A) $a > 0$
(B) $c > 0$
(C) $a > c$
(D) $b^2 - 4ac > 0$
(E) $b^2 - 4ac < 0$

4FBC2

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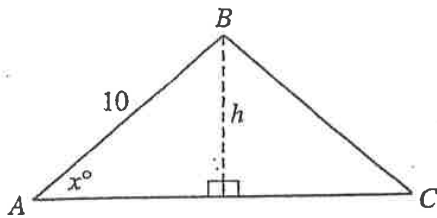
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MATHEMATICS LEVEL 2 TEST—Continued

USE THIS SPACE FOR SCRATCH WORK.

3. What is the fifth term of the geometric sequence whose first three terms are 486, 162, and 54?

(A) 2
(B) 3
(C) 4.5
(D) 6
(E) 9



Note: Figure not drawn to scale.

4. In $\triangle ABC$ above, $x = 55$. What is the value of h ?

(A) 5.74
(B) 8.19
(C) 12.21
(D) 14.28
(E) 17.43

5. If $4x + 8 = \sqrt{94}$, then $(x + 2)^2 =$

(A) 1.70
(B) 2.42
(C) 5.88
(D) 9.70
(E) 23.50

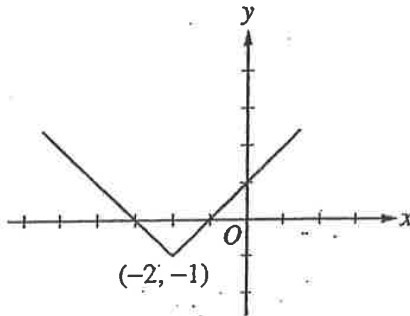
MATHEMATICS LEVEL 2 TEST—Continued

USE THIS SPACE FOR SCRATCH WORK.

5. If $x > 0$ and $y < 0$, then $xy + y$ can be which of the following?

- I. Greater than 0
- II. Equal to 0
- III. Less than 0

- (A) I only
- (B) II only
- (C) III only
- (D) I and II only
- (E) I, II, and III



6. The figure above is the graph of which of the following?

- (A) $y = |x - 2| - 1$
- (B) $y = |x - 1| - 2$
- (C) $y = |x - 1| + 2$
- (D) $y = |x + 1| - 2$
- (E) $y = |x + 2| - 1$

MATHEMATICS LEVEL 2 TEST—Continued

USE THIS SPACE FOR SCRATCH WORK.

8. If $f(x) = \sin x$, $g(x) = \cos x$, and

$h(x) = f(x) - g(x)$, what is the value of $h\left(\frac{\pi}{5}\right)$?

- (A) -0.476
(B) -0.221
(C) 0
(D) 0.221
(E) 0.476

9. In the xy -plane, the graphs of $y = 2^x$ and $y = x^2 - 10x + 19$ intersect at the point (r, s) .
What is the value of r ?

- (A) 5.000
(B) 3.754
(C) 3.696
(D) 1.886
(E) 1.877

10. When a service call by Johnson's Repair Shop takes more than one hour, the labor cost for the service call is modeled by $f(t) = 55 + 20[2(t - 1)]$, where $f(t)$ is the labor cost in dollars and t is the number of hours it takes for the repair. What is the labor cost for a service call that takes 2.75 hours?

- (A) \$115
(B) \$125
(C) \$135
(D) \$145
(E) \$175

MATHEMATICS LEVEL 2 TEST—Continued

USE THIS SPACE FOR SCRATCH WORK.

1. If $f(x) = x^2 + 1$ and $g(x) = 2x - 5$, then

$$f(g(2x)) =$$

- (A) $8x^2 - 3$
(B) $4x^2 - 20x + 26$
(C) $8x^2 - 40x + 52$
(D) $16x^2 - 40x + 26$
(E) $64x^2 - 80x + 101$

2. If the point $\left(-\frac{1}{2}, 1\right)$ is on the graph of $f(x) = a(x - 3)^2 + 50$ in the xy -plane, what is the value of a ?

- (A) -12.625 (B) -4 (C) 4 (D) 4.16 (E) 14

3. If $x \neq 0$, then $\frac{x^{(2-r)}}{x^2} =$

- (A) $\frac{1}{x^2}$
(B) $\frac{1}{x^r}$
(C) $\frac{1}{x^{(r-2)}}$
(D) $\frac{x^2}{x^r}$
(E) $x^{(4-r)}$

MATHEMATICS LEVEL 2 TEST—Continued

USE THIS SPACE FOR SCRATCH WORK.

14. Which of the following is an equation of the line that contains the point $(-1, 4)$ and is perpendicular to the line with equation

$$y = -\frac{3}{2}x + 1?$$

(A) $y = \frac{2}{3}x + 1$

(B) $y = \frac{2}{3}(x - 1) - 4$

(C) $y = \frac{2}{3}(x - 1) + 4$

(D) $y = \frac{2}{3}(x + 1) - 4$

(E) $y = \frac{2}{3}(x + 1) + 4$

15. Data set B is formed by adding 5 to each of the numbers in data set A . Which of the following statistics is the same for data sets A and B ?

(A) Maximum

(B) Mean

(C) Median

(D) Mode

(E) Standard deviation

MATHEMATICS LEVEL 2 TEST—Continued

USE THIS SPACE FOR SCRATCH WORK.

Questions 16-17 refer to the following sequence.

A sequence is recursively defined as follows.

$$\begin{cases} b_1 = 3 \\ b_n = b_{n-1} + 2n - 1, \text{ for } n > 1 \end{cases}$$

16. What are the first five terms of the sequence?

- (A) 3, 4, 7, 12, 19
(B) 3, 6, 9, 12, 15
(C) 3, 6, 11, 18, 27
(D) 6, 9, 12, 15, 18
(E) 6, 11, 18, 27, 38

17. Which of the following is the n th term, b_n , of the sequence?

- (A) $3n$
(B) $3(n+1)$
(C) 3^n
(D) $n^2 + 2$
(E) $n^3 + 2$

MATHEMATICS LEVEL 2 TEST—Continued

USE THIS SPACE FOR SCRATCH WORK.

18. All of the following are equal EXCEPT

(A) $\log_{10} 100$

(B) $\log_5 10$

(C) $\log_2 4$

(D) $-\log_3 \frac{1}{9}$

(E) $-\log_2 \frac{1}{4}$

19. Which of the following functions has all real numbers for its domain?

(A) $f(x) = \sqrt{x}$

(B) $f(x) = \frac{1}{x^2}$

(C) $f(x) = \frac{x^4}{5}$

(D) $f(x) = \frac{|x|}{x-1}$

(E) $f(x) = \frac{x^2 - 4}{x + 2}$

20. In the xyz -coordinate system, how many lines may be drawn perpendicular to a given line at a given point on the line?

(A) 1

(B) 2

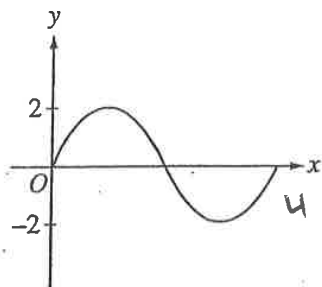
(C) 3

(D) 4

(E) Infinitely many

MATHEMATICS LEVEL 2 TEST—Continued

USE THIS SPACE FOR SCRATCH WORK.



21. The graph shown above has equation $y = 2 \sin x$.

If this graph is shifted $\frac{\pi}{2}$ units to the right, which of the following could be the equation of the shifted graph?

(A) $y = 2 \sin x + \frac{\pi}{2}$

(B) $y = 2 \sin x - \frac{\pi}{2}$

(C) $y = \pi \sin x$

(D) $y = 2 \sin\left(x + \frac{\pi}{2}\right)$

(E) $y = 2 \sin\left(x - \frac{\pi}{2}\right)$

2. Which of the following inequalities must be true for all real numbers x ?

I. $x^2 - 2x > 0$

II. $x^2 - 2x + 1 > 0$

III. $x^2 - 2x + 2 > 0$

(A) None

(B) II only

(C) III only

(D) I and II

(E) II and III

MATHEMATICS LEVEL 2 TEST—*Continued*

USE THIS SPACE FOR SCRATCH WORK.

23. If $\frac{2n}{6}$ is an integer, which of the following must be an integer?

(A) $\frac{n}{12}$

(B) $\frac{n}{4}$

(C) $\frac{n}{2}$

(D) $\frac{2n}{5}$

(E) $\frac{2n}{3}$

24. A line segment is 10 units in length with one endpoint on the y -axis at the point $(0, 6)$. If the segment makes one complete rotation about the point $(0, 6)$, which of the following intervals represents all values of x for which the segment intersects the x -axis?

(A) $[-8, 8]$

(B) $[-8, 0]$

(C) $[-6, 6]$

(D) $[0, 8]$

(E) There is no such interval.

25. A set of 12 numbers has an arithmetic mean of 20. If the numbers 10 and 14 are removed from the set, what is the arithmetic mean of the 10 numbers remaining in the set?

(A) 18.0

(B) 20.0

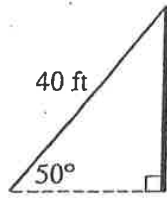
(C) 21.6

(D) 22.0

(E) 22.6

MATHEMATICS LEVEL 2 TEST—Continued

USE THIS SPACE FOR SCRATCH WORK.



Note: Figure not drawn to scale.

26. In the figure above, a cable 40 feet long is attached to a vertical pole. To the nearest foot, how far from the base of the pole is the cable attached to the ground?

- (A) 26 ft
 (B) 31 ft
 (C) 32 ft
 (D) 38 ft
 (E) 48 ft

x	$f(x)$
0	4
1	5
2	3
3	6
4	2
5	1
6	0

27. A function f is defined by the table above. For which of the following values of x does $f(f(x)) = 6$?

- (A) 0 (B) 2 (C) 3 (D) 5 (E) 6

MATHEMATICS LEVEL TEST—Continued

USE THIS SPACE FOR SCRATCH WORK.

28. In a plane, what is the set (locus) of all points equidistant from two intersecting lines in the plane?

- (A) A line
- (B) Two perpendicular lines
- (C) Two parallel lines
- (D) Four points
- (E) None of these

29. Thirty cards are numbered from 1 to 30, inclusive. If one card is drawn at random, what is the probability that the number on the card will be divisible by either 3 or 5?

- (A) $\frac{1}{15}$
- (B) $\frac{1}{5}$
- (C) $\frac{1}{3}$
- (D) $\frac{7}{15}$
- (E) $\frac{8}{15}$

30. If $f(x) = (x+3)(x-1)$ and $g(x) = \frac{1}{x+4}$, what are all values of x for which $g(f(x))$ is undefined?

- (A) $\{-1\}$
- (B) $\{1\}$
- (C) $\{-3, 1\}$
- (D) $\{-1, 3\}$
- (E) $\{-4, -3, 1\}$

MATHEMATICS LEVEL 2 TEST—Continued

USE THIS SPACE FOR SCRATCH WORK.

1. If a circle with center (r, q) in the second quadrant is tangent to the x - and y -axes, then, in terms of q , what does r equal?

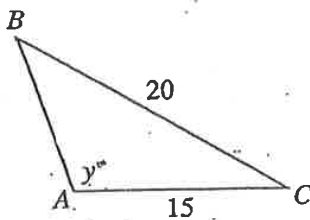
(A) q

(B) $\frac{1}{q}$

(C) $-q$

(D) $1 - q$

(E) $\sqrt{q^2 - 1}$



Note: Figure not drawn to scale.

12. In the figure above, if $y = 140$, what is the measure of $\angle B$ to the nearest degree?

(A) 29°

(B) 30°

(C) 37°

(D) 49°

(E) 59°

MATHEMATICS LEVEL 2 TEST—Continued

USE THIS SPACE FOR SCRATCH WORK.

33. If f is a function that satisfies $f(3x + 2) = x$ for all x , then $f(x) =$

(A) $3x - 2$

(B) $3x$

(C) x

(D) $\frac{x - 3}{2}$

(E) $\frac{x - 2}{3}$

34. In the figure above, \overline{OP} passes through the point $(-3, -5)$. To the nearest degree, what is the measure of angle θ ?

(A) 121°

(B) 211°

(C) 217°

(D) 233°

(E) 239°

MATHEMATICS LEVEL 2 TEST—Continued

USE THIS SPACE FOR SCRATCH WORK.

5. If the frequency of a periodic function is defined as the reciprocal of the period, what is the frequency of $f(x) = 4\sin(2x - 1)$?

(A) $\frac{1}{2\pi}$

(B) $\frac{1}{\pi}$

(C) $\frac{1}{2}$

(D) π

(E) 2π

5. The volume of a certain right circular cylinder is 16. A larger right circular cylinder has radius 25 percent greater and height 50 percent greater than the radius and height, respectively, of the smaller cylinder. What is the volume of the larger cylinder?

(A) 20

(B) 24

(C) 25

(D) 30

(E) 37.5

7. If $f(x) = \frac{x^2 + x - 6}{x - 2}$, what number does $f(x)$ approach as x approaches 2?

(A) 0

(B) 1

(C) 3

(D) 5

(E) $f(x)$ increases without bound.

MATHEMATICS LEVEL 2 TEST—*Continued*

USE THIS SPACE FOR SCRATCH WORK.

38. An operation \blacktriangle is defined on the real numbers x and y by the equation $x \blacktriangle y = |x| - y^2$. Which of the following is true for all real numbers x and y ?

- (A) $x \blacktriangle y = y \blacktriangle x$
- (B) $x \blacktriangle y = (-x) \blacktriangle y$
- (C) If $x \blacktriangle y = 0$, then $y = 0$.
- (D) If $x \blacktriangle y = 0$, then $y = -x$.
- (E) If $x \blacktriangle y = 1$, then $y = 0$.

39. If f and g are functions defined by

$$f(x, y, z) = (x, 0, z) \text{ and } g(x, y, z) = (x, z, y),$$

then $g(f(0, y, z)) =$

- (A) $(0, z, 0)$
- (B) $(0, y, 0)$
- (C) $(0, 0, 0)$
- (D) $(x, z, 0)$
- (E) $(x, y, 0)$

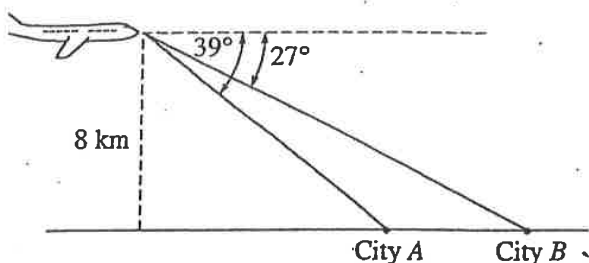
40. The equation $ax = a + 2x$ has a solution for all values of a EXCEPT

- (A) $a = -2$
- (B) $a = -1$
- (C) $a = 0$
- (D) $a = 1$
- (E) $a = 2$

MATHEMATICS LEVEL 2 TEST—Continued

USE THIS SPACE FOR SCRATCH WORK.

1. A function f is defined and continuous on the set of real numbers. If $f(2) = -3$, $f(4) = 6$, and if $f(x) = 0$ for exactly one number x , then x could be
 (A) -2 (B) -1 (C) 0 (D) 3 (E) 5



Note: Figure not drawn to scale.

2. A plane flying at an altitude of 8 kilometers is headed directly toward two cities, A and B, as shown in the figure above. If the angles of depression to the cities are 39° and 27° , respectively, how far apart are the cities?
 (A) 1.32 km
 (B) 1.70 km
 (C) 2.40 km
 (D) 4.91 km
 (E) 5.82 km

3. The equation $4x^3 - 3x^2 - 1 = 0$ has how many nonreal roots?
 (A) None
 (B) One
 (C) Two
 (D) Three
 (E) More than three

MATHEMATICS LEVEL 2 TEST—Continued

USE THIS SPACE FOR SCRATCH WORK.

44. John leaves home at noon driving at 50 miles per hour for t hours. His wife Ann leaves home an hour later driving at 60 miles per hour on the same straight road in the same direction. Which of the following represents the distance between them t hours after noon, for $t \geq 1$?

- (A) $|10t - 60|$
(B) $|10t - 50|$
(C) $|10t - 10|$
(D) $|10t + 10|$
(E) $|10t + 60|$

45. Which of the following expressions are equal to 1 for all real values of x such that $0 < x < \frac{\pi}{2}$?

- I. $\sin 2x \csc 2x$
II. $2 \sin x \cos x$
III. $\sqrt{\sin^2 x + \cos^2 x}$

- (A) I only
(B) II only
(C) III only
(D) I and III only
(E) I, II, and III

46. A certain population of bacteria grows 10 percent larger each day. The population 100 days from now will be how many times the size of the population today?

- (A) 10
(B) 110
(C) 1,100
(D) 1,378
(E) 13,781

MATHEMATICS LEVEL 2 TEST—Continued

USE THIS SPACE FOR SCRATCH WORK.

7. Which of the following is the set of all real numbers x for which there are points on the graph of $y = \sqrt{-x^2}$ in the xy -plane?

- (A) The empty set
(B) The set containing only zero
(C) The set of all positive real numbers
(D) The set of all negative real numbers
(E) The set of all real numbers

Value	Frequency
0	1
2	3
3	2
4	x
5	1

3. In the frequency distribution above, the mean of the distribution is equal to one of the values. What is the frequency of the value 4?

- (A) 0 (B) 2 (C) 3 (D) 4 (E) 5

9. Which of the following intervals contains all of the values of x for which $x^2 < 4$?

- (A) $(-4, 1)$
(B) $(-3, 3)$
(C) $(-1, 4)$
(D) $(0, 2)$
(E) $(0, 5)$

MATHEMATICS LEVEL 2 TEST—*Continued*

USE THIS SPACE FOR SCRATCH WORK

Student Name	Number of Questions Answered Correctly			Total Points
	Test 1	Test 2	Test 3	
Sue	34	15	9	177
Juan	33	19	7	172
Latoya	35	17	10	189

50. In a biology class, three multiple-choice tests were given. On a given test, each question was worth the same number of points. The table above lists the number of questions answered correctly and the total number of points received by each of three students. How many points were awarded for each question on test 2?

- (A) One
- (B) Two
- (C) Three
- (D) Four
- (E) Five

STOP

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

BIOLOGY-E TEST or BIOLOGY-M TEST

You must decide whether you want to take a Biology Test with Ecological Emphasis (BIOLOGY-E) or Molecular Emphasis (BIOLOGY-M) now, before the test begins. The top portion of the page of the answer sheet that you will use to take the Biology Test you have selected must be filled in exactly as illustrated below. When your supervisor tells you to fill in the circle next to the name of the test you are about to take, mark your answer sheet as shown.

For BIOLOGY-E

<input type="radio"/> Literature	<input type="radio"/> Mathematics Level 1	<input type="radio"/> German	<input type="radio"/> Chinese Listening	<input type="radio"/> Japanese Listening
<input checked="" type="radio"/> Biology E	<input type="radio"/> Mathematics Level 2	<input type="radio"/> Italian	<input type="radio"/> French Listening	<input type="radio"/> Korean Listening
<input type="radio"/> Biology M	<input type="radio"/> U.S. History	<input type="radio"/> Latin	<input type="radio"/> German Listening	<input type="radio"/> Spanish Listening
<input type="radio"/> Chemistry	<input type="radio"/> World History	<input type="radio"/> Modern Hebrew	Background Questions: <input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5 <input type="radio"/> 6 <input type="radio"/> 7 <input type="radio"/> 8 <input type="radio"/> 9	
<input type="radio"/> Physics	<input type="radio"/> French	<input type="radio"/> Spanish		

For BIOLOGY-M

<input type="radio"/> Literature	<input type="radio"/> Mathematics Level 1	<input type="radio"/> German	<input type="radio"/> Chinese Listening	<input type="radio"/> Japanese Listening
<input type="radio"/> Biology E	<input type="radio"/> Mathematics Level 2	<input type="radio"/> Italian	<input type="radio"/> French Listening	<input type="radio"/> Korean Listening
<input checked="" type="radio"/> Biology M	<input type="radio"/> U.S. History	<input type="radio"/> Latin	<input type="radio"/> German Listening	<input type="radio"/> Spanish Listening
<input type="radio"/> Chemistry	<input type="radio"/> World History	<input type="radio"/> Modern Hebrew	Background Questions: <input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5 <input type="radio"/> 6 <input type="radio"/> 7 <input type="radio"/> 8 <input type="radio"/> 9	
<input type="radio"/> Physics	<input type="radio"/> French	<input type="radio"/> Spanish		

After filling in the circle next to the name of the test you are taking, locate the Background Questions section, which also appears at the top of your answer sheet (as shown above). This is where you will answer the following Background Questions on your answer sheet.

BACKGROUND QUESTIONS

Please answer the four questions below by filling in the appropriate circle in the Background Questions box on your answer sheet. The information you provide is for statistical purposes only and will not affect your test score.

Question I

How many semesters of biology have you taken in high school? (If you are taking biology this semester, count it as a full semester.) Fill in only one circle of circles 1-3.

- One semester or less — Fill in circle 1.
- Two semesters — Fill in circle 2.
- Three semesters or more — Fill in circle 3.

Question II

Which of the following best describes your biology course? Fill in only one circle of circles 4-6.

- General Biology — Fill in circle 4.
- Biology with emphasis on ecology — Fill in circle 5.
- Biology with emphasis on molecular biology — Fill in circle 6.

Question III

Which of the following best describes your background in algebra? (If you are taking an algebra course this semester, count it as a full semester.) Fill in only one circle of circles 7-8.

- One semester or less — Fill in circle 7.
- Two semesters or more — Fill in circle 8.

Question IV

Have you had or are you currently taking Advanced Placement Biology? If you are, fill in circle 9.

When the supervisor gives the signal, turn the page and begin the Biology Test. There are 100 numbered circles on the answer sheet. There are 60 questions in the core Biology Test, 20 questions in the Biology-E section, and 20 questions in the Biology-M section. Therefore use ONLY circles 1-80 (for Biology-E) OR circles 1-60 plus 100 (for Biology-M) for recording your answers.

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