1. Consider the operation ■ defined by $a \blacksquare b^2 = b^{-a}$, where $a \in \mathbb{R}$ and $b \in \mathbb{R}^+$. If $-4 \blacksquare x = \frac{1}{4}$, then $x =$

A. ± 2

B. $-\frac{1}{2}$ only

C. $\pm \frac{1}{2}$

D. $\frac{1}{2}$ only

E. 2 only

2. Given m and n are two real numbers. What is the value of $m + n$ if $2m - 3ni = 4n + m(2 + 3i) + 4$?

A. -2

B. 0

C. 1

D. 3

E. 5

$$\begin{cases} x + y = 1 \\ x^2 + 2x + 1 = y \end{cases}$$

3. In the system of equations above, $x < 0$. What is the value of y?

A. -2

B. 2

C. 4

D. 8

E. 10

4. Which of the following expressions is true?

A. $(x^2y^3)^2 \cdot x^2y = (xy)^6$

B. $(x^5y^{10})^{\frac{1}{5}} \cdot xy = x^2y$

C. $(3x^2y)^2 \cdot \frac{1}{3}xy^2 = 3x^5y^4$

D. $(2xy^3)^2 \cdot (2xy)^2 = 16x^4y^6$

E. $2^5xy \cdot xy = 5^2x^2y^2$

5. What is the constant term in the expansion of $(2x - 5)^6$?

A. 125

B. 625

C. 1,250

D. 15,625

E. 93,750

6. If $|3x - 1| = -x + 1$, then $x =$

A. -1.0
B. -0.5
C. 0.5
D. 1.0
E. 3.0

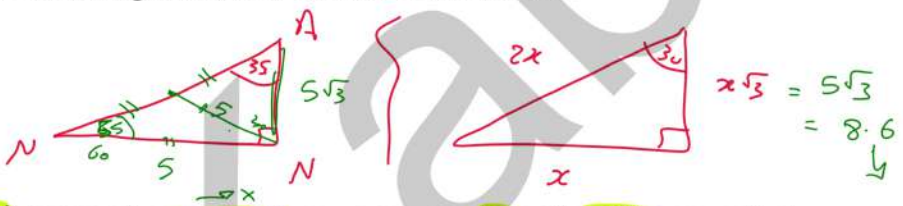
$$3(4x - 5) + 4x - 1 = 2(x - 3) + 7$$

7. Using the equation above, $28x - 6 =$

A. 28
B. 24
C. 22
D. 18
E. 14

8. ΔANE is a right triangle at N such that $m\angle NAE = 35°$. If G is the midpoint of $\overline{AE}$ with $NG = 5\ cm$, what is the length of $\overline{AN}$, to the nearest hundredth?

A. 4.10 *cm*
B. 4.76 *cm*
C. 5.77 *cm*
D. 6.88 *cm*
E. 8.19 *cm*



9. The 5th and 10th terms of a geometric sequence are 48 and 1,536, respectively. The first term of this sequence is also the first term of an arithmetic sequence with a common difference of 6. The 20th term of the arithmetic sequence is:

A. 96
B. 117
C. 162
D. 288
E. 312

10. Rachel runs a small business selling handmade souvenirs. The total cost to produce the souvenirs includes a fixed cost of \$70 for materials and equipment, plus an additional \$3.5 for each souvenir made. If Rachel sells each souvenir for \$9, how many souvenirs does she need to sell to make a profit of \$315?

A. 25
B. 30
C. 50
D. 65
E. 70

11. Given $f(x) = 2x + 4$ and $g(x) = \frac{x}{x+1}$.
Which one of the following expressions represents $(f \circ g)(2x)$?

A. $\frac{3x+1}{2x+1}$

B. $\frac{2x+1}{3x+1}$

C. $\frac{4(3x+1)}{x+1}$

D. $\frac{4(3x+1)}{2x+1}$

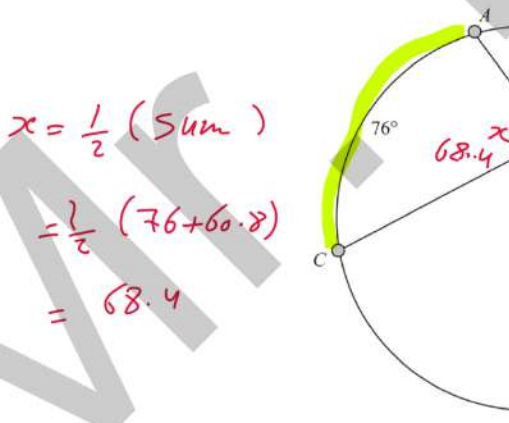
E. $\frac{3x+1}{4(2x+1)}$

12. What are the coordinates of the vertex of the function $f(x) = 3x^2 + 12x - 1$?

A. $(2, 13)$
B. $(2, 35)$
C. $(-2, -13)$
D. $(-2, 35)$
E. $(1, 14)$

13. Two angles $\angle A$ and $\angle B$ are linear pair such that $m\angle A = (3x - 11)°$ and $m\angle B = (2x + 6)°$. What is the value of $x - 4$?

A. 30
B. 33
C. 37
D. 41
E. 45

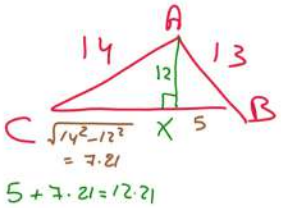


14. In the figure above, O is the center of the circle, and the minor arc DB measures 80% of the size of the minor arc AC. The value of $m\angle AED$ is: *(Figure not drawn to scale)*

A. 52.0°
B. 69.4°
C. 76.0°
D. 111.6°
E. 125.5°

15. In triangle ABC, the lengths of sides $\overline{AB}$ and $\overline{AC}$ are $13\ cm$ and $14\ cm$, respectively. The altitude from vertex A to side $\overline{BC}$ divides the triangle into two right triangles. The length of the altitude is $12\ cm$. To the nearest hundredth, what is the length of $\overline{BC}$?

A. $5.34\ cm$
B. $7.21\ cm$
C. $9.71\ cm$
D. $10.45\ cm$
E. $12.21\ cm$



16. Given points $A(2, 6)$ and $B(8, a)$. If $AB = \sqrt{117}$ units, $a =$

A. -3
B. -1
C. 0
D. 3
E. 5

17. What is the value of x in $\ln(3x - 1) = \ln(8x + 4)$?

A. -1
B. 0
C. 1
D. 2
E. No solution

18. A ball is thrown upwards from the top of a building. The height of the ball, $h(t)$, in meters, after t seconds, is given by the equation: $h(t) = -5t^2 + 16t + 50$. What does "50" represent in the equation?

A. It is the maximum height the ball reached.
B. It is the time in seconds the ball needed to reach its maximum height.
C. It is the initial height of the ball above the ground.
D. It is the time in seconds when the ball hit the ground.
E. It is the minimum height the ball reached.

19. If t varies inversely as m^2, and $t = 2$ when $m = 4$, what is the value of t when $m = -2$?

A. 2
B. 4
C. 5
D. 8
E. 10

$$f(x) = \frac{x^2 + 4x - 5}{x - 4}$$

20. The graph of the function f defined above has $y = ax + b$ as an oblique asymptote, where a and b are two real numbers. The value of $a + b$ is:

A. 1
B. 7
C. 8
D. 9
E. 12

21. The fourth proportional to 4, 9, and 15 is:

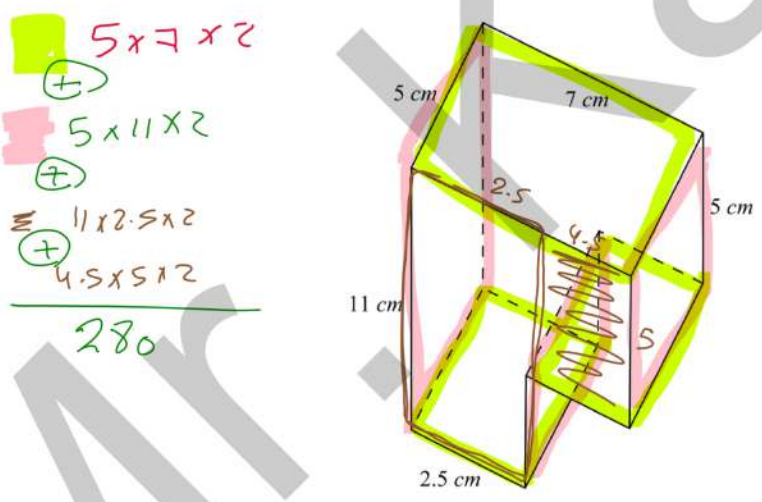
A. 30.0
B. 31.25
C. 33.75
D. 35.0
E. 40.0

22. The product of two positive consecutive odd integers is 483. What is the sum of the two numbers?

A. 40
B. 42
C. 44
D. 46
E. 48

23. The angles with measures $(4x - 11)°$ and $(2x + 21)°$ are vertically opposite. What is the value of $2x + 5$?

A. 16
B. 32
C. 35
D. 37
E. 55



24. What is the surface area of the shape represented in the figure above? *(Figure not drawn to scale)*

A. 242 cm^2
B. 245 cm^2
C. 260 cm^2
D. 272 cm^2
E. 280 cm^2

25. A box contains 8 red balls and 5 blue balls. What is the probability that a random selection of 4 balls from the box contains at least 3 balls of the same color?

A. 0.412
B. 0.503
C. 0.608
D. 0.691
E. 0.711

$3, 7, a, 8, 9, 9, 10, b, 13, 14$

26. The set of data above, arranged from smallest to largest, has an interquartile range of 3. What is the value of $b - a$?

A. 1
B. 3
C. 5
D. 7
E. 9

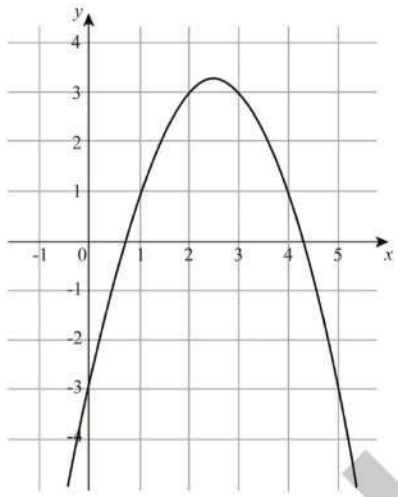
$x^2 - 4x + y^2 + 6y = -4$

27. Which of the following are the coordinates of the center of the circle represented by the equation above?

A. $(-2, 3)$
B. $(2, 3)$
C. $(-2, -3)$
D. $(2, -3)$
E. $(4, -6)$

28. What is the equation of the line that passes through $H(-1, 8)$ and is perpendicular to the line with the equation $3y - 4x = 4$?

A. $y = \frac{-3x+29}{4}$
B. $y = -\frac{3}{4}x + 29$
C. $y = \frac{3x+29}{4}$
D. $y = \frac{4}{3}x + 28$
E. $y = \frac{4x+28}{3}$



29. Which of the following is true about the function f represented in the graph above?

I. The degree of the function is even.

II. The leading coefficient is negative.

III. $f(4) = 1$.

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

30. In a factory, there are two machines, A and B, producing widgets. Machine A produces 60% of the total widgets, while Machine B produces 40%. It is known that 5% of the widgets produced by Machine A are defective, and 2% of the widgets produced by Machine B are defective.

If a randomly selected widget is found to be defective, what is the probability that it was produced by Machine A?

A. $\frac{2}{5}$

B. $\frac{11}{23}$

C. $\frac{18}{35}$

D. $\frac{13}{17}$

E. $\frac{15}{19}$

31. The measure of an angle in a regular octagon is:

A. $90°$
B. $120°$
C. $135°$
D. $145°$
E. $160°$

32. If $2x - 3a + 1 = 4ax - a$, for what value of a does the equation have infinite solutions?

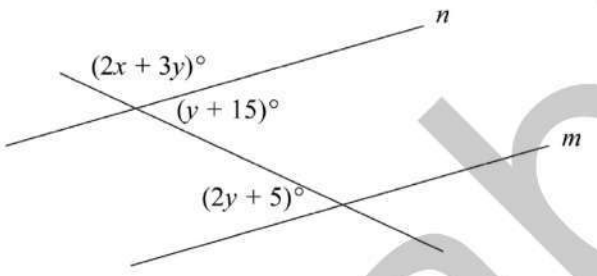
A. $\frac{1}{2}$

B. 1

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

D. 4

E. 6



33. In the figure above, n and m are two parallel lines. What is the value of x? *(Figure not drawn to scale)*

A. 17.5
B. 32.5
C. 40.0
D. 62.5
E. 70.0

34. The width of a rectangle is half of its length. If the area of the rectangle is 72 cm^2, then the width measures:

A. 4 cm
B. 6 cm
C. 8 cm
D. 9 cm
E. 18 cm

35. ΔABG is a right triangle at G such that $m\angle AGB = (2x + 34)°$, and $m\angle ABG = m\angle GAB = (x + y)°$. The value of $2x - y$ is:

A. 17
B. 22
C. 28
D. 31
E. 39

$$(15 - x)(x + 2) = 12$$

36. In the equation above, $x = \frac{13 \pm \sqrt{a}}{2}$ where a is a real number. What is the value of a?

A. 17
B. 117
C. 189
D. 241
E. 255

37. $\left(\frac{\sqrt{m^3}}{\sqrt{n^4}}\right)^{-2} =$

A. $\frac{n^3}{m^4}$

B. $\frac{m^3}{n^4}$

C. $m^4 n^3$

D. $\frac{n^4}{m^3}$

E. $n^4 m^3$

38. In a coordinate plane, points $A(-3, 4)$ and $B(5, -2)$ are the endpoints of a line segment. A third point C is on this segment, such that the distance from A to C is twice the distance from C to B. The coordinates of C are:

A. $\left(0, \frac{7}{3}\right)$

B. $\left(-\frac{7}{3}, 0\right)$

C. $\left(-\frac{7}{3}, 2\right)$

D. $\left(\frac{7}{3}, 0\right)$

E. $\left(\frac{7}{3}, -2\right)$

39. An angle is triple its complement. Which of the following is its measure in degrees?

A. 22.5
B. 30.0
C. 45.0
D. 60.0
E. 67.5

40. The volume of a cylinder is $670\ cm^3$. If the height of the cylinder is $13.5\ cm$, what is the radius of its base?

Given: The volume of a cylinder is: $V = \pi r^2 h$.

A. $1.45\ cm$
B. $3.97\ cm$
C. $4.11\ cm$
D. $4.76\ cm$
E. $5.07\ cm$

41. The width to the length in a rectangle is in the ratio $3:4$. If the perimeter of this rectangle is $56\ cm$, then the width is:

A. $12\ cm$
B. $14\ cm$
C. $16\ cm$
D. $18\ cm$
E. $20\ cm$

42. Which of the following is true for $f(x) = \frac{4}{\sqrt{2x-6}}$?

I. The domain of the function is all real numbers excluding 3.

II. The inverse function of f is $f^{-1}(x) = \frac{8}{x^2} + 3$.

III. There are no roots for the graph of f.

A. **I** only
B. **II** only
C. **III** only
D. **I** and **II**
E. **II** and **III**

43. The vertex angle of an isosceles triangle measures $50°$. The altitude drawn from the vertex to the opposite side has a length of $7\ cm$. The area of this triangle is equal to:

A. $13.5\ cm^2$
B. $17.8\ cm^2$
C. $20.4\ cm^2$
D. $22.8\ cm^2$
E. $28.1\ cm^2$

44. The sum of the interior angles of a polygon is four times the sum of its exterior angles. How many sides does the polygon have?

A. 6 sides
B. 8 sides
C. 10 sides
D. 14 sides
E. 15 sides

45. Two perpendicular lines intersect at point $(0, -3)$. If the equation of one line is $2y - 3x = -6$, what is the y-intercept of the second line?

A. $(0, -9)$
B. $(0, -3)$
C. $(0, -2)$
D. $(0, 3)$
E. $(0, 5)$

46. If x is negative, and $x^2 = y = 16$, $\left(\frac{2y}{\sqrt{|x|}}\right)^{-\frac{y}{8}}$ equals:

A. $\frac{1}{8}$

B. $\frac{1}{16}$

C. $\frac{1}{32}$

D. $\frac{1}{48}$

E. $\frac{1}{256}$

47. The determinant of $A = \begin{pmatrix} 1 & -1 & 3 \\ 0 & 1 & a \\ -7 & 8 & -3 \end{pmatrix}$ is 11. What is the value of a?

A. 3
B. 4
C. 7
D. 9
E. 10

48. The probability that Mariam draws a portrait on any given day is 0.34, and she doesn't draw more than one portrait in a day. The probability that, in a 3-day period, Mariam draws at most two portraits is approximately:

A. 0.944
B. 0.961
C. 0.970
D. 0.977
E. 0.984

49. In quadrilateral $ABCD$, $\overline{AB}$ and $\overline{CD}$ are parallel, and $m\angle A = 70°$. $\overline{AC}$ and $\overline{DB}$ intersect at E, forming an isosceles triangle AEB at E with $m\angle AEB = 66°$.

The measure of $\angle BCE$ is:

A. 13°
B. 22°
C. 30°
D. 53°
E. 66°

50. If $\ln(x - 3) \geq 4$, then x can be equal to:

A. 50.1
B. 52.2
C. 54.5
D. 57.0
E. 57.6