

1. The half-life of a radioactive isotope is 4.3 days. How long will it take to reduce the original amount to 1%?

- (A) 3.2 days
- (B) 16 days
- (C) 29 days
- (D) 40 days

2. Five fair coins are each flipped once. What is the probability that at least two of the coins will show heads?

- (A) 0.19
- (B) 0.80
- (C) 0.81
- (D) 0.84

3. What is the determinant of the following 2×2 matrix?

$$\begin{bmatrix} 1 & 4 \\ 3 & 2 \end{bmatrix}$$

- (A) -10
- (B) -5
- (C) 9
- (D) 10

4. What is the radius of a circle with the following equation?

$$x^2 - 6x + y^2 - 4y - 12 = 0$$

- (A) 3.5
- (B) 4.0
- (C) 5.0
- (D) 6.0

5. What is the value of the following limit?

$$\lim_{x \rightarrow 3} \frac{x^2 - 9}{x - 3}$$

- (A) -6
- (B) 1
- (C) 6
- (D) ∞

6. Given the vector $\mathbf{V} = \mathbf{i} + 2\mathbf{j} + \mathbf{k}$, what is the angle between \mathbf{V} and the x -axis?

- (A) 22°
- (B) 24°
- (C) 66°
- (D) 80°

7. Evaluate the following definite integral.

$$\int_2^\infty \frac{1}{x^2} dx$$

- (A) $1/24$
- (B) $1/8$
- (C) $1/2$
- (D) 2

8. What is the standard deviation of 1, 4, and 7?

- (A) 2.5
- (B) 3.0
- (C) 5.7
- (D) 6.0

9. Which is a true statement about the two vectors?

$$\mathbf{V}_1 = \mathbf{i} + 2\mathbf{j} + \mathbf{k}$$

$$\mathbf{V}_2 = \mathbf{i} + 3\mathbf{j} - 7\mathbf{k}$$

- (A) Both vectors pass through $(0, -1, 6)$.
- (B) The vectors are parallel.
- (C) The vectors are orthogonal.
- (D) The angle between the vectors is 17.4° .

10. What is the area bounded by $y = 0$, $y = e^x$, $x = 0$, and $x = 1$?

- (A) 1.4
- (B) 1.7
- (C) 2.7
- (D) 3.4

11. A function of x is given below. Which (x, y) point is a relative maximum or minimum?

$$y = \frac{1}{4}x^4 - 1.5x^2 + 2x + 5$$

- (A) $(-2, -1)$
- (B) $(-2, -2)$
- (C) $(2, -2)$
- (D) $(-1, -1.75)$

12. The slope of a line is $1/2$. The slope of a second line is $-2/3$. The lines intercept at the point $(3, 1)$. What is the acute angle between the lines?

- (A) 27°
- (B) 50°
- (C) 60°
- (D) 80°

13. A function is given. What value of x maximizes y ?

$$y^2 + y + x^2 - 2x = 5$$

- (A) -1
(B) 1/2
(C) 1
(D) 5

14. An elephant is chained to a corner of a 30 m \times 35 m building. If the chain is 40 m long and the elephant can reach 1 m farther than the chain length, what is the maximum area the elephant can cover?

- (A) 3870 m²
(B) 3960 m²
(C) 3970 m²
(D) 4080 m²

15. What is a point of inflection for the following equation?

$$y = 9x^3 + x^2 - 15x + 32$$

- (A) (-27, -176,000)
(B) (-21.2, -84,400)
(C) (-0.037, 32.6)
(D) (19.2, 63,300)

16. Assume that three force vectors are applied at a single point.

$$\mathbf{F}_1 = \mathbf{i} + 3\mathbf{j} + 4\mathbf{k}$$

$$\mathbf{F}_2 = 2\mathbf{i} + 7\mathbf{j} - \mathbf{k}$$

$$\mathbf{F}_3 = -\mathbf{i} + 4\mathbf{j} + 2\mathbf{k}$$

What is the magnitude of the resultant force vector, \mathbf{R} ?

- (A) 13
(B) 14
(C) 15
(D) 16

17. What is the solution to the differential equation if $x = 1$ at $t = 0$, and $dx/dt = 0$ at $t = 0$?

$$\frac{1}{2} \frac{d^2x}{dt^2} + 4 \frac{dx}{dt} + 8x = 5$$

- (A) $e^{-4t} + 4te^{-4t}$
(B) $\frac{3}{8}e^{-2t}(\cos 2t + \sin 2t) + \frac{5}{8}$
(C) $e^{-4t} + 4te^{-4t} + \frac{5}{8}$
(D) $\frac{3}{8}e^{-4t} + \frac{3}{2}te^{-4t} + \frac{5}{8}$

18. Which value is equal to $\log_e e^{-7x}$?

- (A) $-7x \log_{10} e$
(B) $-7 \log_e 10$
(C) $-7x$
(D) 10^{-7x}

19. What is the probability of picking an orange ball out of a bag containing seven orange balls, eight green balls, and two white balls?

- (A) 0.059
(B) 0.15
(C) 0.24
(D) 0.41

20. What is the greatest positive value of y on the curve $y = 7x^2 - 3x + 8$?

- (A) 3/14
(B) 3/7
(C) 14/3
(D) 215/28

21. Which of the following is equivalent to $\sin 2\theta$?

- (A) $2 \sin \theta \cos \theta$
(B) $\cos^2 \theta - \sin^2 \theta$
(C) $\sin \theta \cos \theta$
(D) $\frac{1 - \cos 2\theta}{2}$

22. If $i \equiv \sqrt{-1}$, what is the value of $(i)^i$?

- (A) i^2
(B) e^{2i}
(C) -1
(D) $e^{-\frac{\pi}{2}}$

23. What is the volume of the object created when the area bounded by $y = 0$, $x = 0$, and $y = \sqrt{4 - x^2}$ is rotated about the y -axis?

- (A) 3.1
(B) 8.4
(C) 17
(D) 34

24. What is the cross product of a vector and a scalar?

- (A) a vector
(B) a scalar
(C) a tensor
(D) cannot be determined