1. The graph of the parametric curve
\[ x = 1 - 2t^3, \quad y = 1 + 2t^3, \quad -\infty < t < \infty \]

is

(a) a straight line
(b) a parabola
(c) an ellipse
(d) a hyperbola
(e) a circle

2. A curve is given by the parametric equations \( x = \cos 2t \) and \( y = \sin t \), then the cartesian equation of the curve is given by:

(a) \( y^2 = \frac{1 - x}{2} \)
(b) \( x^2 + y^2 = 1 \)
(c) \( y = \frac{x - 2}{2} \)
(d) \( x = y^2 + 1 \)
(e) \( y^2 = x + 1 \)
3. The parametric curve $C : x = \frac{1}{3}t^3 - t, \ y = t^2 - 1$ has

(a) a horizontal tangent at $(0, -1)$
(b) a vertical tangent at $(0, -1)$
(c) vertical tangents at $\left( \pm \frac{1}{3}, 0 \right)$
(d) horizontal tangents at $\left( \pm \frac{2}{3}, 0 \right)$
(e) a horizontal tangent at $\left( -\frac{4}{3}, 0 \right)$

4. One of the following statements is **FALSE** with respect to the graph of $r = \cos \left( \frac{\theta}{3} \right), 0 \leq \theta \leq 3\pi$.

(a) a rose with 6 leaves
(b) symmetric with respect to the polar axis
(c) intersect itself at one point between $0 \leq \theta \leq 3\pi$
(d) passing through the pole
(e) directed counter clock-wise
5. The slope of the tangent line to the curve of \( r = \frac{1}{\theta} \) at \( \theta = \frac{\pi}{2} \) is

(a) \( \frac{2}{\pi} \)

(b) 2

(c) \(-2\)

(d) 0

(e) \( \frac{-\pi}{2} \)

6. The polar curves \( r = k \sin \theta, k > 0 \) and \( r = 1 + \cos \theta \) intersect at the point \( \left( \frac{3}{2}, \frac{\pi}{3} \right) \), then the value of \( k \) and the other point of intersection of those curves are:

(a) \( \sqrt{3}, (0, \pi) \)

(b) \( \frac{\sqrt{3}}{3}, (0, 0) \)

(c) \( \frac{\sqrt{3}}{3} \left( \frac{1}{2}, \frac{2\pi}{3} \right) \)

(d) \( \sqrt{3}, \left( \frac{1}{2}, -\frac{\pi}{3} \right) \)

(e) \( \frac{\sqrt{3}}{3} \left( 0, \frac{\pi}{2} \right) \)
7. The area of the region shared by 

\[ r = 8 \text{ and } r = 8(1 + \sin \theta), \]

is 

(a) \( 16(5\pi - 8) \)

(b) \( 32(\pi + 8) \)

(c) \( 96\pi \)

(d) \( 16(3\pi - 8) \)

(e) \( 32\pi \)

8. The length of the parametric curve \( x = \frac{1}{3}t^3 - t, \ y = t^2 - 1, \ 0 \leq t \leq 2, \) is 

(a) \( \frac{14}{3} \)

(b) \( \frac{7}{3} \)

(c) \( \frac{8}{3} \)

(d) \( 2 \)

(e) \( 4 \)
9. The area of the region enclosed by one loop of the curve \( r = 4 \cos 3\theta \) is

(a) \( \frac{4 \pi}{3} \)

(b) \( \frac{8 \pi}{3} \)

(c) \( \frac{2 \pi}{3} \)

(d) \( \frac{\pi}{3} \)

(e) \( \pi \)

10. The equation

\[ 4x^2 + 4y^2 + 4z^2 = 16y - 12z + 3 \]

represents

(a) a sphere with center \( \left(0, 2, -\frac{3}{2}\right) \) and radius \( \sqrt{7} \)

(b) a sphere with center \( \left(0, -2, \frac{3}{2}\right) \) and radius 7

(c) a sphere with center \( (0, 0, 0) \) and radius \( \sqrt{3} \)

(d) a point

(e) no graph in \( \mathbb{R}^3 \)
11. $< a, b, 0 >$ is a non-zero vector perpendicular to $< 2, -1, 3 >$ then $\frac{a^2 + b^2}{a^2} =$

(a) 5  
(b) 4  
(c) 3  
(d) 2  
(e) 1

12. Let $\vec{u} = < 3, -1, 0 >$, and $\vec{v} = < 0, 1, 2 >$. Then $\text{proj}_v \vec{u} =$

(a) $\left< 0, \frac{-1}{5}, \frac{-2}{5} \right>$  
(b) $\left< 0, -1, -2 \right>$  
(c) $\left< \frac{-3}{10}, \frac{1}{10}, 0 \right>$  
(d) $\left< -3, 1, 0 \right>$  
(e) $\left< 0, 1, 2 \right>$
13. Let $A = (1, 0, -4)$, $B = (4, 4, 8)$, and $C = (a, b, c)$ be points in three dimensional space. If $\overrightarrow{AC}$ is the unit vector in the same direction as $\overrightarrow{AB}$, then $26(a + b + c) =$

(a) $-40$
(b) $10$
(c) $20$
(d) $-4$
(e) $50$

14. A vector in two dimensional space $\vec{v}$ that makes an angle $\frac{\pi}{4}$ with the positive $x$-axis and with $|\vec{v}| = 6$ is given by:

(a) $v = \langle 3\sqrt{2}, -3\sqrt{2} \rangle$
(b) $v = \langle -3\sqrt{2}, -3\sqrt{2} \rangle$
(c) $v = \langle 6, 0 \rangle$
(d) $v = \langle -3\sqrt{2}, 3\sqrt{2} \rangle$
(e) $v = \langle 3\sqrt{3}, -3 \rangle$
15. If the angle between the vectors \( \langle 1, 1, -2 \rangle \) and \( \langle 1, x, 0 \rangle \) is 60°, then the sum of all possible values of \( x \) is

(a) 4  
(b) 2  
(c) 0  
(d) -2  
(e) -4

16. If the unit vectors that are parallel to the tangent line to the curve \( y = 2 \sin x \) at the point \( x = \frac{5\pi}{6} \) are given by \( \vec{u} = \pm \frac{1}{a}(i + bj), a > 0 \) then \( a + \sqrt{3}b = \ldots \)

(a) -1  
(b) 1  
(c) 5  
(d) -5  
(e) -2
17. The set of all points equidistant from the points \(A(1, -7, 2)\) and \(B(3, 1, -1)\) is 
(perp stands for perpendicular)

(a) a plane perp to the line \(AB\), with equation \(4x + 16y - 6z = -43\)

(b) a plane perp to the line \(AB\), with equation \(2x + 8y - 3z = 22\)

(c) any line perp to the line \(AB\)

(d) only the point \((2, -3, \frac{1}{2})\)

(e) a line perp to the line \(AB\), and passing through the point \((2, -3, \frac{1}{2})\)

18. If \(\theta\) is the angle between the nonzero vectors \(\vec{a}\) and \(\vec{b}\), then \(\cot \theta =\)

(a) \(\frac{a \cdot b}{|a \times b|}\)

(b) \(\frac{|a \times b|}{a \cdot b}\)

(c) \(\frac{a \cdot b}{|a||b|}\)

(d) \(\frac{|a \times b|}{|a||b|}\)

(e) \((a \cdot b)|a \times b|\)
19. A vector \( \vec{V} \) such that
\[
\langle 1, 2, 1 \rangle \times \vec{V} = \langle 3, 1, 5 \rangle
\]
is:

(a) there is no such vector
(b) \( \langle 1, -3, 0 \rangle \)
(c) \( \langle -1, -7, -2 \rangle \)
(d) \( \langle 2, -1, 1 \rangle \)
(e) \( \langle 5, 5, 4 \rangle \)

20. The area enclosed by the three polar curves
\[
\theta = \pi( r \geq 0), \quad \theta = \frac{\pi}{2} ( r \leq 0)
\]
equals

(a) \( \frac{1}{2} \)
(b) \( 1 \)
(c) \( 2 \)
(d) \( \sqrt{2} \)
(e) \( 2\sqrt{2} \)
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