

Vectors, Polar Coordinates, and Complex Numbers: math test solutions, Grade 12 – download the PDF

Test solutions with the detailed point scale. Add up your points and spot what to review.

Suggested time: 45 minutes. Out of 20 points. Calculator allowed only when the problem says so.

1 Vector basics

/ 3 pts

- a. $\|\mathbf{u}\| = \sqrt{16 + 9} = 5$ and $\|\mathbf{v}\| = \sqrt{25 + 144} = 13$. (1 pt)
- b. $2\mathbf{u} + \mathbf{v} = \langle -8, 6 \rangle + \langle 5, 12 \rangle = \langle -3, 18 \rangle$. (1 pt)
- c. $\mathbf{u} \cdot \mathbf{v} = -20 + 36 = 16$. (1 pt)

2 Work and angle

/ 3 pts

- a. $W = 48 + 48 = 96$ ft·lb. (1 pt)
- b. $\|\mathbf{F}\| = 10$ lb and $\|\mathbf{d}\| = 10$ ft. (1 pt)
- c. $\cos \theta = \frac{96}{100} = 0.96$, so $\theta \approx 16.3^\circ$. (1 pt)

3 Polar conversions

/ 4 pts

- a. $x = 6 \cos 330^\circ = 3\sqrt{3}$ and $y = 6 \sin 330^\circ = -3$: $(3\sqrt{3}, -3)$. (1.5 pts)
- b. $r = \sqrt{18} = 3\sqrt{2}$; quadrant II gives $\theta = \frac{3\pi}{4}$: $\left(3\sqrt{2}, \frac{3\pi}{4}\right)$. (1.5 pts)
- c. $r^2 = 8r \sin \theta$ gives $x^2 + y^2 = 8y$, i.e., $x^2 + (y - 4)^2 = 16$: a circle of center $(0, 4)$ and radius 4. (1 pt)

4 A polar curve

/ 3 pts

- a. $r = 2, 1, 0, 4$ respectively. (2 pts: 0.5 pt per value)
- b. It is a cardioid, symmetric about the vertical line $\theta = \frac{\pi}{2}$ (the y -axis); its farthest point is 4 units below the pole. (1 pt)

5 Complex numbers in polar form

/ 4 pts

- a. $z_1 z_2 = 10 \operatorname{cis} 135^\circ$ (1 pt) $= -5\sqrt{2} + 5\sqrt{2}i$. (1 pt)
- b. $z_1^3 = 8 \operatorname{cis} 300^\circ$ (1 pt) $= 8 \cos 300^\circ + 8i \sin 300^\circ = 4 - 4\sqrt{3}i$. (1 pt)

6 Cube roots

/ 3 pts

$-64 = 64 \operatorname{cis} 180^\circ$, so the modulus is $\sqrt[3]{64} = 4$. (1 pt)

The arguments are $\frac{180^\circ + 360^\circ k}{3} = 60^\circ, 180^\circ, 300^\circ$. (1 pt)

$z_0 = 2 + 2\sqrt{3}i, z_1 = -4, z_2 = 2 - 2\sqrt{3}i$. (1 pt)



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