

1. Multiplication by which of the following leads to rotation by 90 degrees counterclockwise in the complex plane?
  - a.  $i$
  - b.  $90$
  - c.  $-1$
  - d.  $\pi$
  - e. NOTA
  
2. What shape does the curve  $r = 5$  make in the  $xy$ -plane?
  - a. Ellipse
  - b. Line
  - c. Circle
  - d. Point
  - e. NOTA
  
3. Find the solution(s) for the following equation:  $8x^2 + 4x + 5 = 0$ .
  - a.  $-\frac{1}{4} \pm \frac{3}{4}i$
  - b.  $\frac{3}{4} \pm \frac{3}{4}i$
  - c.  $4 \pm 2i$
  - d.  $-\frac{5}{4} \pm \frac{1}{4}i$
  - e. NOTA
  
4.  $(1 - i)^{2017} =$ 
  - a.  $2^{1008}$
  - b.  $2^{1008} * (1 - i)$
  - c.  $-2i$
  - d.  $2^2 * (1 - i)^2$
  - e. NOTA
  
5.  $|3-4i| =$ 
  - a.  $3+4i$
  - b.  $3-4i$
  - c.  $5$
  - d.  $25$
  - e. NOTA

Questions 6-10 refer to the following information:

Quaternions are a set of complex numbers  $i, j, k$ , and  $1$  such that  $i*j*k = -1$ . Multiplication with quaternions is non-commutative, so that  $i*j = -j*i$ . Additionally,  $i^2 = j^2 = k^2 = -1$

6. What is  $k^{2017}$ ?
  - a.  $i$
  - b.  $j$
  - c.  $2i$
  - d.  $-k$
  - e. NOTA
  
7. What is  $i*j$  in terms of  $k$ ?
  - a.  $-k$
  - b.  $k$
  - c.  $k^2$
  - d.  $k^0$
  - e. NOTA
  
8. What is  $i*k$ ?
  - a.  $1$
  - b.  $-1$
  - c.  $-j$
  - d.  $j$
  - e. NOTA
  
9. Simplify:  $i^3jkik^2j$ 
  - a.  $i*k$
  - b.  $-k$
  - c.  $-i$
  - d.  $j$
  - e. NOTA
  
10. What is  $(3i + 2j)*(1+j)$ ?
  - a.  $2j - 2i$
  - b.  $3i + j - 2$
  - c.  $3k + j - 1$
  - d.  $3i + 3k + 2j - 2$
  - e. NOTA

11. Which of the following is not complex?  
 a.  $i$             b.  $3$             c.  $3i+1$             d.  $-7i$             e. NOTA
12. Evaluate:  $\left(\frac{\sqrt{6}-\sqrt{2}}{4} + \frac{\sqrt{6}+\sqrt{2}}{4}i\right)^{2017}$   
 a.  $\frac{\sqrt{6}-\sqrt{2}}{4} + \frac{\sqrt{6}+\sqrt{2}}{4}i$     b.  $\frac{\sqrt{6}-\sqrt{2}}{4} - \frac{\sqrt{6}+\sqrt{2}}{4}i$     c.  $-\frac{\sqrt{6}-\sqrt{2}}{4} + \frac{\sqrt{6}+\sqrt{2}}{4}i$   
 d.  $-\frac{\sqrt{6}-\sqrt{2}}{4} - \frac{\sqrt{6}+\sqrt{2}}{4}i$     e. NOTA
13. A polar conic has an eccentricity of 1.5. What type of conic is it?  
 a. Parabola    b. Hyperbola    c. Circle    d. Ellipse    e. NOTA
14. How many complex solutions exist for the equation:  $z^6 + 4z^5 - z^3 + 1 = 0$ ?  
 a. 7            b. 6            c. 4            d. 2            e. NOTA
15.  $\prod_{n=2}^{255} (i * \log_n(n + 1)) =$   
 a. -4            b. 1024            c. -8            d. -128            e. NOTA
16. How many real solutions exist for the equation  $z^4 + z^3 - z^2 + z - 2 = 0$ ?  
 a. 4            b. 3            c. 2            d. 1            e. NOTA
17. What shape is the polar conic formed by  $r = 5\theta$ ?  
 a. Hyperbola    b. Ellipse    c. Spiral    d. Line    e. NOTA
18. How many lines of symmetry are contained in the conic  $r = 2\sin(4\theta)$ ?  
 a. 1            b. 2            c. 4            d. 8            e. NOTA
19. What is the area enclosed by the polygon formed by the solutions to the equation  $x^6 = 1$  in the Argand plane?  
 a.  $\frac{3\sqrt{3}}{4}$             b.  $\frac{\sqrt{3}}{6}$             c.  $\frac{5\sqrt{3}}{4}$             d.  $\frac{3\sqrt{3}}{2}$             e. NOTA
20. Simplify:  $\frac{(2\text{cis}\theta)^4 \text{cis}(4\theta)}{\text{cis}(8\theta)}$   
 a.  $\cos(2\theta)$             b. 32            c.  $\text{cis}(\theta)$             d.  $(\text{cis}\theta)^4$             e. NOTA

21.  $e^{\frac{i\pi}{4}} =$

- a.  $\frac{\sqrt{2}}{2}$       b.  $2(1 - i)$       c.  $\frac{\sqrt{3}}{2}(i)$       d.  $\frac{\sqrt{2}}{2}(1 + i)$       e. NOTA

22. Solve this system for b (don't bother rationalizing denominators):

$$\frac{i}{a} + \frac{3}{b} = 5$$

$$\frac{2}{a} - \frac{4i}{b} = 8$$

- a.  $\frac{1}{5-4i}$       b.  $5 - 4i$       c.  $3i + 2$       d.  $\frac{1}{3i+2}$       e. NOTA

23. Evaluate the following geometric sum:  $2i - \frac{1}{2} - \frac{i}{8} + \frac{1}{32} \dots$ 

- a.  $\frac{i-8}{9}$       b.  $\frac{32i-8}{17}$       c.  $\frac{5i+4}{16}$       d.  $\frac{5i+8}{15}$       e. NOTA

24. What shape is the following conic:  $r = 2 + 2\sin\theta$ ?

- a. Lemniscate      b. Circle      c. Cardioid      d. Hyperbola      e. NOTA

25. An ant walks along the curve  $Im(Z) = 2Re(Z)$  at a speed of  $\sqrt{5}$  units/sec, starting at the origin and heading in the positive x direction. How long does it take for the ant to get to the point  $4 + 8i$ ?

- a. 1 sec      b. 4 sec      c. 8 sec      d. 12 sec      e. NOTA

26. Simplify:  $\frac{(2+3i)\left(4\text{cis}\left(\frac{\pi}{2}\right)\right)}{e^{i\pi}}$

- a.  $4 - 3i$       b.  $4 + i$       c.  $6 - 12i$       d.  $12 - 8i$       e. NOTA

27. Which of the following is a solution to the equation:  $\cos^2(z) - \sin^2(z) + i\sin(2z) = e^{i\pi}$ ?

- a.  $\frac{\pi}{2}$       b.  $\frac{3\pi}{4}$       c.  $\frac{\pi}{8}$       d.  $\pi$       e. NOTA

28.  $\sum_{n=1}^{2017} i^n =$

- a. i      b. 2017      c. 1      d. 0      e. NOTA

29.  $\prod_{n=1}^{2017} i^n =$

- a.  $i$                       b. 2017                      c. 1                      d. 0                      e. NOTA

30.  $e^{\frac{i\pi}{3}} \cdot e^{\frac{i\pi}{4}}$

- a.  $\frac{1}{2}(\sqrt{6} + 2i\sqrt{6} - 2)$                       b.  $(\sqrt{3} + i\sqrt{2} + i\sqrt{6} - \sqrt{3})$   
c.  $\frac{1}{2}(i\sqrt{2} + i\sqrt{3} - \sqrt{2})$                       d.  $\frac{1}{2}(\sqrt{6} + i\sqrt{2} + i\sqrt{6} - \sqrt{2})$   
e. NOTA