1. A
For example, take any vector lying along the real axis. Multiplying by i gives a purely imaginary number, lying along the imaginary axis.

2. C
This is the set of all 2D points of equal distance from the origin.

3. A
Using the quadratic equation, we have $\frac{-4\pm\sqrt{16-4*8*5}}{2*8} = -\frac{1}{4}\pm\frac{3}{4}i$

4. B
$$(1-i)^2 = -2i, so\ (1-i)^{2016} = (-2i)^{1008} * (1-i) = 2^{1008} * (1-i)$$

5. C
Using the Pythagorean theorem for distance, $\sqrt{3^2+4^2} = 5$

6. E
By itself, k behaves just like the normal imaginary unit i. So $k^{2017} = k^{2016} * k = 1 * k = k$

7. B
We had given that i*j*k=-1, so (i*j)*k=-1. We know that k*k=-1, so (i*j) must be k.

8. C
We know that j*i = -i*j, so j*i*k=-i*j*k=1. Then j*(i*k) = 1, so i*k=-j.

9. B
$$i^3jkik^2j = -ijki(-1)j = ijkij = -k * k * -k = k^3 = -k$$

10. D
FOILing gives $3i + 3ij + 2j + 2j^2 = 3i + 3k + 2j - 2$

11. E
All of those numbers are complex, they just aren't all imaginary.

12. A
$\left(\frac{\sqrt{6}-\sqrt{2}}{4} + \frac{\sqrt{6}+\sqrt{2}}{4}i\right)^{2017} = \left(cis75^\circ\right)^{2017} = cis75^\circ = \frac{\sqrt{6}-\sqrt{2}}{4} + \frac{\sqrt{6}+\sqrt{2}}{4}i$

13. B
If a polar conic has an eccentricity greater than one, it is a hyperbola.

14. B
All of the solutions are in the complex plane, so there are 6 complex solutions (and they are all distinct).

15. C
There are 254 factors in the expansion of the product, so we can pull out $i^{254} = -1$. Then, due to the fact that $\log_a b = \frac{\log b}{\log a}$, all but the first and last values for n will cancel, and we have $\prod_{n=2}^{255} \log_n(n+1) = \log_2 256 = 8$. So our final answer is -8.

16. C
We can factor the equation into $(z^2+1)*(z-1)*(z+2)$. Thus two of the solutions are real.

17. C
This is a spiral of Archimedes.

18. D
This is an 8-petaled rose, so there are eight lines of symmetry (four centered on petals, four between petals).

19. D
There are six solutions to this equation, forming a hexagon in the complex plane, with the length from the center to the vertex being 1. Then the total area is $6 * \frac{1^2\sqrt{3}}{4} = \frac{3\sqrt{3}}{2}$

20. E

$$\frac{(2cis\theta)^4 \operatorname{cis}(4\theta)}{\operatorname{cis}(8\theta)} = \frac{16(cis\theta)^4 * (cis\theta)^4}{(cis\theta)^8} = 16$$

21. D
By Euler's theorem, $e^{i\theta} = cis\theta \rightarrow e^{\frac{i\pi}{4}} = \cos\left(\frac{\pi}{4}\right) + isin\left(\frac{\pi}{4}\right) = \frac{\sqrt{2}}{2}(1+i)$

22. A
Let x=1/a and y=1/b. Then we have $xi + 3y = 5$ and $2x - 4iy = 8$. Multiplying the first equation by 2i and adding to the second equation gives $6iy = 8 + 10i \rightarrow y = 5 - 4i$. Then $b = \frac{1}{5-4i}$.

23. B
The sum of an infinite geometric series is given by $\frac{a}{1-r} = \frac{2i}{1-\frac{i}{4}} = \frac{8i}{4-i} * \frac{4+i}{4+i} = \frac{32i-8}{17}$

24. C
For conics of the form $r = a + bcos\theta$, if a/b=1, the conic is a cardioid.

25. B
The point is$4\sqrt{5}$ units from the origin, so it will take 4 sec.

26. D

$$\frac{(2+3i)\left(4\,\text{cis}\left(\frac{\pi}{2}\right)\right)}{e^{i\pi}} = \frac{(2+3i)(4)(i)}{-1} = -8i + 12$$

27. A

$\cos^2(\text{z}) - \sin^2(\text{z}) + \sin(2\text{z}) = -1\ \cos^2(\text{z}) - \sin^2(\text{z}) + 2\sin(\text{z})\cos(\text{z}) = \big(\cos(\text{z}) + \text{i}\sin(\text{z})\big)^2 = cis^2(z)$. Then $cis(z) = e^{\frac{i\pi}{2}}$, so $z = \frac{\pi}{2}$

28. A

The sequence is $i + -1 + -i + 1 + i + \cdots + i$. Each set of four terms will cancel, leaving only the very last term, so the entire sum is i.

29. A

Similar to the previous problem, each set of four terms will multiply out to -1. There are 2016/4=504 sets of four terms, so the first 2016 terms multiply out to 1. This leaves the last term, i.

30. E

$$e\text{^}(i\pi/3)\cdot e\text{^}(i\pi/4) = cis\left(\frac{\pi}{3}\right) * cis\left(\frac{\pi}{4}\right) = \left(\frac{1}{2} + \frac{\sqrt{3}i}{2}\right)\left(\frac{\sqrt{2}}{2} + \frac{i\sqrt{2}}{2}\right)$$
$$= \frac{1}{4}(\sqrt{2} + i\sqrt{2} + i\sqrt{6} - \sqrt{6})$$