CONCEPTUAL

① The odd one out is $(-3, \frac{3\pi}{4})$.

② The horizontal line $y=2$.

③ See end of this file.

COMPUTATIONAL

① $-\pi$

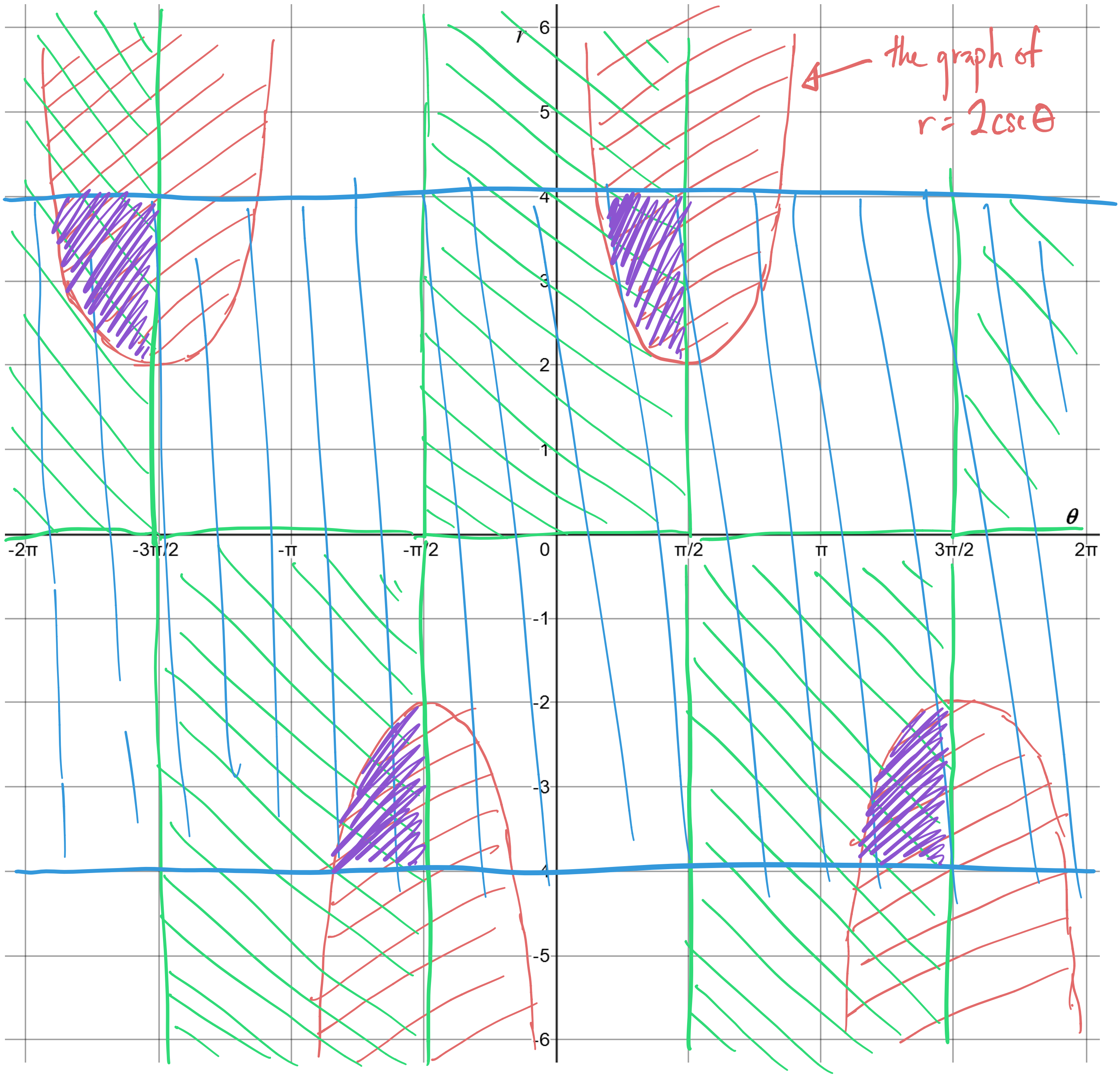
② $r = 2a\cos\theta + 2b\sin\theta$ (Write out eqn in Cartesian and then substitute.

This is traced out once as $0 \le \theta < \pi$ for example.

③ ⓐ $$\int_{5\pi/6}^{2\pi/3} (\theta\sin\theta)(\cos\theta - \theta\sin\theta)\,d\theta = \boxed{\frac{\pi^2\sqrt{3}}{32} + \frac{61\pi^3}{1296}}$$

ⓑ

$$\int_{\frac{2\pi}{3}}^{\frac{5\pi}{6}} \frac{1}{2}\theta^2\,d\theta = \frac{61\pi^3}{1296} \qquad \frac{\pi^2}{6\sqrt{3}} \qquad \frac{25\pi^2}{96\sqrt{3}}$$



Region A is defined by

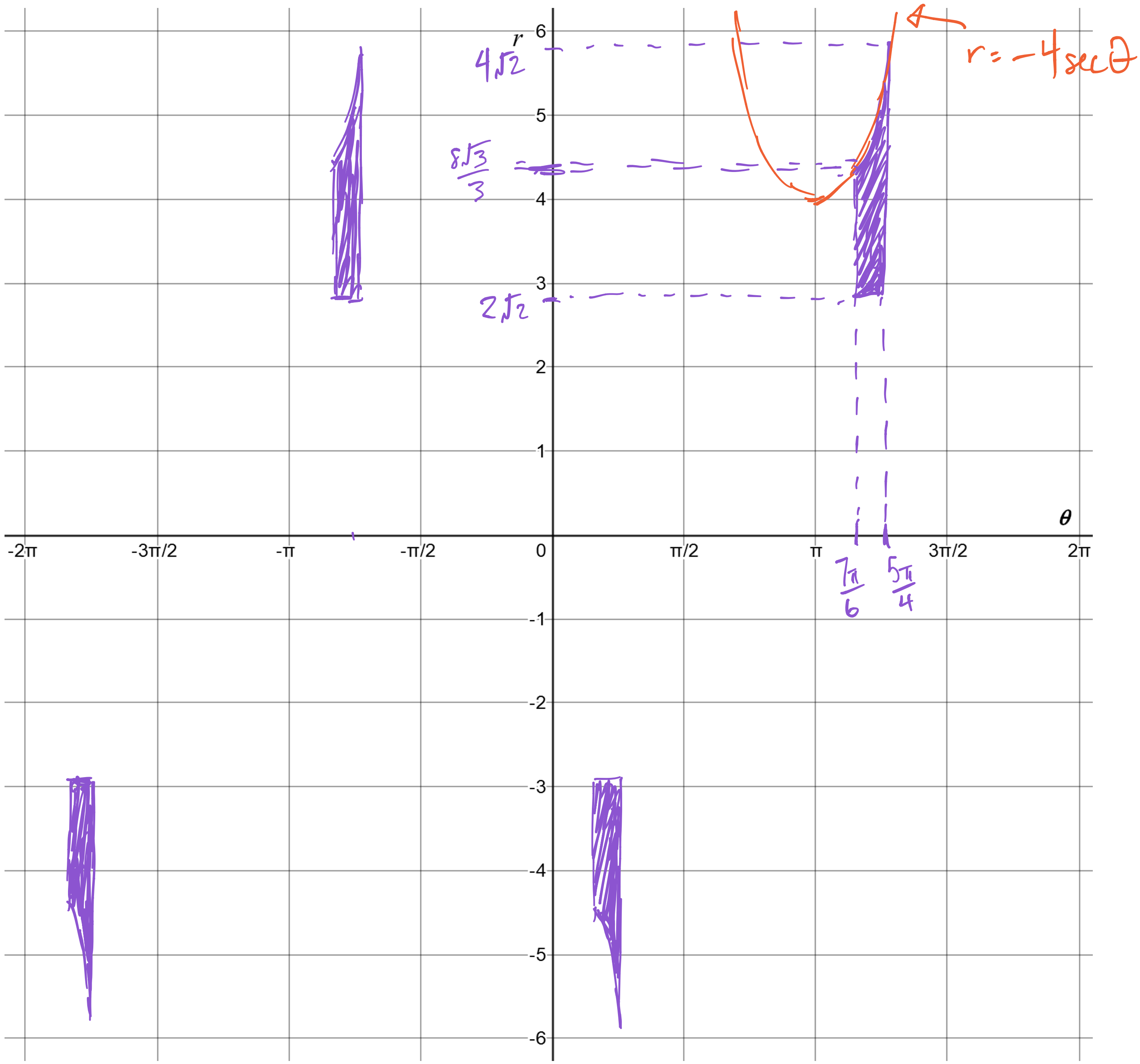
$y \geq 2$ i.e. $r\sin\theta > 2$

$x \geq 0$ $r\cos\theta \geq 0$

$x^2+y^2 \leq 16$ $|r| \leq 4$

The regions satisfying all three constraints has been shaded in purple.

($\geq$ vs $>$ is not important in this problem)



I'll let you check that this is the answer for region B.