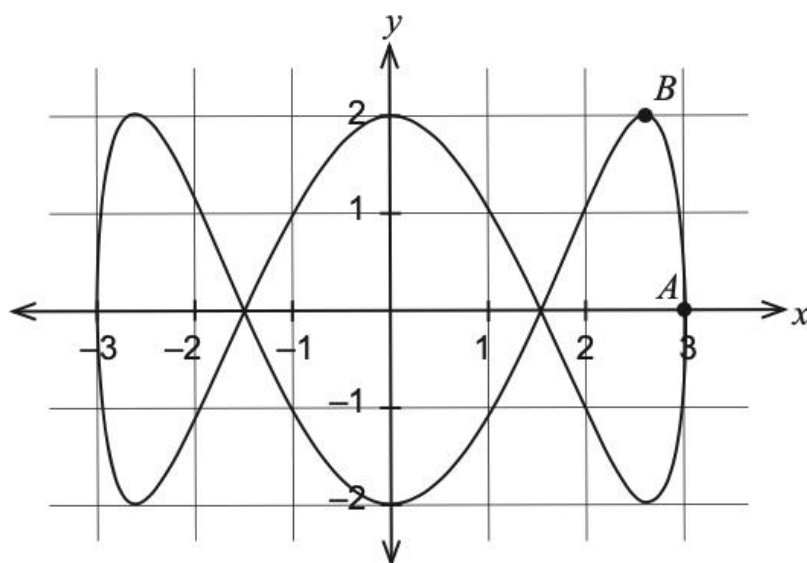


Question 15**(13 marks)**

A battery-powered model race car moves around a race track as indicated in the diagram below. The car's initial position is point A .



At any time t seconds, the velocity vector $\underline{v}(t)$ of the model race car is given by:

$$\underline{v}(t) = \begin{pmatrix} -\sin\left(\frac{t}{3}\right) \\ 2 \cos(t) \end{pmatrix} \text{ metres per second.}$$

- (a) Determine the initial velocity vector and show this on the diagram above. (2 marks)
- (b) Write an expression that will determine the change in displacement over the first $\frac{3\pi}{2}$ seconds. (2 marks)

(c) Determine the displacement vector $\underline{r}(t)$.

(3 marks)

It can be shown that the model race car's speed is at a minimum when it reaches point B on the track, one of the sharpest points on the curve.

(d) Determine the acceleration vector \underline{a} when the car reaches point B , giving components correct to 0.01. (3 marks)

(e) Determine the distance, correct to 0.01 metres, that the model race car travels in completing one lap of the track. (3 marks)