

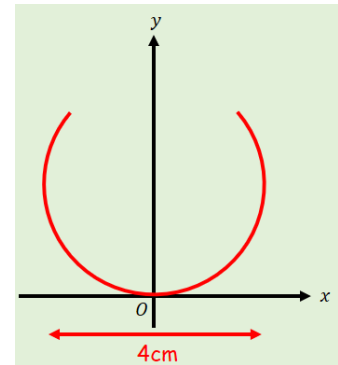
## 4D Modelling with Volumes of Revolution

1. The diagram shows a model of a goldfish bowl. The cross section of the bowl is described by the curve with parametric equations:

$$x = 2\sin t, \quad y = 2\cos t + 2, \quad \frac{\pi}{6} \leq t \leq \frac{11\pi}{6}$$

Where the units of  $x$  and  $y$  are in cm. The bowl is formed by rotating this curve about the  $y$ -axis to form a solid of revolution.

- a) Find the volume of water required to fill the model to a height of 3cm.



- b) The real bowl has a diameter of 48cm. Find the volume of water needed to fill it to the corresponding height