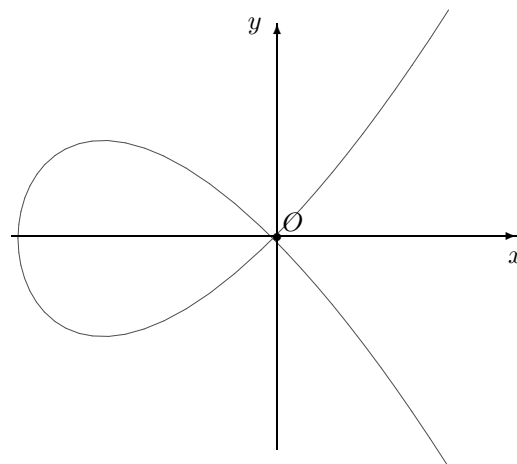


**2004 Calculus Challenge: the questions which students found hard**

**6.** Consider the curve  $\mathcal{C}$  described by the equation:  $y^2 = x^3 + x^2$ .

- (a) Find the coordinates of the points of  $\mathcal{C}$  at which the tangent lines are parallel to the  $x$ -axis.
- (b) Find the equations of the tangents to  $\mathcal{C}$  at the origin  $(0,0)$  and justify your answer.



**13.** A tank of brine has 1000 litre capacity and initially contains 50 kilograms of salt dissolved in water.

Brine is drawn from the tank at rate of 5 litres per minute and water is added to the tank at the same rate to maintain the volume of solution at 1000 litres.

The tank is well-stirred so that the concentration of salt is uniform at all times.

Let  $S$  denote the amount of salt (in kilograms) in the tank after  $t$  minutes.

- (a) What is the approximate net change  $\Delta S$  in the amount of salt in the tank in the time interval  $[t, t + \Delta t]$  if  $\Delta t$  is small?

Write your answer as a constant multiple of  $S\Delta t$ .

- (b) Write down an equation relating  $dS/dt$  and  $S$ .
- (c) How many minutes pass before there are only 25 kilograms of salt in the tank?