**9.** **In this question you must show all stages of your working.**
**Solutions relying entirely on calculator technology are not acceptable.**

A drink is put in a freezer to cool.

The temperature, $\theta°\text{C}$, of the drink, $t$ minutes after it is put in the freezer, is modelled by the differential equation

$$\frac{\mathrm{d}\theta}{\mathrm{d}t} = -k(\theta + 15)$$

where $k$ is a positive constant.

Given that the temperature of the drink when it was put in the freezer was $21°\text{C}$,

(a) solve the differential equation to show that, according to the model,

$$\theta = A\mathrm{e}^{-kt} + B$$

where $A$ and $B$ are integers to be found.

**(5)**

Given that 20 minutes after the drink is put in the freezer, its temperature is $12.9°\text{C}$,

(b) find the value of $k$, giving the answer to 3 significant figures.

**(2)**

(c) Hence find, according to the model, the temperature of the drink, one hour after it was put in the freezer. Give the answer to one decimal place.

**(2)**

**(Total for Question 9 is 9 marks)**

**10.**

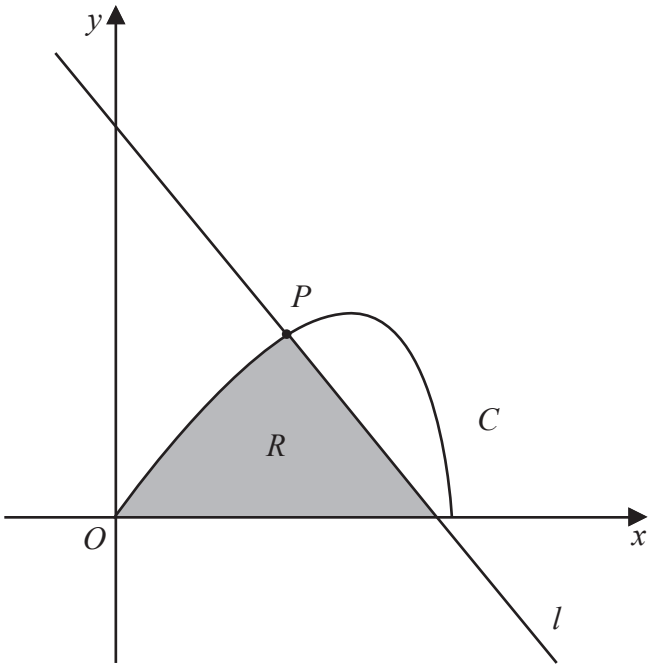



**Figure 2**

**In this question you must show all stages of your working.**
**Solutions relying entirely on calculator technology are not acceptable.**

Figure 2 shows a sketch of the curve $C$ with parametric equations

$$x = 8\cos\theta \qquad y = 5\sin 2\theta \qquad 0 \leqslant \theta \leqslant \frac{\pi}{2}$$

The point $P$ with parameter $\theta = \frac{\pi}{3}$ lies on $C$.

The line $l$ is the normal to $C$ at $P$, as shown in Figure 2.

(a) Use calculus to show that $l$ has equation

$$y = p\sqrt{3}\,x + q\sqrt{3}$$

where $p$ and $q$ are rational constants to be found.

**(4)**

The finite region $R$, shown shaded in Figure 2, is bounded by $C$, $l$ and the $x$-axis.

(b) Using algebraic integration, find the exact area of $R$, giving the answer in the form $A + B\sqrt{3}$ where $A$ and $B$ are rational constants.

**(6)**

**(Total for Question 10 is 10 marks)**

**TOTAL FOR PAPER IS 75 MARKS**