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

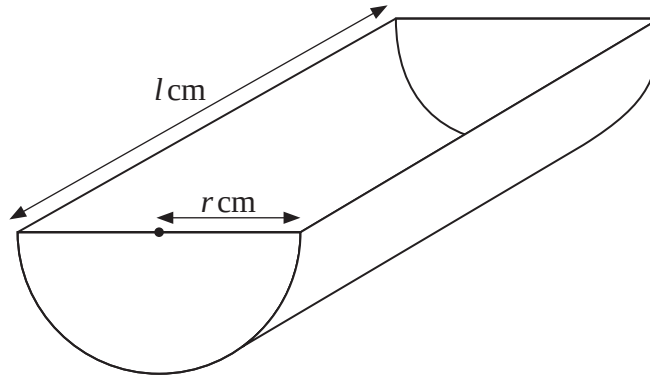

Figure 4

Figure 4 shows a design for a feeding trough.

The trough is modelled as a hollow, semicircular cylinder of radius r cm and length l cm.

The trough will be made from sheet metal of negligible thickness.

Given that the capacity of the trough will be $90\,000\pi\,\text{cm}^3$

(a) show that the total area, $A\,\text{cm}^2$, of sheet metal required to make the trough is given by

$$A = \frac{180\,000\pi}{r} + \pi r^2$$

(4)

(b) Use calculus to find the radius of the trough for which A is a minimum.

(4)

(c) Show that the radius found in part (b) gives the minimum value of A.

(2)

Given that the sheet metal costs £30 per square metre

(d) calculate the minimum cost of sheet metal required to make one trough.

(2)

(e) State one assumption you have made in calculating your answer to part (d).

(1)