1 Oskar is designing a building. Fig. 12 shows his design for the end wall and the curve of the roof. The units for x and y are metres.

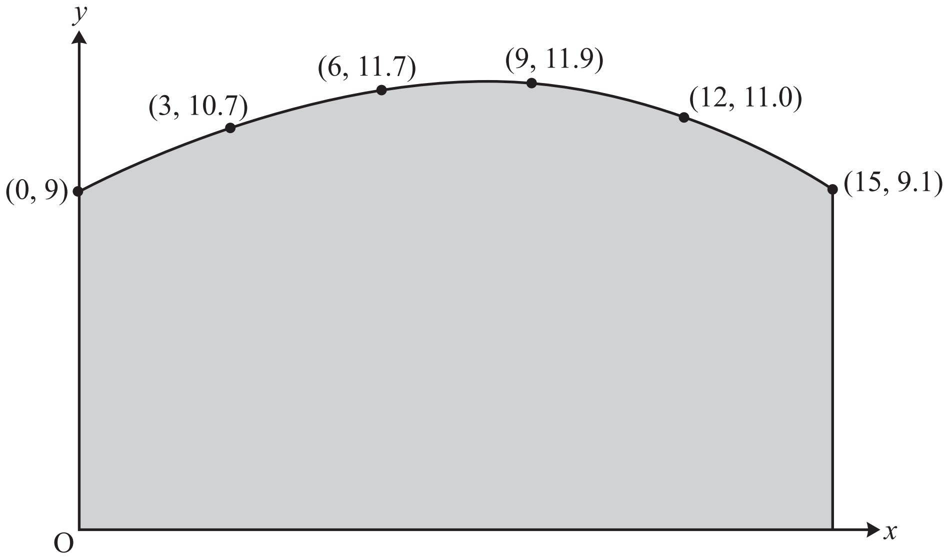


Fig. 12

(i) Use the trapezium rule with 5 strips to estimate the area of the end wall of the building. **[4]**

(ii) Oskar now uses the equation $y = -0.001x^3 - 0.025x^2 + 0.6x + 9$, for $0 \leqslant x \leqslant 15$, to model the curve of the roof.

(A) Calculate the difference between the height of the roof when $x = 12$ given by this model and the data shown in Fig. 12. **[2]**

(B) Use integration to find the area of the end wall given by this model. **[4]**

2 Fig. 7 shows a curve and the coordinates of some points on it.

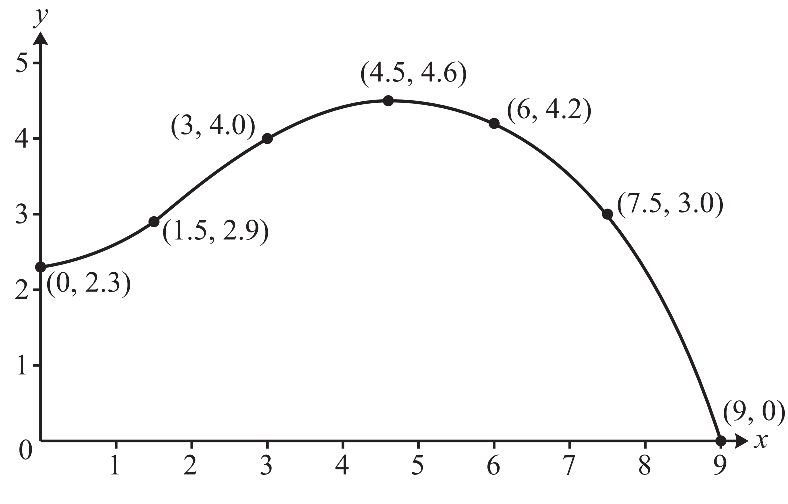


Fig. 7

Use the trapezium rule with 6 strips to estimate the area of the region bounded by the curve and the positive x- and y-axes. **[4]**

3 A farmer digs ditches for flood relief. He experiments with different cross-sections. Assume that the surface of the ground is horizontal.

(i)

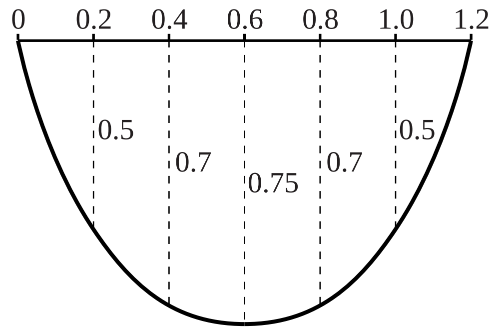


Fig. 9.1

Fig. 9.1 shows the cross-section of one ditch, with measurements in metres. The width of the ditch is 1.2 m and Fig. 9.1 shows the depth every 0.2 m across the ditch.

Use the trapezium rule with six intervals to estimate the area of cross-section. Hence estimate the volume of water that can be contained in a 50-metre length of this ditch. **[5]**

(ii) Another ditch is 0.9 m wide, with cross-section as shown in Fig. 9.2.

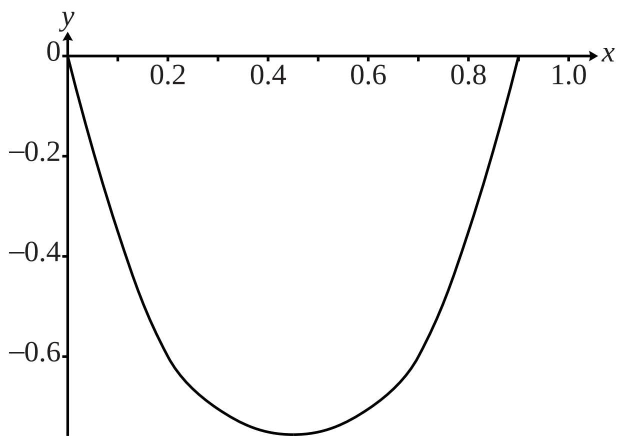


Fig. 9.2

With x- and y-axes as shown in Fig. 9.2, the curve of the ditch may be modelled closely by $y = 3.8x^4 - 6.8x^3 + 7.7x^2 - 4.2x$.

(A) The actual ditch is 0.6 m deep when $x = 0.2$. Calculate the difference between the depth given by the model and the true depth for this value of x. **[2]**

(B) Find $\int (3.8x^4 - 6.8x^3 + 7.7x^2 - 4.2x)\,dx$. Hence estimate the volume of water that can be contained in a 50-metre length of this ditch. **[5]**

4 **(a)**

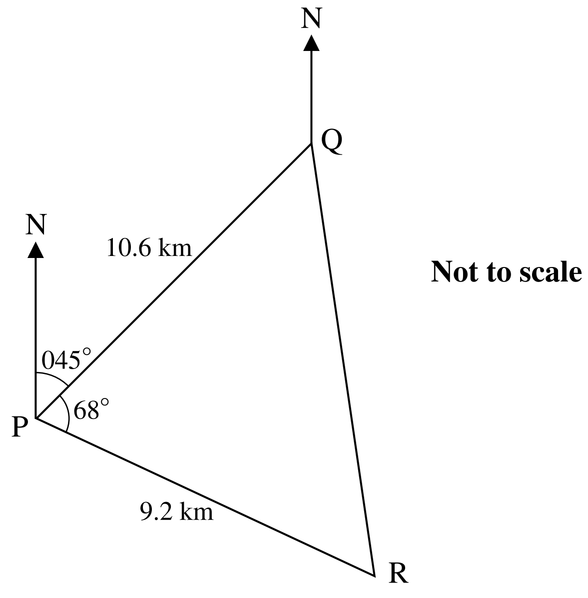
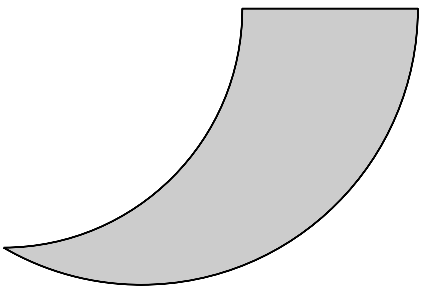


Fig. 11.1

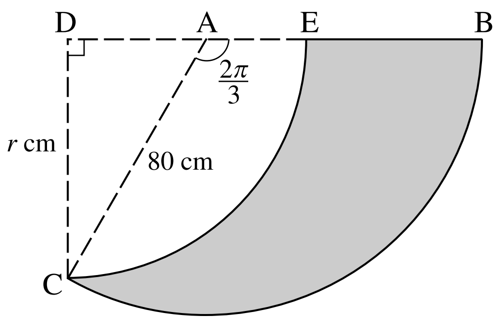
A boat travels from P to Q and then to R. As shown in Fig. 11.1, Q is 10.6 km from P on a bearing of 045°. R is 9.2 km from P on a bearing of 113°, so that angle QPR is 68°.

Calculate the distance and bearing of R from Q. **[5]**

(b) Fig. 11.2 shows the cross-section, EBC, of the rudder of a boat.



rudder



detail of construction

Fig. 11.2

BC is an arc of a circle with centre A and radius 80 cm. Angle CAB = $\frac{2\pi}{3}$ radians.

EC is an arc of a circle with centre D and radius r cm. Angle CDE is a right angle.

(i) Calculate the area of sector ABC. **[2]**

(ii) Show that $r = 40\sqrt{3}$ and calculate the area of triangle CDA. **[3]**

(iii) Hence calculate the area of cross-section of the rudder. **[3]**

5

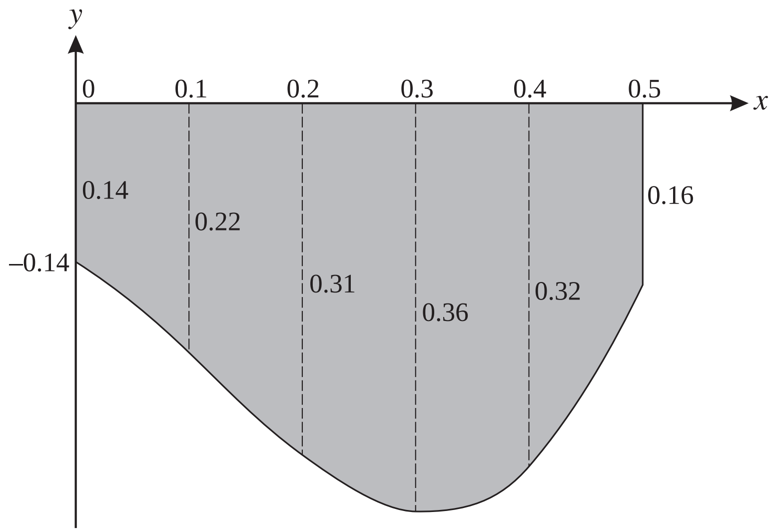


Fig. 12

A water trough is a prism 2.5 m long. Fig. 12 shows the cross-section of the trough, with the depths in metres at 0.1 m intervals across the trough. The trough is full of water.

(i) Use the trapezium rule with 5 strips to calculate an estimate of the area of cross-section of the trough.

Hence estimate the volume of water in the trough. [5]

(ii) A computer program models the curve of the base of the trough, with axes as shown and units in metres, using the equation $y = 8x^3 - 3x^2 - 0.5x - 0.15$, for $0 \leqslant x \leqslant 0.5$.

Calculate $\int_0^{0.5} (8x^3 - 3x^2 - 0.5x - 0.15)\,dx$ and state what this represents.

Hence find the volume of water in the trough as given by this model. [7]