

SETU
DEPARTMENT OF BUILT ENVIRONMENT

BEng (Honours) in Civil Engineering

QUALIFYING MATHS EXAMINATION (YEAR 1)

Examination Date	FRIDAY 29th AUGUST 2025
Starting Time	14:00
Duration	3 Hours
Examiner	Dr Ciara Fitzpatrick

INSTRUCTIONS TO CANDIDATES:

Answer all FOUR questions.

All questions carry equal marks.

Graph paper is provided.

Log tables are available.

Question 1

(a) Solve the following for x :

(i) $x^2 - 11x + 18 = 0$ [3 marks]

(ii) $x^2 - 5x + 3 = 0$ [3 marks]

(b) Solve the following for x :

(i) $\frac{2x-2}{x} \times \frac{2}{x} = 1$ [3 marks]

(ii) $\frac{1}{x+2} + \frac{x}{4} = 1$ [4 marks]

(c) For the functions $f(x) = 3x^2 + 5x - 3$ and $g(x) = 1 - 3x$

(i) On graph paper, using the same axes, plot the graphs of $f(x)$ and $g(x)$ for the domain $-3 \leq x \leq 2$.

[6 marks]

(ii) **Use the graphs** to find the solution to $3x^2 + 5x - 3 = 0$

[3 marks]

(iii) **Use the graphs** to find the solution to $3x^2 + 8x - 4 = 0$
(i.e. where $3x^2 + 5x - 3 = 1 - 3x$)

[3 marks]

[TOTAL = 25 MARKS]

Question 2

(a) Transpose the following formulae to make the symbol in square brackets the new subject:

(i) $A = \left(\frac{a+b}{2}\right)h$ [a] [2 marks]

(ii) $V = \pi r^2 h$ [r] [2 marks]

(iii) $T = 2\pi\sqrt{\frac{l}{mg}}$ [l] [3 marks]

(iv) $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ [v] [3 marks]

(b) Simplify the following:

(i) $5a^3 \times 4a^6$ [2 marks]

(ii) $\frac{\sqrt{(x^6)}}{x(3x^2)^2}$ [3 marks]

(c) Without the aid of a calculator, evaluate

$$\frac{8^7 \times 2^2}{16^5} \quad [3 \text{ marks}]$$

(d) Solve the following equations for x , giving your answer to 3 decimal places where appropriate:

(i) $e^x = 1.26$ [1 marks]

(ii) $3^x = \frac{1}{9}$ [2 marks]

(iii) $2 \log(x) = \log(5)$ [2 marks]

(iv) $\log_2(x) - \log_2(8) = 1$ [2 marks]

[TOTAL = 25 MARKS]

Question 3

- (a) Figure 3.1 shows the plan of a University campus, $ABCD$. The points C , D , and E are main doors to buildings on the campus. $[DE]$, $[DC]$ and $[EC]$ are pathways between the main doors.

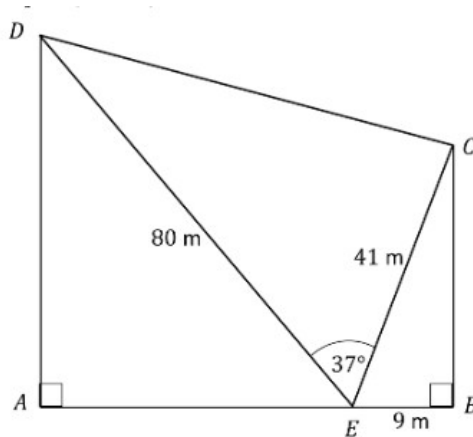


Figure 3.1 (not to scale)

- (i) Work out $|BC|$ the distance from B to C . [2 marks]
- (ii) Show that angle $\angle CEB = 77^\circ$, correct to the nearest degree. [1 marks]
- (iii) Use the size of the angle $\angle CEB = 77^\circ$ to work out $|AD|$ the distance from A to D . [3 marks]
- (iv) Calculate the area of triangle CDE . [2 marks]
- (v) Work out $|DC|$ the distance from D to C . [3 marks]

- (b) Figure 3.2 shows a triangular flag. (Note that this is NOT a right-angled triangle).

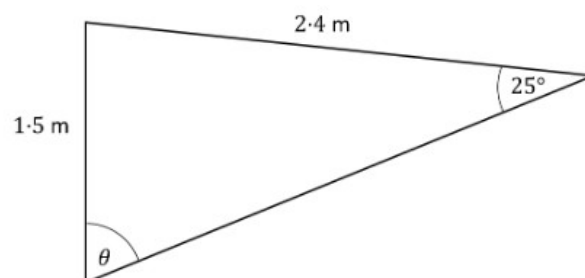


Figure 3.2 (not to scale)

Calculate the angle θ , correct to the nearest degree.

[3 marks]

(c) Figure 3.3 shows a square based pyramid.

$|AB| = |AC| = |AD| = |AE| = 10$ m and $|BC| = |CD| = |DE| = |EB| = 8$ m.

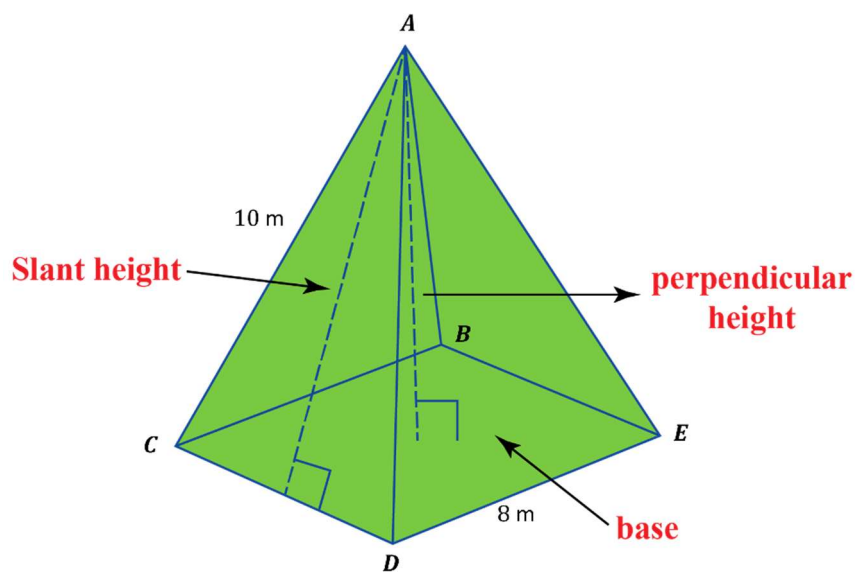


Figure 3.3 (not to scale)

- (i) Calculate the size of the angle $\angle DAE$, correct to 1 decimal place.
[3 marks]
- (ii) Work out the perpendicular height of the pyramid (i.e. the shortest distance from the apex A to the square base), correct to 1 decimal place.
[5 marks]
- (iii) Calculate the total surface area of the pyramid, correct to 1 decimal place.
[3 marks]

[TOTAL = 25 MARKS]

Question 4

(a) Differentiate the following with respect to x :

(i) $y = x^4 \cos x$ [3 marks]

(ii) $y = \frac{3x^2}{5-x}$ [3 marks]

(iii) $y = 2 \sin(5x)$ [3 marks]

(iv) $y = \ln x + 4e^{-x}$ [3 marks]

(v) $y = (8x + 1)^5$ [3 marks]

(b) The concentration of bacteria in a tank is given by the equation

$$c = 200e^{-0.05t}$$

where c is the concentration in ppm, and t is the time in hours.

- (i) Find the **rate of change** of the concentration in the tank at time $t = 3$ hours.
- (ii) State the units, and whether the concentration is increasing or decreasing.

[4 marks]

(c) The volume of water in a tank is given by the equation

$$V = 2 + 15t - 4t^2$$

where V is the volume in m^3 , and t is the time in minutes.

- (i) Find the **maximum** volume of water in the tank.
- (ii) State how you know that this must be a maximum value.

[6 marks]

[TOTAL = 25 MARKS]

END OF PAPER