

**Note**

M = method mark, A = accuracy/answer mark. Accept any equivalent correct method. Where a candidate makes an error, allow follow-through marks for subsequent work that is correct for the values used.

## Section A — Algebra (18 marks)

1. (a) Expand and simplify  $(2x - 3)(x + 5)$ . [2]

$$(2x - 3)(x + 5) = 2x^2 + 10x - 3x - 15 - M1$$

$$= 2x^2 + 7x - 15 - A1$$

**Answer:**  $2x^2 + 7x - 15$

1. (b) Factorize fully  $3x^2 - 27$ . [2]

$$3x^2 - 27 = 3(x^2 - 9) - M1$$

$$x^2 - 9 \text{ is a difference of two squares, so } x^2 - 9 = (x - 3)(x + 3) - A1$$

**Answer:**  $3(x - 3)(x + 3)$

1. (c) Simplify  $\frac{x^2 - 9}{x^2 + 7x + 12}$ . [3]

$$\text{Numerator: } x^2 - 9 = (x - 3)(x + 3) - M1$$

$$\text{Denominator: } x^2 + 7x + 12 = (x + 3)(x + 4) - M1$$

$$\frac{(x - 3)(x + 3)}{(x + 3)(x + 4)} = \frac{x - 3}{x + 4}, \text{ cancelling the common factor } (x + 3) - A1$$

**Answer:**  $\frac{x - 3}{x + 4}$

2. Solve the quadratic equation  $2x^2 - 5x - 3 = 0$ . [3]

Two numbers with product  $2 \times (-3) = -6$  and sum  $-5$  are  $-6$  and  $+1$ :

$$2x^2 - 6x + x - 3 = 0$$

$$2x(x - 3) + 1(x - 3) = 0$$

$$(2x + 1)(x - 3) = 0 - M1$$

$$2x + 1 = 0 \Rightarrow x = -\frac{1}{2} - \text{A1}$$

$$x - 3 = 0 \Rightarrow x = 3 - \text{A1}$$

(Formula method also acceptable:  $x = \frac{5 \pm \sqrt{25 + 24}}{4} = \frac{5 \pm 7}{4}$ .)

**Answer:**  $x = -\frac{1}{2}$  or  $x = 3$

**3.** Solve the simultaneous equations  $3x + 2y = 16$  and  $x - y = 3$ . **[4]**

$$3x + 2y = 16 \dots (1)$$

$$x - y = 3 \dots (2)$$

$$(2) \times 2: 2x - 2y = 6 \dots (3) - \text{M1}$$

$$(1) + (3): 5x = 22 - \text{M1}$$

$$x = \frac{22}{5} = 4.4 - \text{A1}$$

Substituting into (2):  $4.4 - y = 3$ , so  $y = 1.4 - \text{A1}$

**Answer:**  $x = 4.4, y = 1.4$

**4. (a)** Make  $r$  the subject of the formula  $V = \frac{4}{3}\pi r^3$ . **[2]**

$$3V = 4\pi r^3$$

$$r^3 = \frac{3V}{4\pi} - \text{M1}$$

$$r = \sqrt[3]{\frac{3V}{4\pi}} - \text{A1}$$

**Answer:**  $r = \sqrt[3]{\frac{3V}{4\pi}}$

**4. (b)** Solve the inequality  $5 - 2x \leq 11$ , and represent your solution on a number line. **[2]**

$$-2x \leq 11 - 5$$

$$-2x \leq 6$$

Dividing by  $-2$  reverses the inequality sign — M1

$$x \geq -3 - \text{A1}$$

Number line: a **filled (solid) circle** at  $-3$  with an arrow pointing to the right.

**Answer:**  $x \geq -3$

## Section B — Functions and Graphs (17 marks)

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5. (a) Find  $f(-2)$  where  $f(x) = 3x - 4$ . [1]

$$f(-2) = 3(-2) - 4 = -6 - 4 = -10 - \text{A1}$$

**Answer:**  $f(-2) = -10$

5. (b) Find  $fg(3)$ . [2]

$$g(3) = 3^2 + 1 = 9 + 1 = 10 - \text{M1}$$

$$f(10) = 3(10) - 4 = 30 - 4 = 26 - \text{A1}$$

**Answer:**  $fg(3) = 26$

5. (c) Find  $f^{-1}(x)$ . [3]

$$\text{Let } y = 3x - 4 - \text{M1}$$

$$y + 4 = 3x, \text{ so } x = \frac{y+4}{3} - \text{M1}$$

$$\text{Interchanging the variables: } f^{-1}(x) = \frac{x+4}{3} - \text{A1}$$

**Answer:**  $f^{-1}(x) = \frac{x+4}{3}$

6. (a) Find the coordinates of the two points where  $y = x^2 - 4x - 5$  crosses the  $x$ -axis. [2]

$$\text{At the } x\text{-axis, } y = 0: x^2 - 4x - 5 = 0$$

$$(x - 5)(x + 1) = 0 - \text{M1}$$

$$x = 5 \text{ or } x = -1 - \text{A1}$$

**Answer:** (5, 0) and (-1, 0)

6. (b) Write down the coordinates of the point where the curve crosses the  $y$ -axis. [1]

$$\text{At the } y\text{-axis, } x = 0: y = 0^2 - 4(0) - 5 = -5 - \text{A1}$$

**Answer:** (0, -5)

6. (c) Express  $x^2 - 4x - 5$  in the form  $(x - a)^2 + b$ , and state the turning point. [3]

$$x^2 - 4x = (x - 2)^2 - 4 - \text{M1}$$

$$x^2 - 4x - 5 = (x - 2)^2 - 4 - 5 = (x - 2)^2 - 9 - \text{A1}$$

$$\text{The minimum occurs when } (x - 2)^2 = 0, \text{ that is } x = 2, \text{ giving } y = -9 - \text{A1}$$

**Answer:**  $(x - 2)^2 - 9$ ; turning point (2, -9)

**6. (d)** Sketch the curve, labelling the intercepts and the turning point. **[2]**

A parabola opening upwards (positive  $x^2$  coefficient), symmetrical about the line  $x = 2$  — A1

Cutting the  $x$ -axis at  $(-1, 0)$  and  $(5, 0)$ , the  $y$ -axis at  $(0, -5)$ , with minimum point  $(2, -9)$  all labelled — A1

**Answer: upward parabola through  $(-1, 0)$ ,  $(5, 0)$ ,  $(0, -5)$  with minimum at  $(2, -9)$**

**7. (a)** Find the gradient of  $AB$ , where  $A(-1, 2)$  and  $B(3, 10)$ . **[1]**

$$m = \frac{10-2}{3-(-1)} = \frac{8}{4} = 2 \text{ — A1}$$

**Answer: gradient = 2**

**7. (b)** Find the equation of  $AB$  in the form  $y = mx + c$ . **[2]**

Using  $y - y_1 = m(x - x_1)$  with  $A(-1, 2)$  and  $m = 2$ :

$$y - 2 = 2(x + 1) \text{ — M1}$$

$$y - 2 = 2x + 2, \text{ so } y = 2x + 4 \text{ — A1}$$

(Check with  $B$ :  $2(3) + 4 = 10$ .)

**Answer:  $y = 2x + 4$**

## Section C — Geometry and Mensuration (16 marks)

8. (a) Find angle  $PQR$ , giving a reason, when reflex angle  $POR = 232^\circ$ . [2]

The reflex angle at the center and angle  $PQR$  at the circumference stand on the same arc  $PR$ , so the angle at the center is twice the angle at the circumference — M1

$$\text{angle } PQR = \frac{232^\circ}{2} = 116^\circ \text{ — A1}$$

**Answer: angle  $PQR = 116^\circ$  (the angle at the center is twice the angle at the circumference)**

8. (b)  $PQRS$  is a cyclic quadrilateral with angle  $QRS = 97^\circ$ . Find angle  $QPS$ . [2]

Opposite angles of a cyclic quadrilateral add up to  $180^\circ$  — M1

$$\text{angle } QPS = 180^\circ - 97^\circ = 83^\circ \text{ — A1}$$

**Answer: angle  $QPS = 83^\circ$  (opposite angles of a cyclic quadrilateral are supplementary)**

9. Triangles  $ABC$  and  $ADE$  are similar,  $BC \parallel DE$ ,  $AB = 6$  cm,  $AD = 15$  cm,  $BC = 8$  cm. Find  $DE$ . [3]

$$\text{Scale factor} = \frac{AD}{AB} = \frac{15}{6} = 2.5 \text{ — M1}$$

$$\frac{DE}{BC} = \frac{AD}{AB}, \text{ so } DE = 8 \times 2.5 \text{ — M1}$$

$$DE = 20 \text{ — A1}$$

**Answer:  $DE = 20$  cm**

10. (a) Calculate the volume of a cone with  $r = 5$  cm and  $h = 12$  cm. [3]

$$V = \frac{1}{3}\pi r^2 h = \frac{1}{3} \times \pi \times 5^2 \times 12 \text{ — M1}$$

$$= \frac{1}{3} \times \pi \times 25 \times 12 = 100\pi \text{ — M1}$$

$$= 100 \times 3.142 = 314.2 \text{ — A1}$$

**Answer: 314 cm<sup>3</sup> (3 s.f.)**

10. (b) Calculate the total surface area of the cone. [3]

$$\text{Slant height: } l = \sqrt{r^2 + h^2} = \sqrt{5^2 + 12^2} = \sqrt{25 + 144} = \sqrt{169} = 13 \text{ cm — M1}$$

$$\text{Total surface area} = \pi r l + \pi r^2 = \pi(5)(13) + \pi(5)^2 = 65\pi + 25\pi = 90\pi \text{ — M1}$$

$$= 90 \times 3.142 = 282.78 \text{ — A1}$$

**Answer: 283 cm<sup>2</sup> (3 s.f.)**

11. A sector has radius 9 cm and angle  $140^\circ$ . Find the arc length and the area. [3]

$$\text{Arc length} = \frac{140}{360} \times 2\pi r = \frac{7}{18} \times 2 \times \pi \times 9 = 7\pi = 21.994 - \text{M1, A1}$$

$$\text{Area} = \frac{140}{360} \times \pi r^2 = \frac{7}{18} \times \pi \times 81 = 31.5\pi = 98.973 - \text{A1}$$

**Answer: arc length = 22.0 cm; area = 99.0 cm<sup>2</sup> (3 s.f.)**

## Section D — Trigonometry (14 marks)

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**12. (a)** In triangle  $ABC$ , angle  $ABC = 90^\circ$ ,  $AB = 7.4$  cm,  $BC = 11.2$  cm. Find  $AC$ . **[2]**

By Pythagoras' theorem,  $AC^2 = AB^2 + BC^2 = 7.4^2 + 11.2^2 = 54.76 + 125.44 = 180.2$  — M1

$$AC = \sqrt{180.2} = 13.4238\dots \text{ — A1}$$

**Answer:**  $AC = 13.4$  cm (3 s.f.)

**12. (b)** Calculate the size of angle  $BAC$ . **[2]**

$$\tan(BAC) = \frac{\text{opposite}}{\text{adjacent}} = \frac{BC}{AB} = \frac{11.2}{7.4} = 1.51351\dots \text{ — M1}$$

$$\text{angle } BAC = \tan^{-1}(1.51351\dots) = 56.561\dots^\circ \text{ — A1}$$

**Answer:** angle  $BAC = 56.6^\circ$  (1 d.p.)

**13. (a)** In triangle  $PQR$ ,  $PQ = 8.3$  cm,  $QR = 12.6$  cm, angle  $PQR = 68^\circ$ . Find  $PR$ . **[3]**

$$PR^2 = PQ^2 + QR^2 - 2(PQ)(QR)\cos(PQR) \text{ — M1}$$

$$PR^2 = 8.3^2 + 12.6^2 - 2(8.3)(12.6)\cos 68^\circ$$

$$PR^2 = 68.89 + 158.76 - 209.16 \times 0.374607 = 227.65 - 78.353 = 149.297 \text{ — M1}$$

$$PR = \sqrt{149.297} = 12.2187\dots \text{ — A1}$$

**Answer:**  $PR = 12.2$  cm (3 s.f.)

**13. (b)** Calculate the area of triangle  $PQR$ . **[2]**

$$\text{Area} = \frac{1}{2}ab\sin C = \frac{1}{2} \times 8.3 \times 12.6 \times \sin 68^\circ \text{ — M1}$$

$$= 52.29 \times 0.927184 = 48.4823\dots \text{ — A1}$$

**Answer:** area = 48.5 cm<sup>2</sup> (3 s.f.)

**14. (a)**  $AB = 64$  m and the angle of elevation of  $T$  from  $A$  is  $27^\circ$ . Find the height of the mast. **[2]**

$$\tan 27^\circ = \frac{TB}{64}, \text{ so } TB = 64 \tan 27^\circ \text{ — M1}$$

$$TB = 64 \times 0.509525 = 32.6096\dots \text{ — A1}$$

**Answer:** height = 32.6 m (3 s.f.)

**14. (b)** The angle of elevation of  $T$  from  $C$  is  $41^\circ$ . Calculate  $BC$ . **[3]**

$$\tan 41^\circ = \frac{TB}{BC} \text{ — M1}$$

$$BC = \frac{TB}{\tan 41^\circ} = \frac{32.6096}{0.869287} \text{ — M1}$$

$$BC = 37.5128\dots - A_1$$

**Answer:**  $BC = 37.5 \text{ m (3 s.f.)}$

## Section E — Data Handling (15 marks)

**15. (a)** Write down the modal class. [1]

The greatest frequency is 15, which belongs to the interval  $20 < t \leq 30$  — M1

**Answer:**  $20 < t \leq 30$  **minutes**

**15. (b)** Calculate an estimate of the mean time taken. [4]

Using the mid-value of each class:

| Time, $t$ minutes | Mid-value $x$ | Frequency $f$ | $fx$ |
|-------------------|---------------|---------------|------|
| $0 < t \leq 10$   | 5             | 4             | 20   |
| $10 < t \leq 20$  | 15            | 9             | 135  |
| $20 < t \leq 30$  | 25            | 15            | 375  |
| $30 < t \leq 40$  | 35            | 12            | 420  |
| $40 < t \leq 50$  | 45            | 7             | 315  |
| $50 < t \leq 60$  | 55            | 3             | 165  |
| <b>Total</b>      |               | 50            | 1430 |

Correct mid-values 5, 15, 25, 35, 45, 55 — M1

Products  $f \times x$  formed and summed:  $\sum fx = 20 + 135 + 375 + 420 + 315 + 165 = 1430$  — M1

$$\text{Mean} = \frac{\sum fx}{\sum f} = \frac{1430}{50} \text{ — M1}$$

$$= 28.6 \text{ — A1}$$

**Answer:** **estimated mean** = 28.6 **minutes**

**15. (c)** Write down the class containing the median and explain how you decided. [2]

There are 50 values, so the median lies between the 25th and 26th values — M1

Cumulative frequencies: 4, 13, 28, 40, 47, 50. The 25th and 26th values both fall in the third class, since the cumulative frequency passes 25 there — A1

**Answer:**  $20 < t \leq 30$  **minutes**

**16.** Find the probability that a student chosen at random took more than 40 minutes. [2]

$$\text{Number taking more than 40 minutes} = 7 + 3 = 10 \text{ — M1}$$

$$P = \frac{10}{50} = \frac{1}{5} - A1$$

**Answer:**  $\frac{1}{5}$

**17. (a)** Describe the type of correlation expected. [1]

The further a student lives from school, the longer the journey tends to take — A1

**Answer: positive correlation**

**17. (b)** Explain the use of the line of best fit and state one limitation. [2]

Draw a vertical line up from 3.5 km on the horizontal axis until it meets the line of best fit, then read across horizontally to the time axis; this value is the estimated travel time — A1

Limitation (any one): the estimate is only an average trend and individual students vary because of traffic, mode of transport or route; or the line is drawn by eye, so it is not exact — A1

**Answer: read up from 3.5 km to the line, then across to the time axis; the estimate is only an average and ignores individual variation such as traffic or transport used**

**18.** The mean mass of 8 parcels is 12.5 kg. A ninth parcel of mass 17 kg is added. Find the new mean. [3]

Total mass of the 8 parcels =  $8 \times 12.5 = 100$  kg — M1

New total =  $100 + 17 = 117$  kg — M1

New mean =  $\frac{117}{9} = 13$  — A1

**Answer: 13 kg**

## Mark Allocation Summary

| Section | Topic                    | Marks     |
|---------|--------------------------|-----------|
| A       | Algebra                  | 18        |
| B       | Functions and Graphs     | 17        |
| C       | Geometry and Mensuration | 16        |
| D       | Trigonometry             | 14        |
| E       | Data Handling            | 15        |
|         | <b>Total</b>             | <b>80</b> |

**END OF MEMORANDUM**