

Dr Oliver Mathematics
OCR FMSQ Additional Mathematics
2025 Paper
2 hours

The total number of marks available is 100.

You must write down all the stages in your working.

You are permitted to use a scientific or graphical calculator in this paper.

Give your final answers to a degree of accuracy that is appropriate to the context.

1. Find the coefficient of x^3 in the expansion of (3)

$$(2 - 3x)^5.$$

2. In this question you must show detailed reasoning. (3)

Solve the inequality

$$7 < 3(x - 2) + 1 < 16.$$

3. Determine the exact value of (3)

$$x^2 - x + 5$$

when

$$x = 3 + \sqrt{2}.$$

4. Determine the equation of the tangent to the curve (4)

$$y = 4 + x + x^2$$

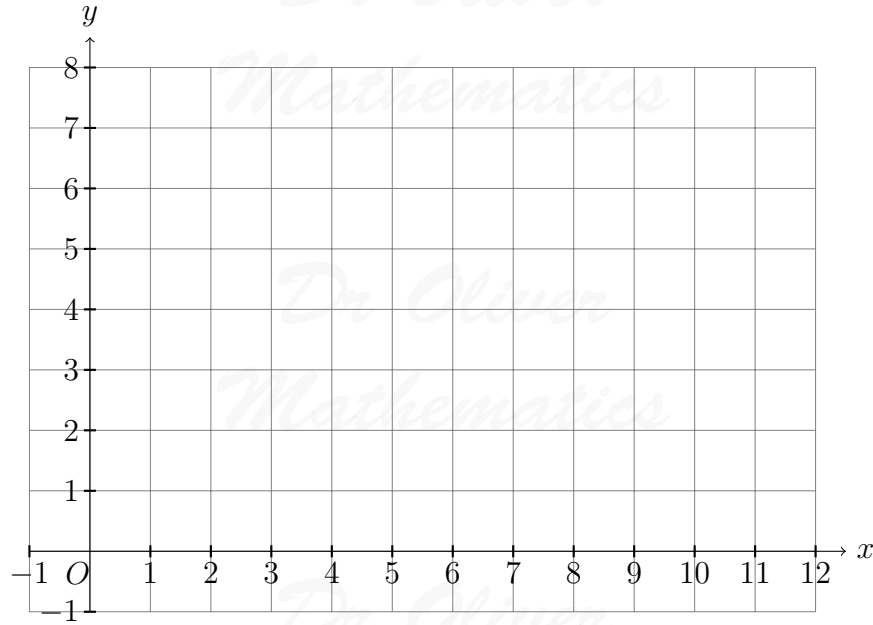
at the point $(1, 6)$.

5. (a) On the grid below, indicate the region for which the following inequalities hold. (4)
You should shade the region that is **not** satisfied by the inequalities.

$$2x + 3y \leq 12$$

$$x + 3y \geq 9$$

$$x \geq 0.$$



- (b) Write down the minimum value of (1)

$$2x + y$$

within this region.

6. A car accelerates from rest in a straight line.

At time t seconds the displacement of the car, s metres, is modelled by the equation

$$s = \frac{1}{2}t^3 - \frac{1}{24}t^4.$$

- (a) Determine the maximum velocity of the car. (6)
 (b) Describe what is happening when $t \geq 9$. (2)
7. A small club consists of 10 members. (2)
 (a) In how many ways can 4 members be chosen from the 10 members? (2)
 (b) You are given that half of the members are male and half are female.

In how many ways can 4 members be chosen so that

- (i) they are either all male or all female, (2)
 (ii) 2 are male and 2 are female? (2)
8. **In this question you must show detailed reasoning.**

- (a) Solve the simultaneous equations (4)

$$y = 2x^2 - 5x + 4 \text{ and } x + y = 2.$$

- (b) State the geometrical relationship between the graphs of (1)

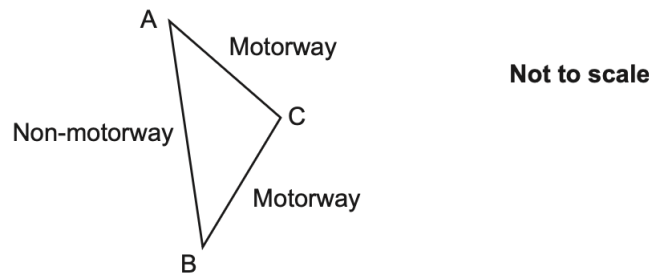
$$y = 2x^2 - 5x + 4 \text{ and } x + y = 2.$$

9. Tom plans to travel by car from a point A to a point B .

There are two routes that he can take.

- He can take either a motorway route or a non-motorway route.
- Tom models the roads used on these two routes as straight lines.
- The line AB represents the non-motorway route.
- The lines AC and CB represent the two motorways used for the motorway route.

The diagram illustrates the two routes where C is the junction of the motorways.



You are given that

- $AC = 50$ km,
- $CB = 40$ km, and
- angle $ACB = 120^\circ$.

- (a) Calculate the distance AB . (3)

In his model Tom assumes that

- he drives at a constant speed,
- he can move through the junction at C without losing speed, and
- his speed on the non-motorway route is kv where v is his speed on the motorway route, k is a constant, and $k < 1$.

- (b) Determine the value of k such that the time taken to travel each route is the same. (3)

10. In this question you must show detailed reasoning.

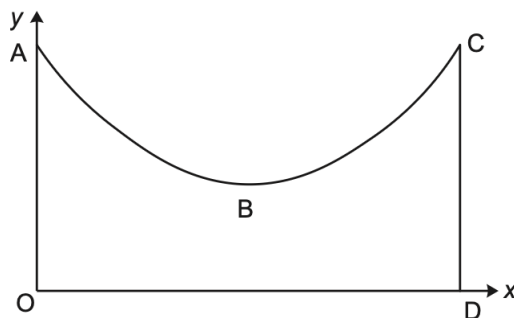
(5)

Solve the equation

$$\frac{1}{x-5} - \frac{1}{x} + \frac{5}{6} = 0.$$

11. A rectangular metal plate $OACD$ is aligned on a coordinate system such that O is the origin and A , C , and D have coordinates $(0, 16)$, $(6, 16)$, and $(6, 0)$, respectively.

A curved section ABC is removed from $OACD$ to leave the shape $OABCD$ shown in the diagram.



The curved edge ABC has equation

$$y = x^2 - 6x + 16,$$

and B is the stationary point on the curve.

- (a) By completing the square, determine the coordinates of B . (3)

- (b) The line $y = k$ is such that it cuts the **area** of the shape $OABCD$ in half. (5)

Find the value of k .

12. Heidi and Charlie have been asked to solve the equation

$$f(x) = 1.3^x - x = 0.$$

- (a) Show by sign change that $f(x) = 0$ has a root, α , in the interval $[1, 2]$. (2)

- (b) Heidi attempts to solve the equation $f(x) = 0$ using the iterative formula (2)

$$x_{r+1} = \frac{\log_{10} x_r}{\log_{10} 1.3}.$$

She starts with $x_0 = 1.4$.

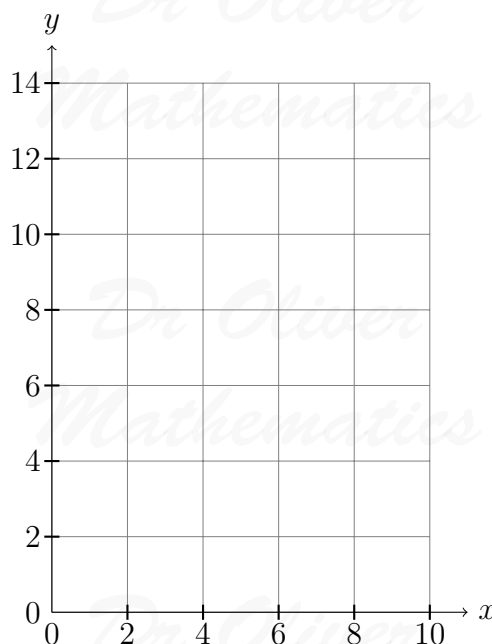
Show that the sequence derived from this iterative formula fails to find α .

- (c) Charlie attempts to solve the equation $f(x) = 0$ using the iterative formula (3)

$$x_{r+1} = 1.3^{x_r}.$$

Starting with $x_0 = 1.4$, determine the value of α correct to 3 significant figures.

- (d) (i) Plot both the curve $y = 1.3^x$ and the line $y = x$ on the grid below to show that there is another root, β , which you should identify on your graph. (4)



- (ii) Give the integer interval within which β lies. (1)
- (e) Without doing any further calculation, use your graph to explain why Charlie will not find β using his iterative formula. (2)
13. (a) You are given that (3)

$$\sin 2\theta = 0.7.$$

Find the values of θ for $0^\circ \leq \theta \leq 360^\circ$.

Give your answers correct to 1 decimal place.

- (b) Given that $0^\circ \leq \theta \leq 90^\circ$, show that (3)

$$\frac{1}{\sin^2 \theta} - \frac{1}{\tan^2 \theta} \equiv 1.$$

14. A tower AB stands vertically at a point A . (5)

- C is a point due south of A and on the same horizontal level.

- The distance AC is 55 m.
- From C the angle of elevation of B is 36° .
- D is a point due west of the tower and 15 m higher than A and C .
- The horizontal distance of D from the tower is 35 m.

Find the angle of elevation of B from D .

15. The table shows population data for a country.
 t is the number of years after 1920.

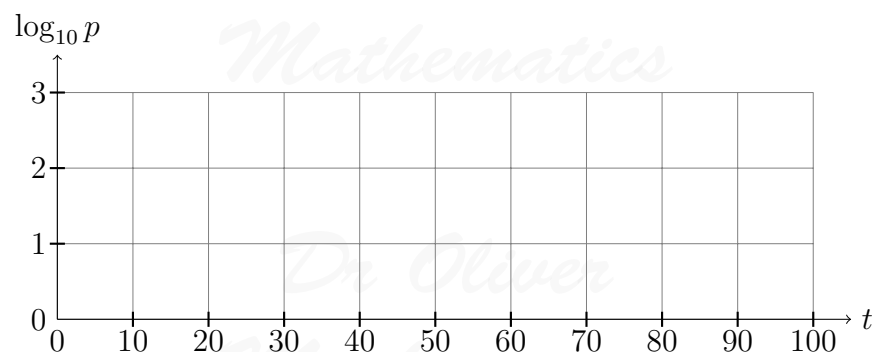
Years after 1920 (t)	0	20	40	60	80	100
Population in millions (p)	20	31.7	51.3	79.6	126.2	200

Jane believes that this population growth may be modelled by the equation

$$p = c \times 10^{kt},$$

where c and k are constants.

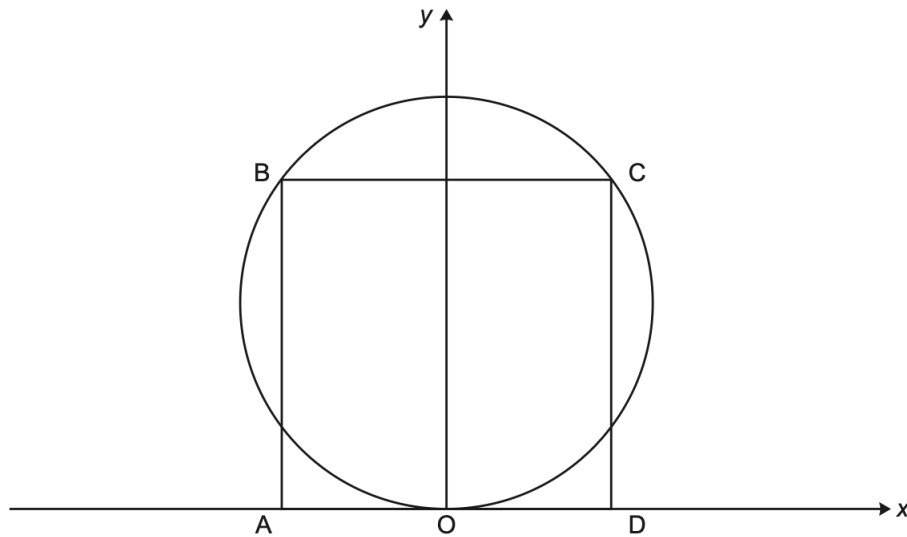
- (a) Derive an equation for $\log_{10} p$ in terms of c , k , and t . (3)
- (b) Plot the points $(t, \log_{10} p)$ for the 6 values of t on the grid. (3)
 (You may use the blank row in the table above for your values of $\log_{10} p$.)



- (c) On the grid draw a line of best fit. (1)
- (d) (i) State the value of c . (1)
 (ii) Using your line, or otherwise, estimate a value for k . (1)
- (e) According to the model what will be the population in 2040? (2)
- (f) Give a reason why this model may **not** be realistic in the long term. (1)

16. A square with vertices $ABCD$ is aligned in a coordinate system where the coordinates of A , B , C , and D are $(-8, 0)$, $(-8, 16)$, $(8, 16)$, and $(8, 0)$ respectively.

- The origin, O , is the midpoint of AD .
- A circle is such that it passes through the points B and C and touches the line AD at the origin as shown in the diagram.



- (a) the radius of the circle, (4)
- (b) the equation of the circle. (3)