Please write clearly in block capitals.

Centre number | | | | | |  Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____
I declare this is my own work.

# AS
# MATHEMATICS

## Paper 1

Thursday 16 May 2024  Afternoon  Time allowed: 1 hour 30 minutes

**Materials**
- You must have the AQA Formulae for A-level Mathematics booklet.
- You should have a graphical or scientific calculator that meets the requirements of the specification.

**Instructions**
- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer each question in the space provided for that question.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do **not** write outside the box around each page or on blank pages.
- Show all necessary working; otherwise marks for method may be lost.
- Do all rough work in this book. Cross through any work that you do not want to be marked.

**Information**
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.

**Advice**
- Unless stated otherwise, you may quote formulae, without proof, from the booklet.
- You do not necessarily need to use all the space provided.

| For Examiner's Use | |
|---|---|
| Question | Mark |
| 1 | |
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| **TOTAL** | |

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## Section A

Answer **all** questions in the spaces provided.

**1** It is given that $\tan \theta° = k$, where $k$ is a constant.

Find $\tan (\theta + 180)°$

Circle your answer.

**[1 mark]**

$-k$ $\quad$ $-\frac{1}{k}$ $\quad$ $\frac{1}{k}$ $\quad$ $k$

**2** Curve $C$ has equation $y = \frac{1}{(x-1)^2}$

State the equations of the asymptotes to curve $C$

Tick (✓) **one** box.

**[1 mark]**

$x = 0$ and $y = 0$ ☐

$x = 0$ and $y = 1$ ☐

$x = 1$ and $y = 0$ ☐

$x = 1$ and $y = 1$ ☐

Do not write outside the box

**3** Express $\dfrac{\sqrt{3}+3\sqrt{5}}{\sqrt{5}-\sqrt{3}}$ in the form $a+\sqrt{b}$, where $a$ and $b$ are integers.

Fully justify your answer.

**[4 marks]**

**Turn over for the next question**

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**4 (a) (i)** By using a suitable trigonometric identity, show that the equation

$$\sin\theta \tan\theta = 4\cos\theta$$

can be written as

$$\tan^2\theta = 4$$

**[1 mark]**

**4 (a) (ii)** Hence solve the equation

$$\sin\theta \tan\theta = 4\cos\theta$$

where $0° < \theta < 360°$

Give your answers to the nearest degree.

**[3 marks]**

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**4 (b)** Deduce all solutions of the equation

$$\sin 3\alpha \tan 3\alpha = 4 \cos 3\alpha$$

where $0° < \alpha < 180°$

Give your answers to the nearest degree.

**[3 marks]**

**Turn over for the next question**

Do not write outside the box

**5** A student is looking for factors of the polynomial $f(x)$

They suggest that $(x - 2)$ is a factor of $f(x)$

The method they use to check this suggestion is to calculate $f(-2)$
They correctly calculate that $f(-2) = 0$

They conclude that their suggestion is correct.

**5 (a)** Make **one** comment about the student's **method**.

**[1 mark]**

_____

_____

_____

**5 (b)** Make **two** comments about the student's **conclusion**.

**[2 marks]**

1 _____

_____

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2 _____

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**6** Determine the set of values of $x$ which satisfy the inequality

$$3x^2 + 3x > x + 6$$

Give your answer in exact form using set notation.

**[4 marks]**

**Turn over for the next question**

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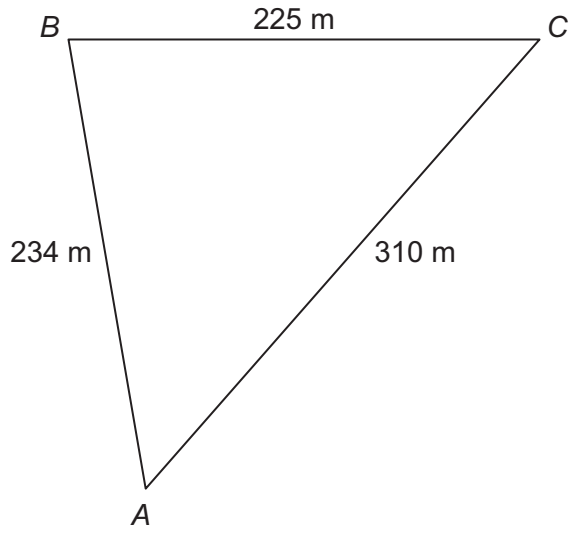
**7** A triangular field of grass, *ABC*, has boundaries with lengths as follows:

$AB = 234$ m $\quad BC = 225$ m $\quad AC = 310$ m

The field is shown in the diagram below.




**7 (a)** Find angle *A*

**[2 marks]**

Do not write outside the box

**7 (b)** Farmers calculate the number of sheep they can keep in a field, by allowing one sheep for every 1200 $m^2$ of grass.

Find the maximum number of sheep which can be kept in the field *ABC*

**[3 marks]**

**Turn over for the next question**

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**8** It is given that

$$\ln x - \ln y = 3$$

**8 (a)** Express $x$ in terms of $y$ in a form not involving logarithms.

**[3 marks]**

**8 (b)** Given also that

$$x + y = 10$$

find the exact value of $y$ and the exact value of $x$

**[3 marks]**

Do not write outside the box

**9** A curve has equation $y = \mathrm{f}(x)$ where

$$\mathrm{f}(x) = x\,(6 - x)$$

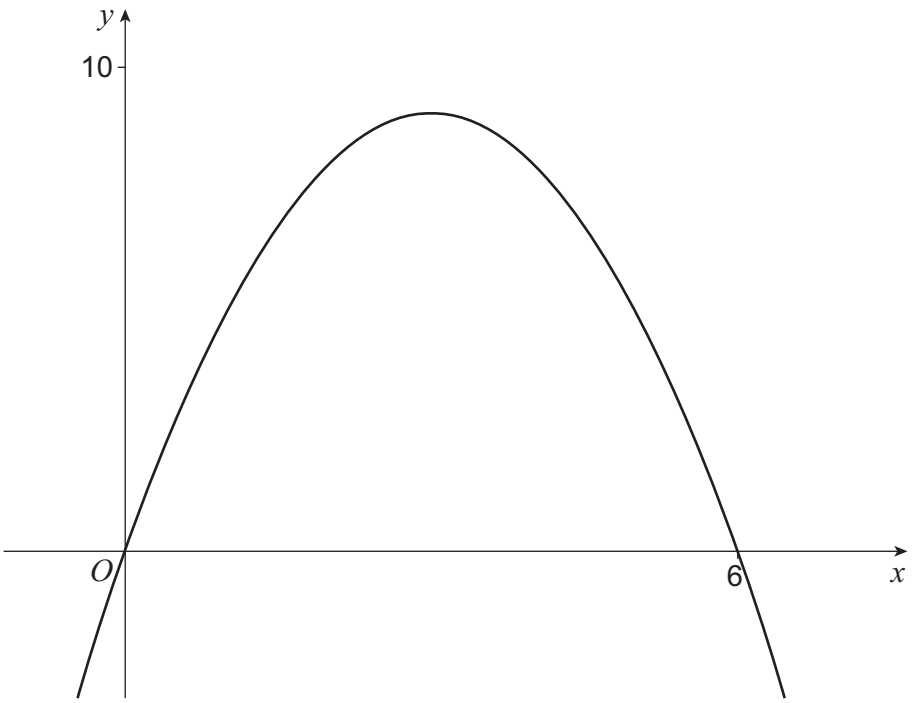
**9 (a)** Find $\mathrm{f}'(x)$

**[2 marks]**

**9 (b)** The diagram below shows the graph of $y = \mathrm{f}(x)$

On the same diagram sketch the gradient function for this curve, stating the coordinates of any points where the gradient function cuts the axes.

**[3 marks]**



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**10** It is given that

$$\frac{dy}{dx} = (x + 2)(2x - 1)^2$$

and when $x = 6$ , $y = 900$

Find $y$ in terms of $x$

**[6 marks]**

Do not write outside the box

**11** It is given that for the continuous function $g$

- $g'(1) = 0$
- $g'(4) = 0$
- $g''(x) = 2x - 5$

**11 (a)** Determine the nature of each of the turning points of $g$

Fully justify your answer.

**[3 marks]**

**11 (b)** Find the set of values of $x$ for which $g$ is an increasing function.

**[2 marks]**

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**12** The monthly mean temperature of a city, $T$ degrees Celsius, may be modelled by the equation

$$T = 15 + 8\sin(30m - 120)^\circ$$

where $m$ is the month number, counting January = 1, February = 2, through to December = 12

**12 (a)** Using this model, calculate the monthly mean temperature of the city for May, the fifth month.

**[2 marks]**

**12 (b)** Using this model, find the month with the highest mean temperature.

**[2 marks]**

**12 (c)** Climate change may affect the parameters, 8, 30, 120 and 15, used in this model.

**12 (c) (i)** State, with a reason, which parameter would be increased because of an overall rise in temperatures.

**[1 mark]**

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**12 (c) (ii)** State, with a reason, which parameter would be increased because of the occurrence of more extreme temperatures.

**[1 mark]**

_____

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**END OF SECTION A**

**Turn over for Section B**

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## Section B

Answer **all** questions in the spaces provided.

**13** A particle is moving in a straight line with constant acceleration $a$ m s$^{-2}$

The particle's velocity, $v$ m s$^{-1}$, varies with time, $t$ seconds, so that

$$v = 3 - 4t$$

Deduce the value of $a$

Circle your answer.

**[1 mark]**

$-4$ $-1$ $3$ $4$

Do not write outside the box

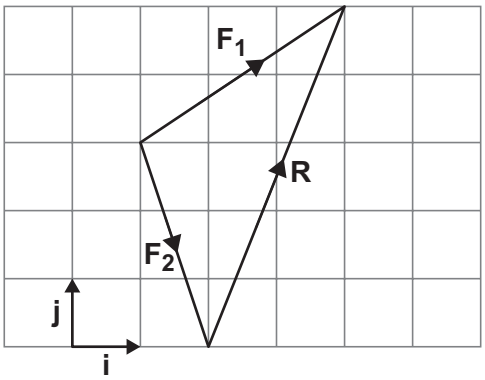
**14** Two forces, $\mathbf{F_1} = 3\mathbf{i} + 2\mathbf{j}$ newtons and $\mathbf{F_2} = \mathbf{i} - 3\mathbf{j}$ newtons, are added together to find a resultant force, **R** newtons.

This vector addition can be represented using a diagram.

Identify the diagram below which correctly represents this vector addition.

Tick (✓) **one** box.

**[1 mark]**

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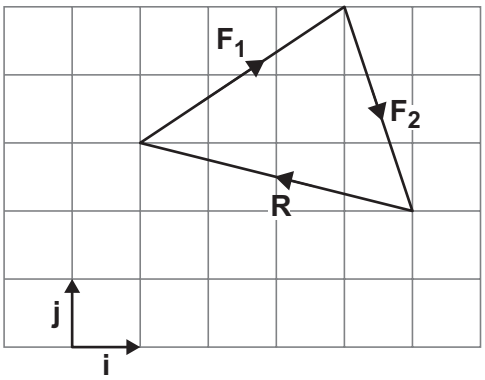


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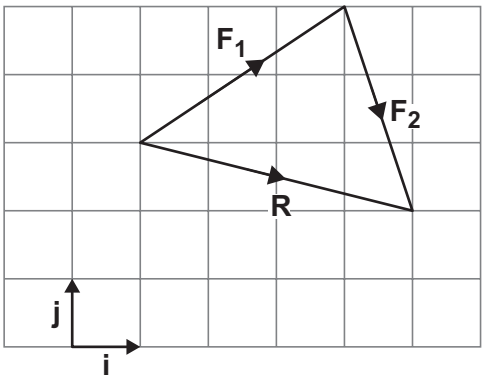


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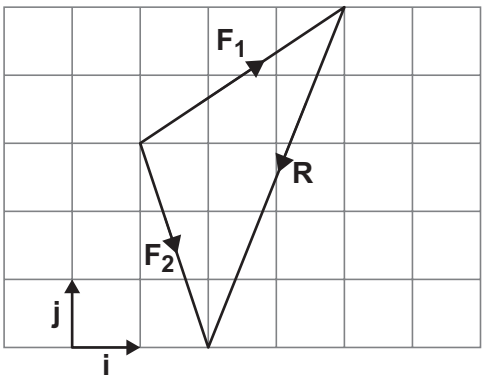


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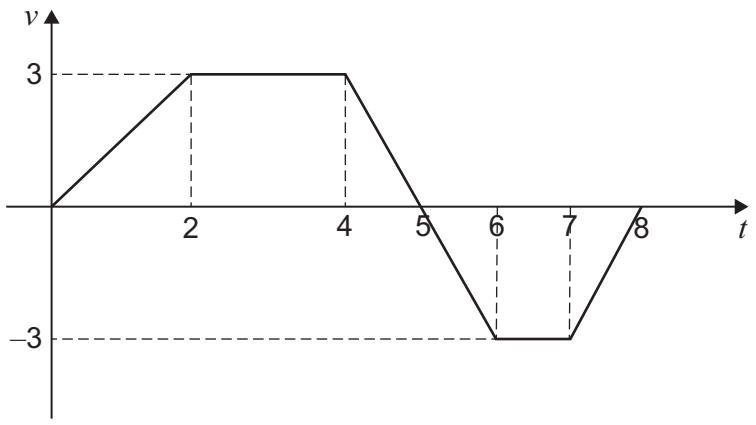
**15** A graph indicating how the velocity, $v$ m s$^{-1}$, of a particle changes with respect to time, $t$ seconds, is shown below.




**15 (a)** Find the total distance travelled by the particle over the 8 second period shown.

**[3 marks]**

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**15 (b)** A student claims that

"The displacement of the particle is less than the distance travelled."

State the range of values of $t$ for which this claim is true.

**[1 mark]**

**Turn over for the next question**

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**16** **In this question use $g = 9.8$ m s$^{-2}$**

A ball is launched vertically upwards from the Earth's surface with velocity $u$ m s$^{-1}$

The ball reaches a maximum height of 15 metres.

You may assume that air resistance can be ignored.

Find the value of $u$

**[3 marks]**

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**17** A particle moves in a straight line with acceleration $a$ m s$^{-2}$, at time $t$ seconds, where

$$a = 10 - 6t$$

The particle's velocity, $v$ m s$^{-1}$, and displacement, $r$ metres, are both initially zero.

Show that

$$r = t^2(5 - t)$$

Fully justify your answer.

**[4 marks]**

**Turn over for the next question**

Do not write outside the box

**18** It is given that two points $A$ and $B$ have position vectors

$$\overrightarrow{OA} = \begin{bmatrix} 5 \\ -1 \end{bmatrix} \text{ metres} \qquad \text{and} \qquad \overrightarrow{OB} = \begin{bmatrix} 13 \\ 5 \end{bmatrix} \text{ metres.}$$

**18 (a)** Show that the distance from $A$ to $B$ is 10 metres.

**[3 marks]**

Do not write outside the box

**18 (b)** A constant resultant force, of magnitude $R$ newtons, acts on a particle so that it moves in a straight line passing through the same two points $A$ and $B$

At $A$, the speed of the particle is 3 m $s^{-1}$ in the direction from $A$ to $B$

The particle takes 2 seconds to travel from $A$ to $B$

The mass of the particle is 150 grams.

Find the value of $R$

**[3 marks]**

**Turn over for the next question**

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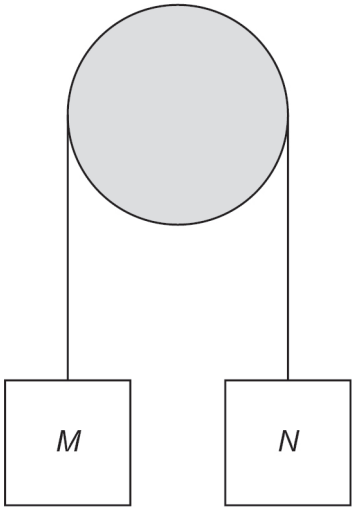
**19** Two objects, *M* and *N*, are connected by a light inextensible string that passes over a smooth peg.

*M* has a mass of 0.6 kilograms.

*N* has a mass of 0.5 kilograms.

*M* and *N* are initially held at rest, with the string taut, as shown in the diagram below.




*M* and *N* are released at the same instant and begin to move vertically.

You may assume that air resistance can be ignored.

**19 (a)** It is given that *M* and *N* move with acceleration $a$ m s$^{-2}$

By forming two equations of motion show that

$$a = \frac{1}{11}g$$

**[5 marks]**

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**19 (b)** The speed of $N$, 0.5 seconds after its release, is $\frac{g}{k}$ m s$^{-1}$ where $k$ is a constant.

Find the value of $k$

**[2 marks]**

**19 (c)** State **one** assumption that must be made for the answer in part **(b)** to be valid.

**[1 mark]**

**END OF QUESTIONS**

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**ANSWER IN THE SPACES PROVIDED**

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