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# A-level MATHEMATICS

## Paper 2

Wednesday 13 June 2018

Morning

Time allowed: 2 hours

### 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 require extra space, use an AQA supplementary answer book; do **not** use the space provided for a different question.
- 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 100.

### 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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17	
<b>TOTAL</b>	



**Section A**Answer **all** questions in the spaces provided.**1** Which of these statements is correct?Tick **one** box.**[1 mark]**

$x = 2 \Rightarrow x^2 = 4$

$x^2 = 4 \Rightarrow x = 2$

$x^2 = 4 \Leftrightarrow x = 2$

$x^2 = 4 \Rightarrow x = -2$

**2** Find the coefficient of  $x^2$  in the expansion of  $(1 + 2x)^7$ 

Circle your answer.

**[1 mark]**

42

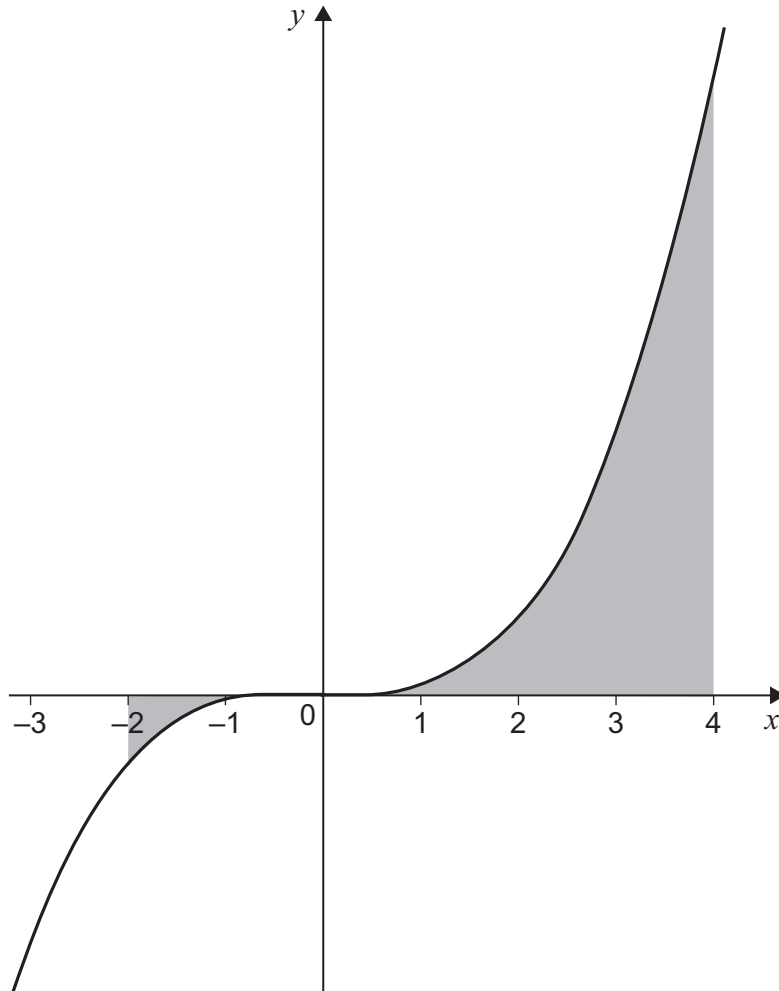
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21

84



3

The graph of  $y = x^3$  is shown.

Find the total shaded area.

Circle your answer.

**[1 mark]**

-68

60

68

128

Turn over ►

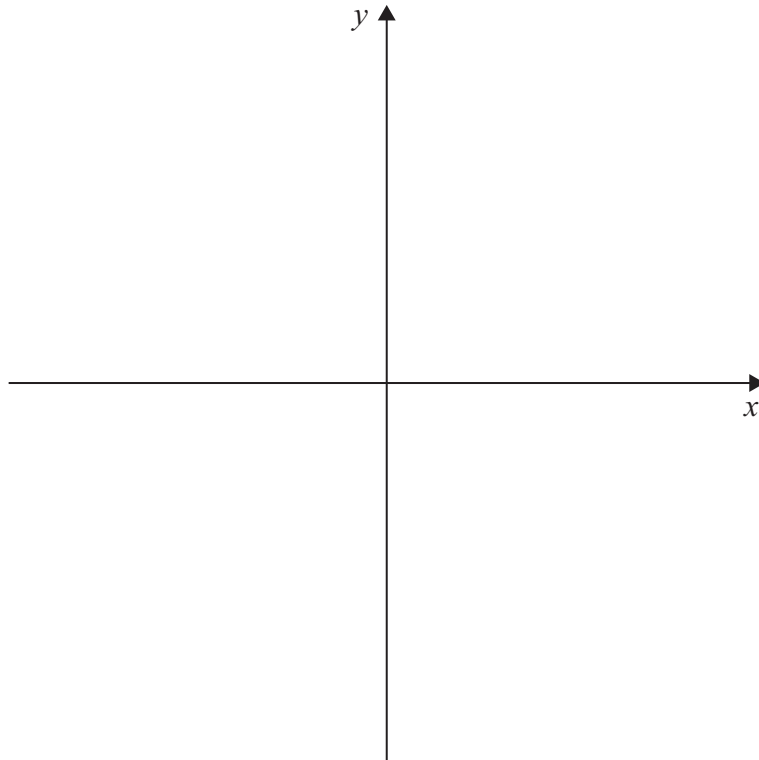


4 A curve,  $C$ , has equation  $y = x^2 - 6x + k$ , where  $k$  is a constant.

The equation  $x^2 - 6x + k = 0$  has two distinct positive roots.

4 (a) Sketch  $C$  on the axes below.

[2 marks]



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**4 (b)** Find the range of possible values for  $k$ .

Fully justify your answer.

**[4 marks]**

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**5**

Prove that 23 is a prime number.

**[2 marks]**

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**6**

Find the coordinates of the stationary point of the curve with equation

$$(x + y - 2)^2 = e^y - 1$$

**[7 marks]**

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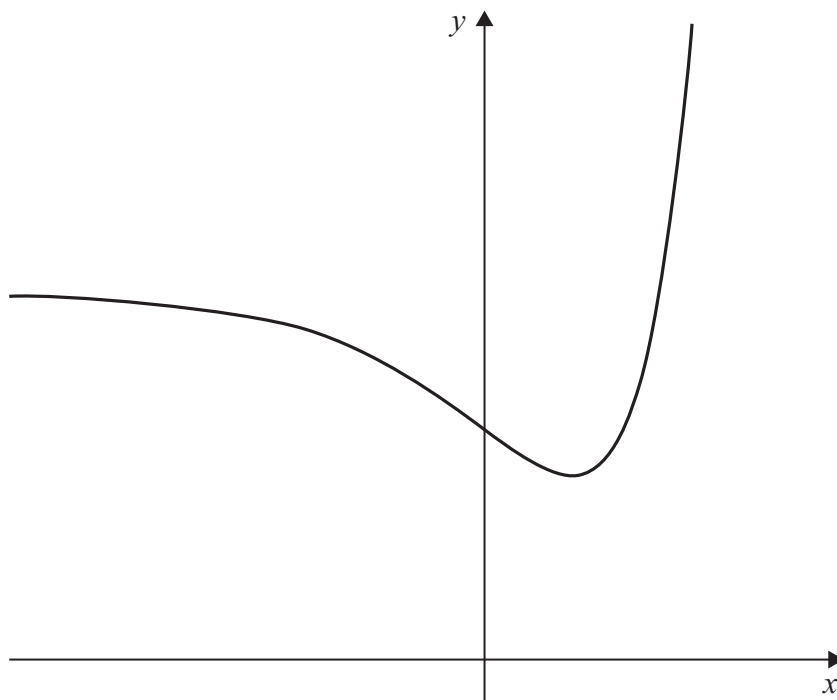
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7 A function  $f$  has domain  $\mathbb{R}$  and range  $\{y \in \mathbb{R} : y \geq e\}$

The graph of  $y = f(x)$  is shown.



The gradient of the curve at the point  $(x, y)$  is given by  $\frac{dy}{dx} = (x - 1)e^x$

Find an expression for  $f(x)$ .

Fully justify your answer.

**[8 marks]**

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**Turn over for the next question**

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**8 (a)** Determine a sequence of transformations which maps the graph of  $y = \sin x$  onto the graph of  $y = \sqrt{3} \sin x - 3 \cos x + 4$

Fully justify your answer.

[7 marks]

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8 (b) (i) Show that the least value of  $\frac{1}{\sqrt{3}\sin x - 3\cos x + 4}$  is  $\frac{2 - \sqrt{3}}{2}$

[2 marks]

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8 (b) (ii) Find the greatest value of  $\frac{1}{\sqrt{3}\sin x - 3\cos x + 4}$

[1 mark]

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Turn over for the next question

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**9** A market trader notices that daily sales are dependent on two variables:

number of hours,  $t$ , after the stall opens

total sales,  $x$ , in pounds since the stall opened.

The trader models the rate of sales as directly proportional to  $\frac{8-t}{x}$

After two hours the rate of sales is £72 per hour and total sales are £336

**9 (a)** Show that

$$x \frac{dx}{dt} = 4032(8 - t)$$

**[3 marks]**

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**9 (b)** Hence, show that

$$x^2 = 4032t(16 - t)$$

**[3 marks]**

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**Question 9 continues on the next page**

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**9 (c)** The stall opens at 09.30.

**9 (c) (i)** The trader closes the stall when the rate of sales falls below £24 per hour.

Using the results in parts (a) and (b), calculate the earliest time that the trader closes the stall.

[6 marks]

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**9 (c) (ii)** Explain why the model used by the trader is not valid at 09.30.

**[2 marks]**

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**Turn over for Section B**

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**Section B**

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

- 10** A garden snail moves in a straight line from rest to  $1.28 \text{ cm s}^{-1}$ , with a constant acceleration in 1.8 seconds.

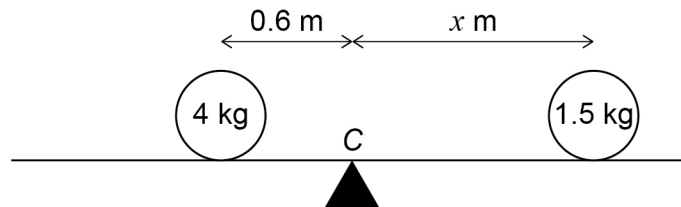
Find the acceleration of the snail.

Circle your answer.

[1 mark]

$2.30 \text{ ms}^{-2}$        $0.71 \text{ ms}^{-2}$        $0.0071 \text{ ms}^{-2}$        $0.023 \text{ ms}^{-2}$

- 11** A uniform rod,  $AB$ , has length 4 metres.  
The rod is resting on a support at its midpoint  $C$ .  
A particle of mass 4 kg is placed 0.6 metres to the left of  $C$ .  
Another particle of mass 1.5 kg is placed  $x$  metres to the right of  $C$ , as shown.



The rod is balanced in equilibrium at  $C$ .

Find  $x$ .

Circle your answer.

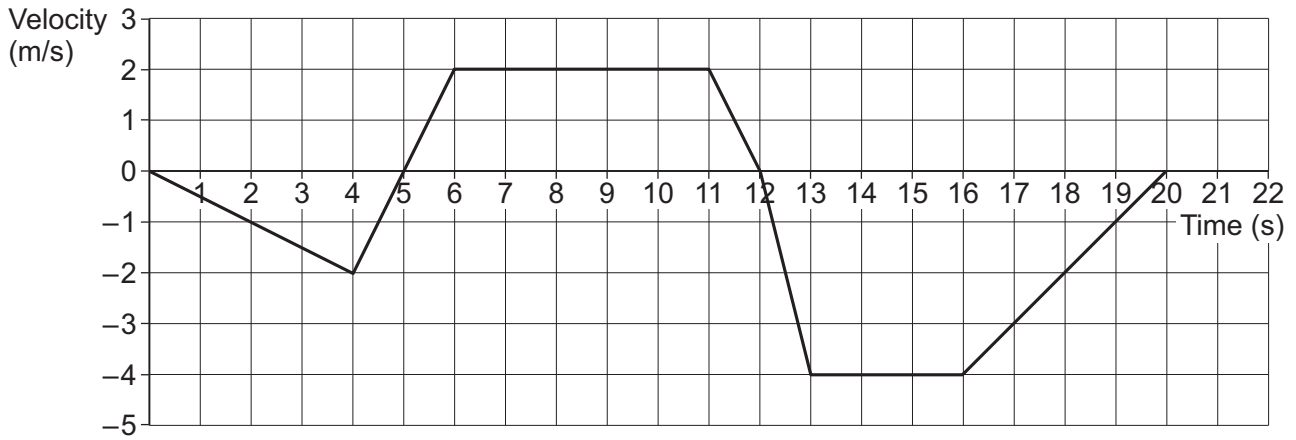
[1 mark]

1.8 m      1.5 m      1.75 m      1.6 m





**12** The graph below shows the velocity of an object moving in a straight line over a 20 second journey.



**12 (a)** Find the maximum magnitude of the acceleration of the object. **[1 mark]**

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**12 (b)** The object is at its starting position at times 0,  $t_1$  and  $t_2$  seconds.  
Find  $t_1$  and  $t_2$  **[4 marks]**

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

A boy attempts to move a wooden crate of mass 20 kg along horizontal ground. The coefficient of friction between the crate and the ground is 0.85

**13 (a)** The boy applies a horizontal force of 150 N. Show that the crate remains stationary. **[3 marks]**

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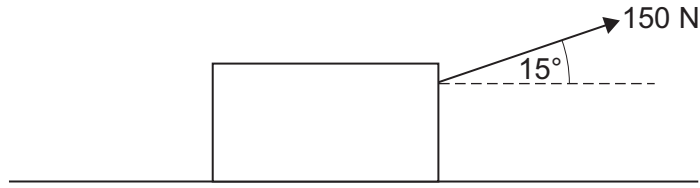
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**13 (b)**

Instead, the boy uses a handle to pull the crate forward. He exerts a force of 150 N, at an angle of  $15^\circ$  above the horizontal, as shown in the diagram.



Determine whether the crate remains stationary.

Fully justify your answer.

**[5 marks]**

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- 14** A quadrilateral has vertices  $A$ ,  $B$ ,  $C$  and  $D$  with position vectors given by

$$\vec{OA} = \begin{bmatrix} 3 \\ 5 \\ 1 \end{bmatrix}, \vec{OB} = \begin{bmatrix} -1 \\ 2 \\ 7 \end{bmatrix}, \vec{OC} = \begin{bmatrix} 0 \\ 7 \\ 6 \end{bmatrix} \text{ and } \vec{OD} = \begin{bmatrix} 4 \\ 10 \\ 0 \end{bmatrix}$$

- 14 (a)** Write down the vector  $\vec{AB}$

**[1 mark]**

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- 14 (b)** Show that  $ABCD$  is a parallelogram, but not a rhombus.

**[5 marks]**

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**15** A driver is road-testing two minibuses, A and B, for a taxi company.

The performance of each minibus along a straight track is compared.

A flag is dropped to indicate the start of the test.

Each minibus starts from rest.

The acceleration in  $\text{m s}^{-2}$  of each minibus is modelled as a function of time,  $t$  seconds, after the flag is dropped:

$$\text{The acceleration of A} = 0.138t^2$$

$$\text{The acceleration of B} = 0.024t^3$$

**15 (a)** Find the time taken for A to travel 100 metres.

Give your answer to four significant figures.

**[4 marks]**

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**15 (b)** The company decides to buy the minibus which travels 100 metres in the shortest time.

Determine which minibus should be bought.

**[4 marks]**

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**15 (c)** The models assume that both minibuses start moving immediately when  $t = 0$   
In light of this, explain why the company may, in reality, make the wrong decision.

**[1 mark]**

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**16** In this question use  $g = 9.81 \text{ m s}^{-2}$

A particle is projected with an initial speed  $u$ , at an angle of  $35^\circ$  above the horizontal.

It lands at a point 10 metres vertically below its starting position.

The particle takes 1.5 seconds to reach the highest point of its trajectory.

**16 (a)** Find  $u$ .

**[3 marks]**

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**16 (b)** Find the total time that the particle is in flight.

**[3 marks]**

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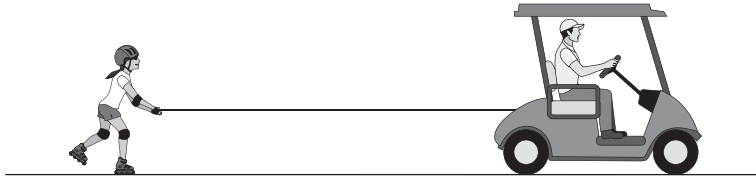
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17

A buggy is pulling a roller-skater, in a straight line along a horizontal road, by means of a connecting rope as shown in the diagram.



The combined mass of the buggy and driver is 410 kg  
A driving force of 300 N and a total resistance force of 140 N act on the buggy.

The mass of the roller-skater is 72 kg  
A total resistance force of  $R$  newtons acts on the roller-skater.

The buggy and the roller-skater have an acceleration of  $0.2 \text{ ms}^{-2}$

17 (a) (i) Find  $R$ .

[3 marks]

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**17 (a) (ii)** Find the tension in the rope.

**[3 marks]**

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**17 (b)** State a necessary assumption that you have made.

**[1 mark]**

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**Question 17 continues on the next page**

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**17 (c) (ii)** Explain the change in motion that the driver noticed.

**[2 marks]**

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**END OF QUESTIONS**



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