



**Surname** \_\_\_\_\_

**Other Names** \_\_\_\_\_

**Centre Number** \_\_\_\_\_

**Candidate Number** \_\_\_\_\_

**Candidate Signature** \_\_\_\_\_

**I declare this is my own work.**

**A-level  
MATHEMATICS**

**Paper 2**

**7357/2**

**Wednesday 10 June 2020 Afternoon**

**Time allowed: 2 hours**

**At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.**

**[Turn over]**



- 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.
- Answer ALL questions.
- You must answer each question in the space provided for that question.
- Do NOT write 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 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.**

**DO NOT TURN OVER UNTIL TOLD TO DO SO**



**SECTION A**

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

- 1 Which one of these functions is decreasing for all real values of  $x$ ?**

**Circle your answer. [1 mark]**

$$f(x) = e^x$$

$$f(x) = -e^{1-x}$$

$$f(x) = -e^{x-1}$$

$$f(x) = -e^{-x}$$



**2** Which one of the following equations has no real solutions?

**Tick (✓) ONE box. [1 mark]**

**$\cot x = 0$**

**$\ln x = 0$**

**$|x + 1| = 0$**

**$\sec x = 0$**

**[Turn over]**





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**[Turn over]**



4 Using small angle approximations, show that for small, non-zero, values of  $x$

$$\frac{x \tan 5x}{\cos 4x - 1} \approx A$$

where  $A$  is a constant to be determined. [4 marks]

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**5** Use integration by substitution to show that

$$\int_{-\frac{1}{4}}^6 x\sqrt{4x+1} dx = \frac{875}{12}$$

**Fully justify your answer.  
[6 marks]**

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**6** The line  $L$  has equation

$$5y + 12x = 298$$

A circle,  $C$ , has centre  $(7, 9)$

$L$  is a tangent to  $C$ .

**6 (a)** Find the coordinates of the point of intersection of  $L$  and  $C$ .

**Fully justify your answer.**  
**[5 marks]**

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7  $a$  and  $b$  are two positive irrational numbers.

The sum of  $a$  and  $b$  is rational.

The product of  $a$  and  $b$  is rational.

Caroline is trying to prove  $\frac{1}{a} + \frac{1}{b}$  is rational.

Here is her proof:

Step 1  $\frac{1}{a} + \frac{1}{b} = \frac{2}{a+b}$

Step 2 2 is rational and  $a + b$  is non-zero and rational.

Step 3 Therefore  $\frac{2}{a+b}$  is rational.

Step 4 Hence  $\frac{1}{a} + \frac{1}{b}$  is rational.



**7 (a) (i) Identify Caroline's mistake.  
[1 mark]**

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**[Turn over]**

7 (a) (ii) Write down a correct version of the proof. [2 marks]

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**7 (b) Prove by contradiction that the difference of any rational number and any irrational number is irrational. [4 marks]**

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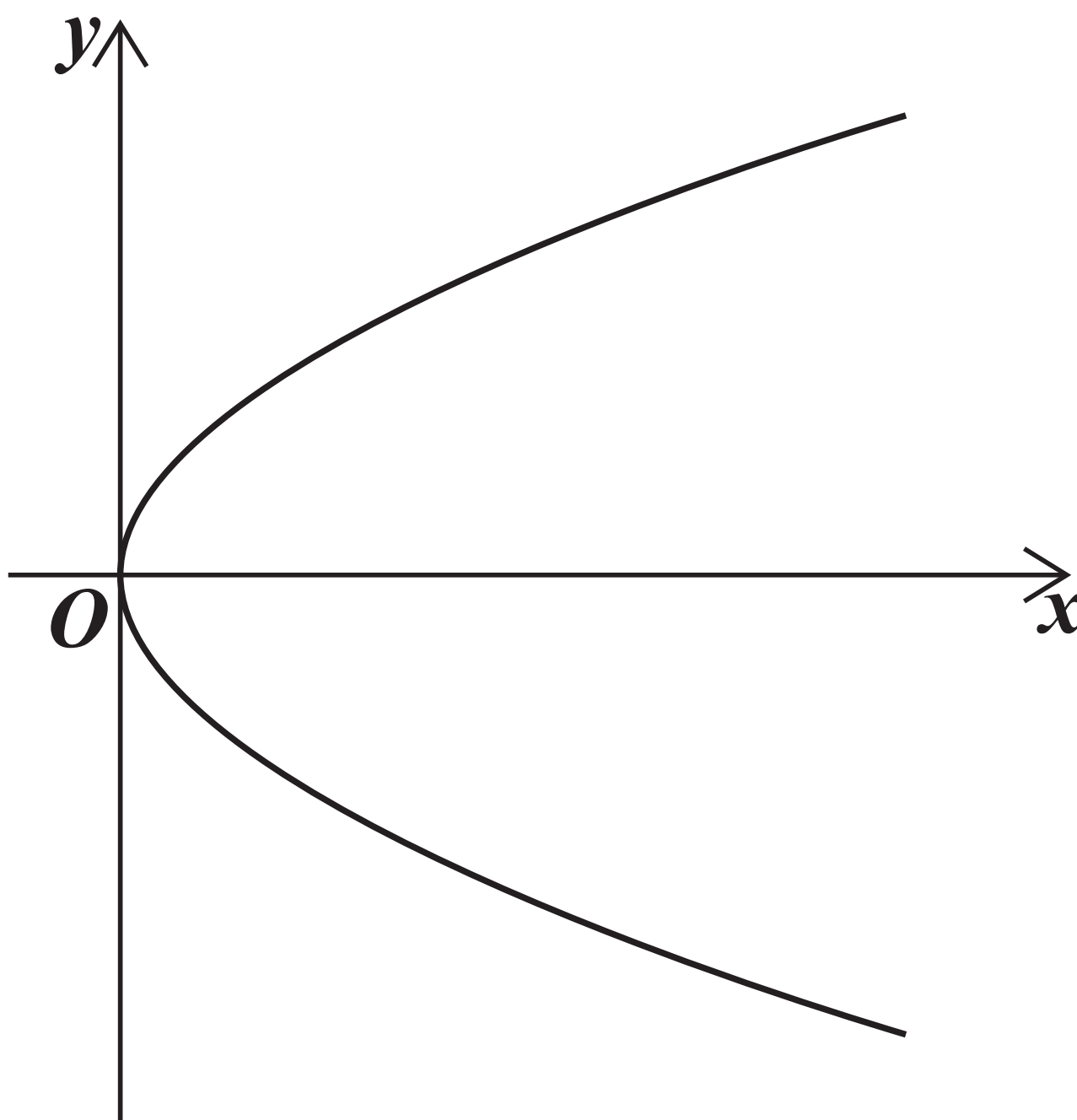
- 8 The curve defined by the parametric equations

$$x = t^2 \quad \text{and} \quad y = 2t$$

$$-\sqrt{2} \leq t \leq \sqrt{2}$$

is shown in FIGURE 1 below.

FIGURE 1



- 8 (a) Find a Cartesian equation of the curve in the form  $y^2 = f(x)$   
[2 marks]

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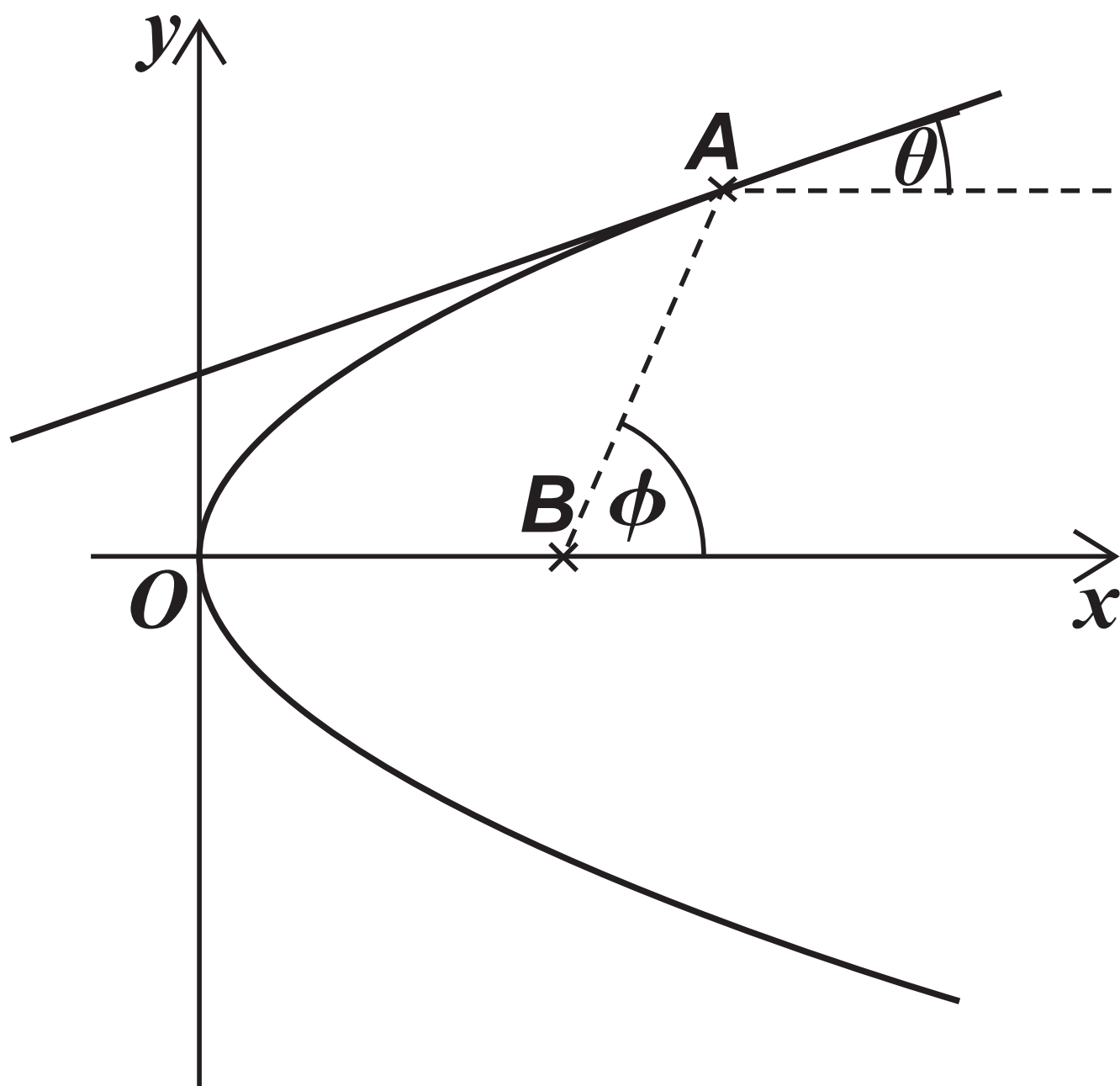


8(b) The point  $A$  lies on the curve where  $t = a$

The tangent to the curve at  $A$  is at an angle  $\theta$  to a line through  $A$  parallel to the  $x$ -axis.

The point  $B$  has coordinates  $(1, 0)$

The line  $AB$  is at an angle  $\phi$  to the  $x$ -axis.













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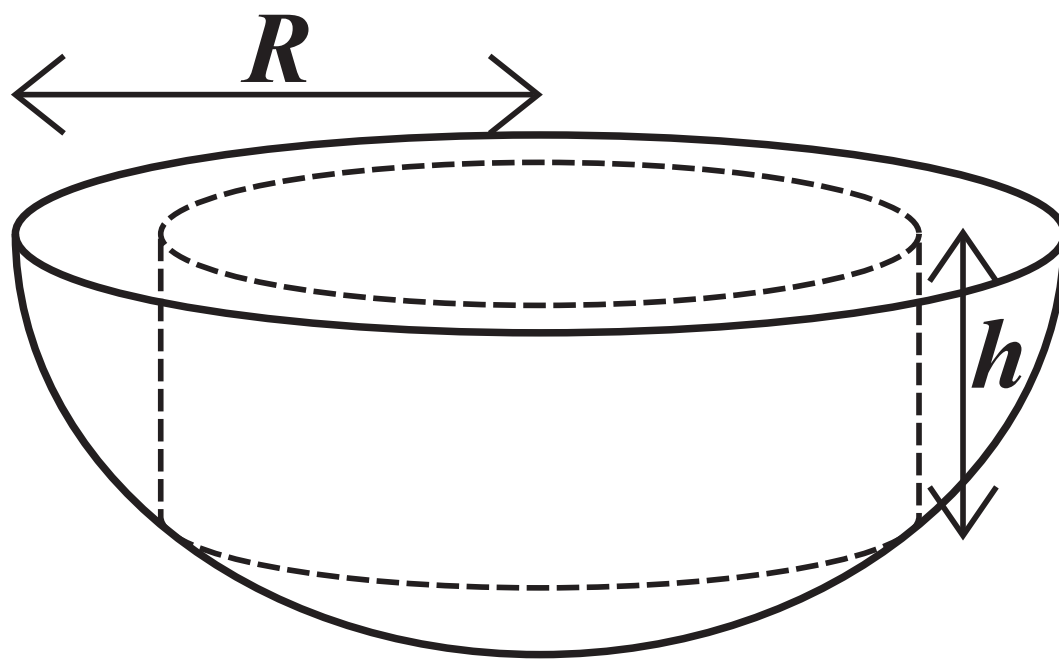
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9 A cylinder is to be cut out of the circular face of a solid hemisphere.

The cylinder and the hemisphere have the same axis of symmetry.

The cylinder has height  $h$  and the hemisphere has a radius of  $R$ .













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**[Turn over]**

**SECTION B**

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



**10** A vehicle is driven at a constant speed of  $12 \text{ m s}^{-1}$  along a straight horizontal road.

**Only one of the statements below is correct.**

**Identify the correct statement.**

**Tick (✓) ONE box. [1 mark]**

The vehicle is accelerating

The vehicle's driving force exceeds the total force resisting its motion

The resultant force acting on the vehicle is zero

The resultant force acting on the vehicle is dependent on its mass

**[Turn over]**



11 A number of forces act on a particle such that the resultant

force is  $\begin{pmatrix} 6 \\ -3 \end{pmatrix}$  N

One of the forces acting on the

particle is  $\begin{pmatrix} 8 \\ -5 \end{pmatrix}$  N



**45**

**Calculate the total of the other forces acting on the particle.**

**Circle your answer. [1 mark]**

$$\begin{pmatrix} 2 \\ -2 \end{pmatrix} \text{ N}$$

$$\begin{pmatrix} 14 \\ -8 \end{pmatrix} \text{ N}$$

$$\begin{pmatrix} -2 \\ 2 \end{pmatrix} \text{ N}$$

$$\begin{pmatrix} -14 \\ 8 \end{pmatrix} \text{ N}$$

**[Turn over]**



12

A particle,  $P$ , is moving with constant velocity  $8\mathbf{i} - 12\mathbf{j}$

A second particle,  $Q$ , is moving with constant velocity  $a\mathbf{i} + 9\mathbf{j}$

$Q$  travels in a direction which is parallel to the motion of  $P$ .

Find  $a$ .

Circle your answer. [1 mark]

-6

-5

5

6



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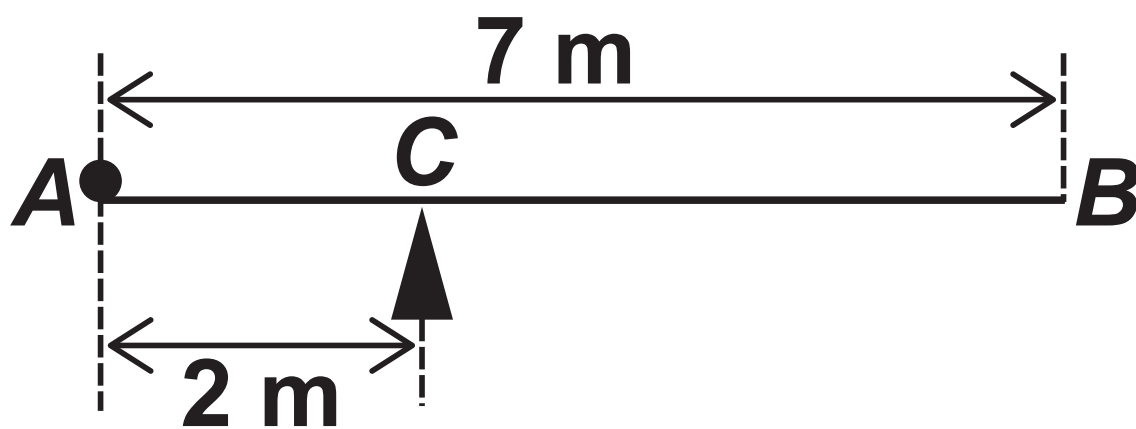
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13 A uniform rod,  $AB$ , has length 7 metres and mass 4 kilograms.

The rod rests on a single fixed pivot point,  $C$ , where  $AC = 2$  metres.

A particle of weight  $W$  newtons is fixed at  $A$ , as shown in the diagram.



The system is in equilibrium with the rod resting horizontally.

13 (a) Find  $W$ , giving your answer in terms of  $g$ . [2 marks]

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**13(b)**

**Explain how you have used the fact that the rod is uniform in part (a). [1 mark]**

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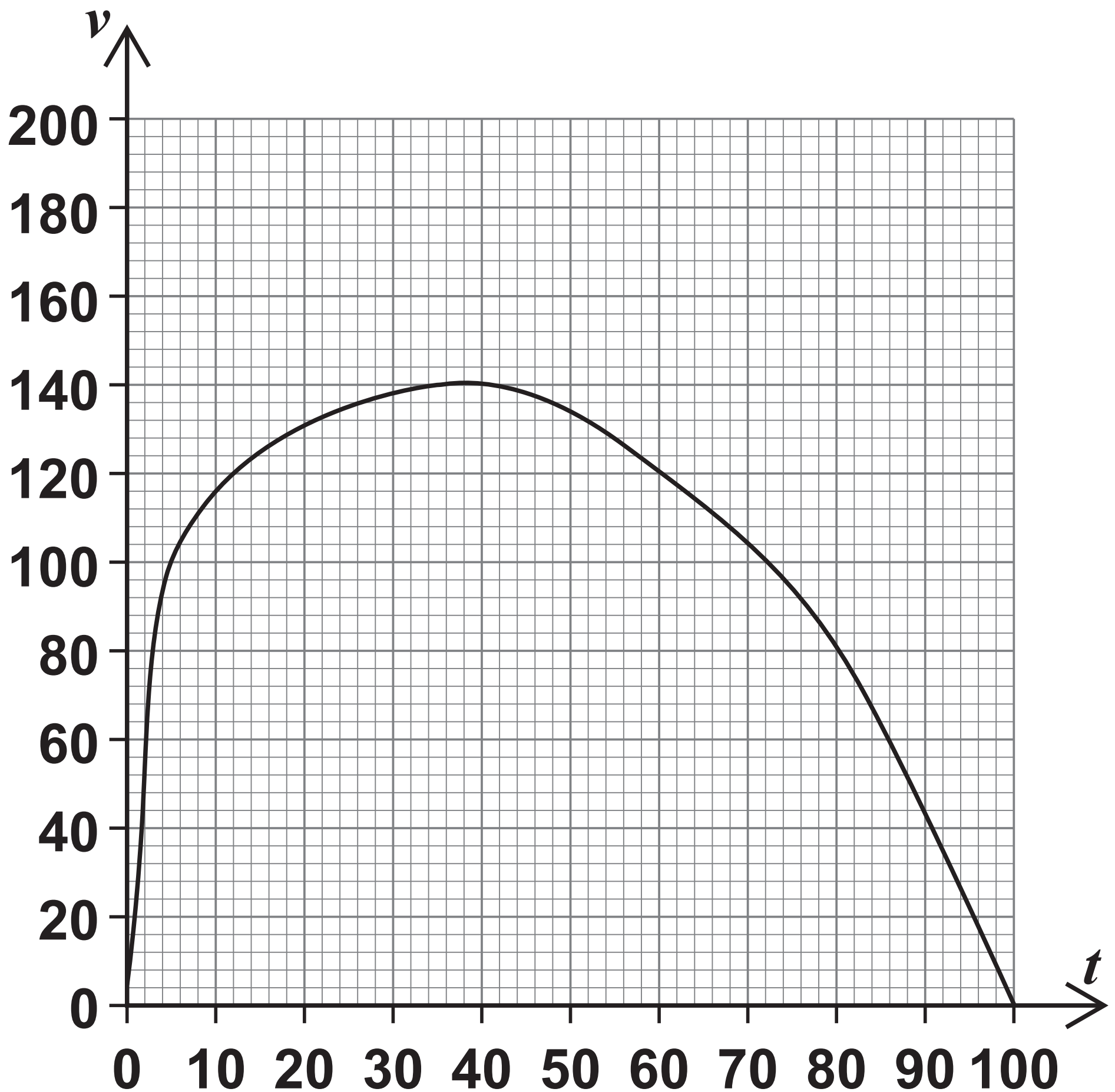
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**[Turn over]**



- 15 A particle is moving in a straight line with velocity  $v \text{ m s}^{-1}$  at time  $t$  seconds as shown by the graph below.





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**15(b) Over the same time period, the curve can be very closely modelled by a particular quadratic.**

**Explain how you could find an alternative estimate using this quadratic. [1 mark]**

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**[Turn over]**

16

Two particles  $A$  and  $B$  are released from rest from different starting points above a horizontal surface.

$A$  is released from a height of  $h$  metres.

$B$  is released at a time  $t$  seconds after  $A$  from a height of  $kh$  metres, where  $0 < k < 1$

Both particles land on the surface 5 seconds after  $A$  was released.

Assuming any resistance forces may be ignored, prove that

$$t = 5(1 - \sqrt{k})$$

Fully justify your answer.  
[5 marks]

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17 A ball is projected forward from a fixed point,  $P$ , on a horizontal surface with an initial speed  $u \text{ m s}^{-1}$ , at an acute angle  $\theta$  above the horizontal.

The ball needs to first land at a point at least  $d$  metres away from  $P$ .

You may assume the ball may be modelled as a particle and that air resistance may be ignored.

Show that

$$\sin 2\theta \geq \frac{dg}{u^2}$$

[6 marks]

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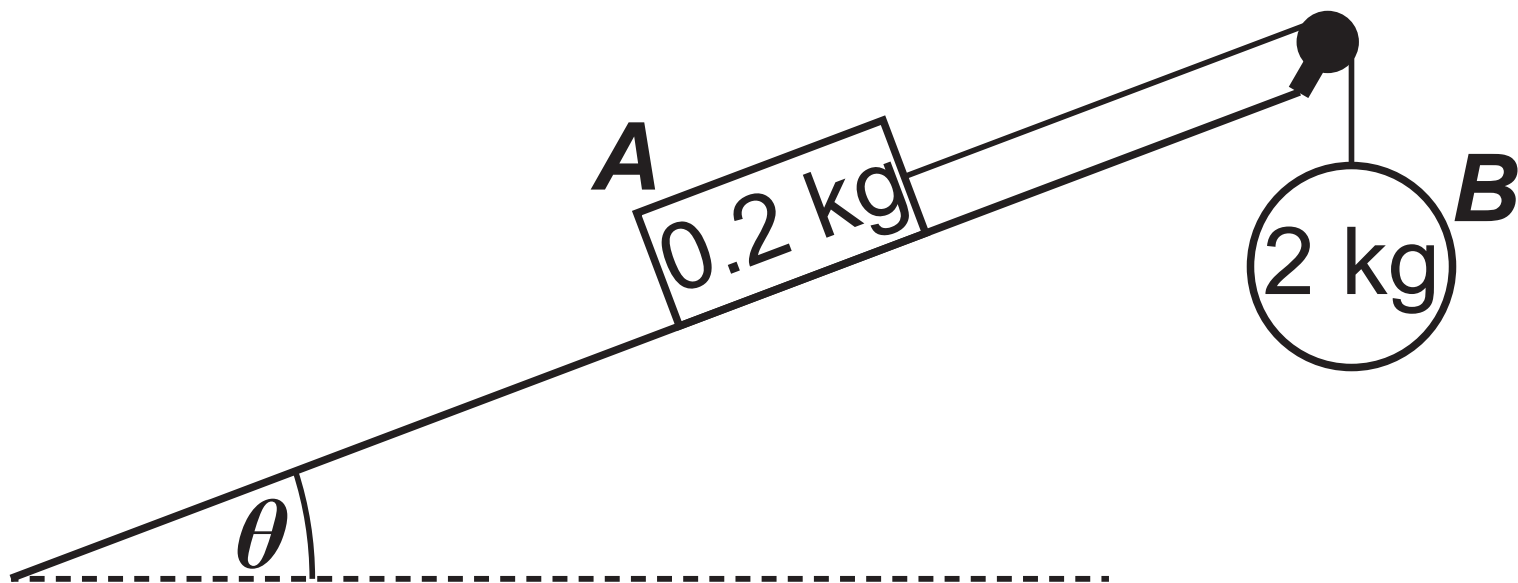
18 Block A, of mass 0.2 kg, lies at rest on a rough plane.

The plane is inclined at an angle  $\theta$  to the horizontal, such

$$\text{that } \tan \theta = \frac{7}{24}$$

A light inextensible string is attached to A and runs parallel to the line of greatest slope until it passes over a smooth fixed pulley at the top of the slope.

The other end of this string is attached to particle B, of mass 2 kg, which is held at rest so that the string is taut, as shown in the diagram below.



- 18 (a) ***B* is released from rest so that it begins to move vertically downwards with an acceleration of  $\frac{543}{625} g m s^{-2}$**

**Show that the coefficient of friction between *A* and the surface of the inclined plane is 0.17**  
**[8 marks]**

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**[Turn over]**



**18 (b) IN THIS QUESTION USE**

$$g = 9.81 \text{ M S}^{-2}$$

**When  $A$  reaches a speed of  $0.5 \text{ m s}^{-1}$  the string breaks.**

**18 (b) (i) Find the distance travelled by  $A$  after the string breaks until first coming to rest. [4 marks]**

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**18 (b) (ii) State an assumption that could affect the validity of your answer to part (b)(i). [1 mark]**

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**[Turn over]**

- 19** A particle moves so that its acceleration,  $a \text{ m s}^{-2}$ , at time  $t$  seconds may be modelled in terms of its velocity,  $v \text{ m s}^{-1}$ , as

$$a = -0.1v^2$$

The initial velocity of the particle is  $4 \text{ m s}^{-1}$

- 19 (a)** By first forming a suitable differential equation, show that

$$v = \frac{20}{5 + 2t}$$

**[6 marks]**

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