

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Friday 23 May 2025 – Afternoon

AS Level Mathematics A

H230/02 Pure Mathematics and Mechanics

**Time allowed: 1 hour 30 minutes
plus your additional time allowance**

YOU MUST HAVE:

**the Printed Answer Booklet or any suitable paper
provided by the centre. The Printed Answer Booklet may
be enlarged by the centre.**

a scientific or graphical calculator

**Insert for Questions 10, 11 and 11(d) (with this
document)**

YOU CAN USE:

A model for Question 5

READ INSTRUCTIONS OVERLEAF



INSTRUCTIONS

Use black ink. You can use an HB pencil, but only for graphs and diagrams.

If you use the Printed Answer Booklet write your answer to each question in the space provided in the PRINTED ANSWER BOOKLET. If you need extra space use the lined page at the end of the Printed Answer Booklet. The question numbers must be clearly shown.

If you use the Printed Answer Booklet fill in the boxes on the front of the Printed Answer Booklet.

Answer ALL the questions.

Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

Give non-exact numerical answers correct to 3 significant figures unless a different degree of accuracy is specified in the question.

The acceleration due to gravity is denoted by $g \text{ m s}^{-2}$. When a numerical value is needed use $g = 9.8$ unless a different value is specified in the question.

Do NOT send this Question Paper for marking. Keep it in the centre or recycle it.

INFORMATION

The total mark for this paper is 75.

The marks for each question are shown in brackets [].

ADVICE

Read each question carefully before you start your answer.

FORMULAE

AS Level Mathematics A (H230)

Binomial series

$$(a + b)^n = a^n + {}^nC_1 a^{n-1}b + {}^nC_2 a^{n-2}b^2 + \dots + {}^nC_r a^{n-r}b^r + \dots + b^n$$

$(n \in \mathbb{N}),$

where ${}^nC_r = {}_nC_r = \binom{n}{r} = \frac{n!}{r!(n-r)!}$

Differentiation from first principles

$$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

Standard deviation

$$\sqrt{\frac{\sum (x - \bar{x})^2}{n}} = \sqrt{\frac{\sum x^2}{n} - \bar{x}^2} \quad \text{or} \quad \sqrt{\frac{\sum f(x - \bar{x})^2}{\sum f}} = \sqrt{\frac{\sum fx^2}{\sum f} - \bar{x}^2}$$

The binomial distribution

If $X \sim B(n, p)$ then $P(X = x) = \binom{n}{x} p^x (1-p)^{n-x}$, mean of X is np , variance of X is $np(1-p)$

Kinematics

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$s = \frac{1}{2}(u + v)t$$

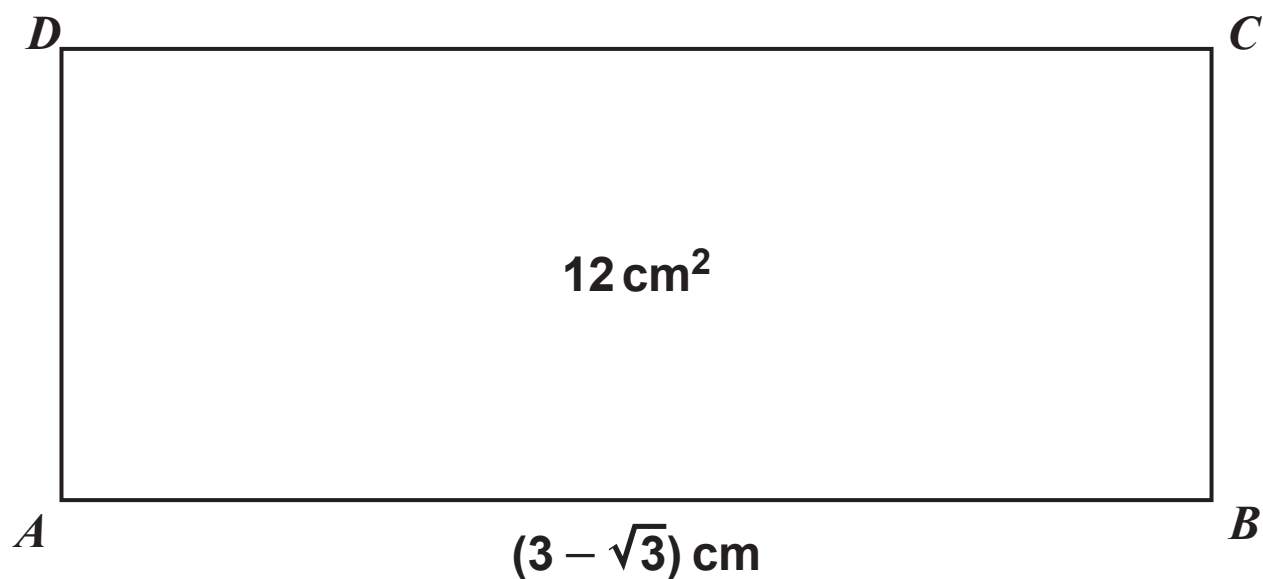
$$v^2 = u^2 + 2as$$

$$s = vt - \frac{1}{2}at^2$$

SECTION A

Pure Mathematics

- 1 Determine the equation of the line that passes through the point $(1, 3)$ and is perpendicular to the line with equation $3x + 6y - 5 = 0$. Give your answer in the form $ax + by + c = 0$ where a , b and c are integers to be determined. [3]
- 2 In this question you must show detailed reasoning.



The diagram shows the rectangle $ABCD$ where $AB = (3 - \sqrt{3}) \text{ cm}$.

The area of $ABCD$ is 12 cm^2 .

Find the perimeter of $ABCD$. Give your answer in the form $(a + b\sqrt{3}) \text{ cm}$, where a and b are integers to be determined. [4]

3 In a triangle ABC , $AB = 9$ cm, $BC = 7$ cm and $AC = 4$ cm.

(a) Show that $\cos CAB = \frac{2}{3}$. [2]

(b) Hence find the exact value of $\sin CAB$. [2]

(c) Find the exact area of triangle ABC . [2]

**4 The cubic polynomial $2x^3 - kx^2 + 4x + k$, where k is a constant, is denoted by $f(x)$.
It is given that $f'(2) = 16$.**

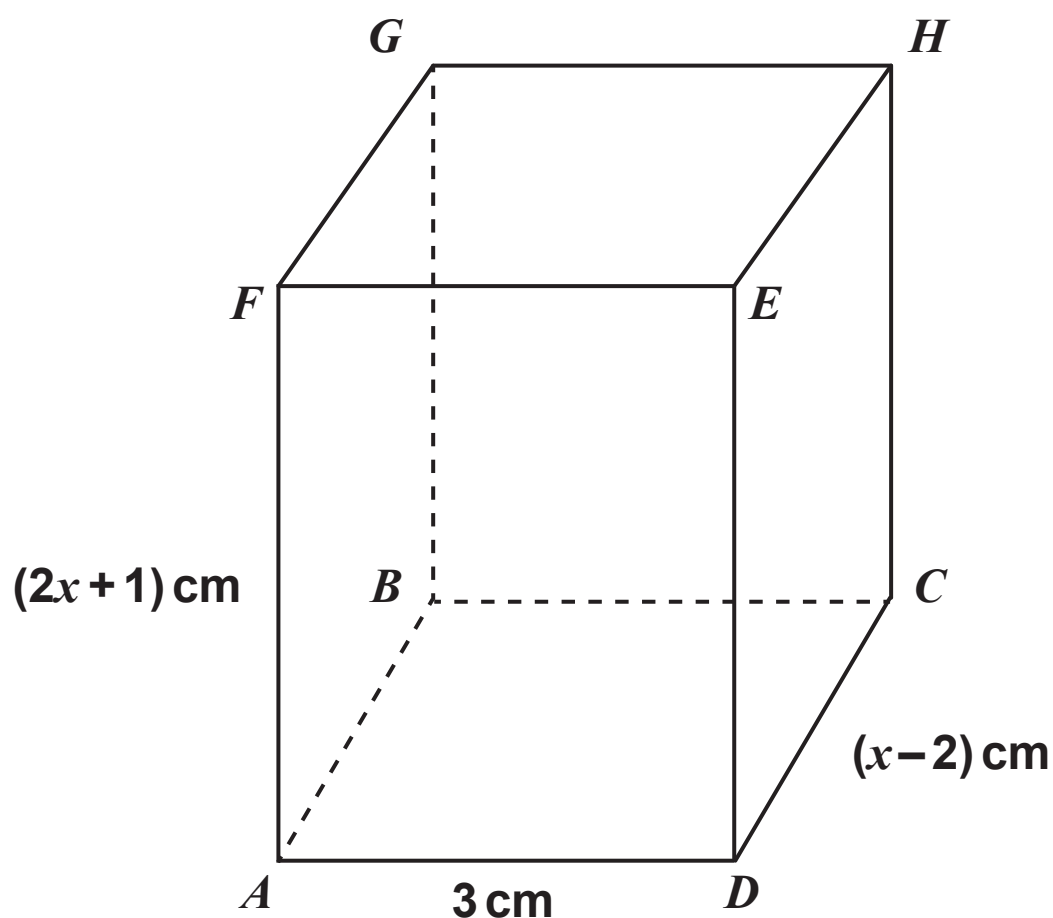
(a) Show that $k = 3$. [4]

For the remainder of the question, you should use this value of k .

(b) Use the factor theorem to show that $(2x + 1)$ is a factor of $f(x)$. [2]

(c) Hence show that the equation $f(x) = 0$ has only ONE real root. [4]

- 5 In this question you must show detailed reasoning. You may use a model to help you.



The diagram shows the cuboid $ABCDEFGH$ where $AD = 3\text{ cm}$, $AF = (2x + 1)\text{ cm}$ and $DC = (x - 2)\text{ cm}$.

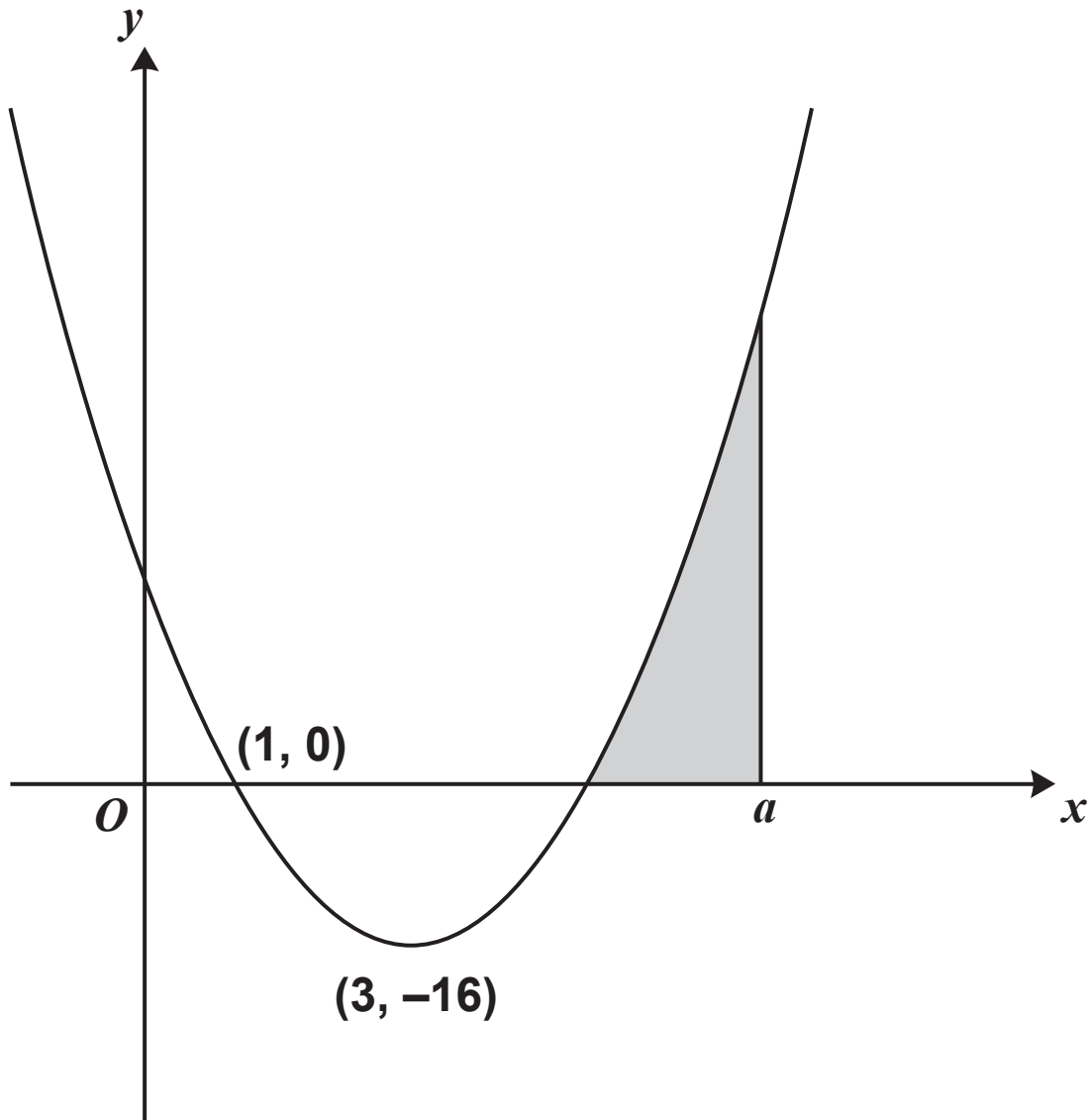
The volume of the cuboid is at most 9 cm^3 .

Find the range of possible values of x . Give your answer in interval notation. [5]

- 6 (a) The curve $y = \ln x$ is stretched by a scale factor 3 in the x -direction.**

State the equation of the curve after it has been stretched. [2]

- (b) Describe fully the SINGLE transformation that transforms the curve $y = x^2 + 1$ to the curve $y = x^2 - 6x + 8$. [4]**



The diagram shows the curve with equation $y = f(x)$ where $f(x)$ is a quadratic function. The curve intersects the x -axis at the point $(1, 0)$ and has its minimum at the point $(3, -16)$.

(a) Show that $f(x) = 4x^2 - 24x + 20$. [3]

The shaded region is enclosed by the curve, the x -axis, and the line $x = a$. The area of the shaded region is $\frac{100}{3}$ units².

(b) Determine the exact value of the constant a . [6]

- 8 The curves $e^x - 2e^y = 1$ and $2e^x + 3e^{2y} = 41$ intersect at the point P .**
- (a) Show that the y -coordinate of P satisfies the equation $3e^{2y} + 4e^y - 39 = 0$. [1]**
- (b) In this question you must show detailed reasoning.**

Hence find the exact coordinates of P . [5]

SECTION B

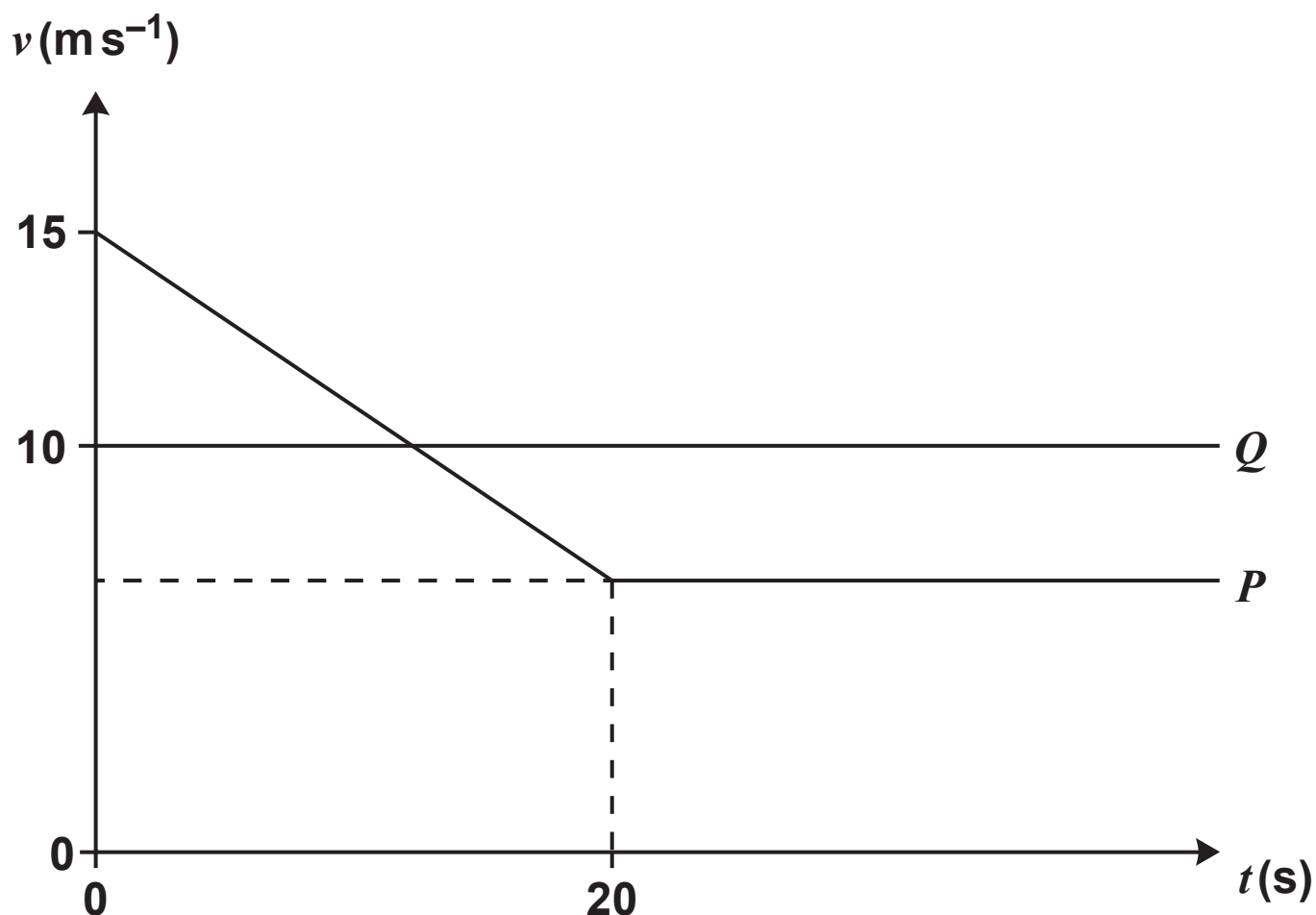
Mechanics

- 9 An athlete runs with velocity $v \text{ m s}^{-1}$ along a horizontal straight running track AB . At time t seconds after passing A , $v = 0.05t^2 - 0.4t + k$, where k is a constant.

- (a) Find the acceleration of the athlete when $t = 6$. [2]
- (b) Given that the minimum velocity of the athlete is 6.6 m s^{-1} , show that $k = 7.4$. [3]

The athlete runs in a straight line from A to B in 13.1 seconds.

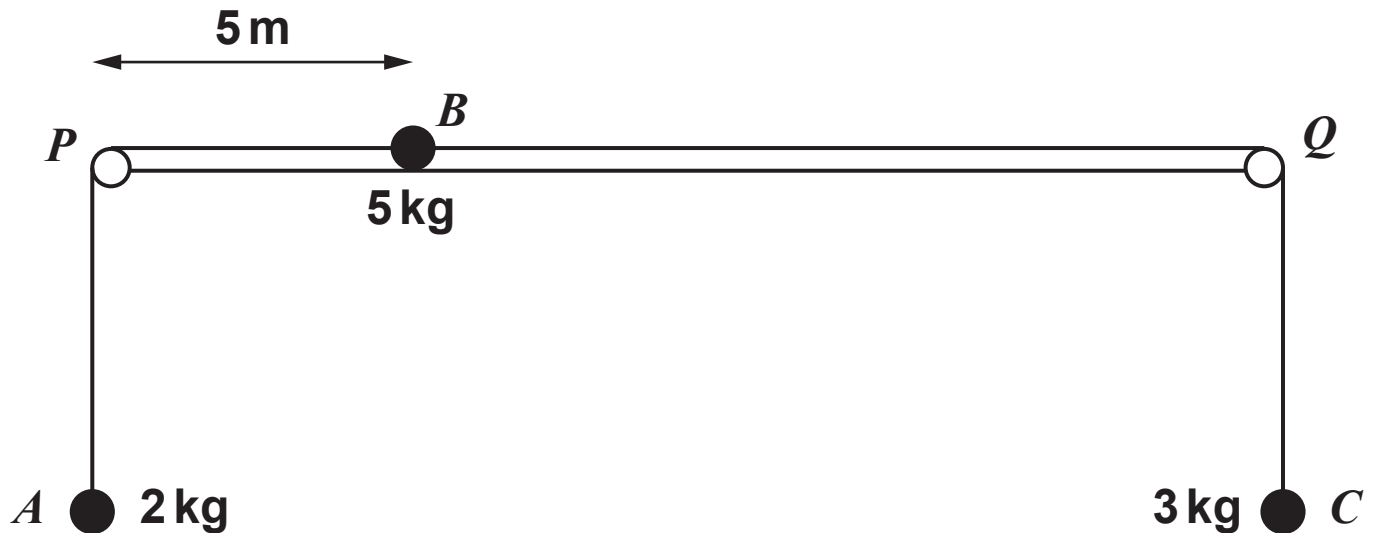
- (c) Calculate the distance AB . [2]



The velocity-time graph represents the motion of two cyclists P and Q who are travelling along a straight, horizontal road. At time $t = 0$, the cyclists pass the same point on the road with P cycling at 15 m s^{-1} and Q cycling at 10 m s^{-1} .

From time $t = 0$, P cycles with constant deceleration 0.4 m s^{-2} for 20 seconds and Q cycles at a constant velocity of 10 m s^{-1} . From $t = 20$ onwards, P 's velocity remains constant.

- (a) Find the value of t when P and Q have the same velocity. [2]
- (b) Determine the value of t when Q overtakes P . [4]



One end of a light inextensible string is attached to a particle A of mass 2 kg. The other end of the string is attached to a second particle B of mass 5 kg. Particle B is in contact with a smooth horizontal surface. The string passes over a small smooth pulley P which is fixed at one edge of the surface. Particle A hangs vertically below P .

A second light inextensible string is attached to B . The other end of this second string is attached to a third particle C of mass 3 kg. This string passes over a small smooth pulley Q which is fixed at the other edge of the surface. Particle C hangs vertically below Q (see diagram).

The system is released from rest with the strings taut and B a distance 5 m from P . In the subsequent motion A does not reach P .

- (a) Determine, in terms of g , the tension in the string connecting B and C . [4]

When the particles have been in motion for 3 seconds the string connecting A and B breaks. Particle B reaches Q after a further 2 seconds.

- (b) Determine the distance PQ . [6]
- (c) State what it would mean about the tension in the string connecting B and C if pulley Q could NOT be assumed to be smooth. [1]

It is given that in fact the horizontal surface is NOT smooth. When the system, as shown in the diagram, is released, it remains at rest. (You may assume that pulley Q IS smooth.)

- (d) Complete the diagram in the Printed Answer Booklet or the Insert showing all the forces acting on B . [1]
- (e) State the magnitude of the frictional force acting on B . Give a brief justification for your answer. [1]

END OF QUESTION PAPER



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