AQA

Please write clearly in block capitals.

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

Surname ____________________

Forename(s) ____________________

Candidate signature ____________________

AS MATHEMATICS

Unit Mechanics 1B

Tuesday 20 June 2017 Afternoon Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:
- the blue AQA booklet of formulae and statistical tables.

You may use a graphics calculator.

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.
- Write the question part reference (eg (a), (b)(i) etc) in the left-hand margin.
- 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.
- Do not write outside the box around each page.
- 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.
- The **final** answer to questions requiring the use of calculators should be given to three significant figures, unless stated otherwise.
- Take $g = 9.8 \text{ m s}^{-2}$, unless stated otherwise.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	

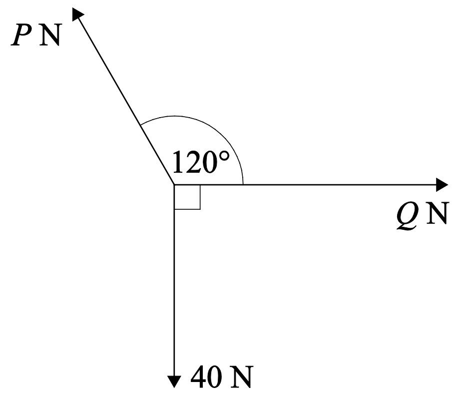
Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

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

Answer **all** questions.

Answer each question in the space provided for that question.

1 Three forces, of magnitude 40 N, P N and Q N, all act in a horizontal plane. These forces are in equilibrium. The diagram shows the forces.



(a) Find P.

[3 marks]

(b) Find Q.

[3 marks]

QUESTION PART REFERENCE	**Answer space for question 1**

Do not write outside the box

QUESTION PART REFERENCE	Answer space for question 1

2 A man stands on a trolley that is free to move on a horizontal surface and subject to no resistance forces. The mass of the man is $70\ \mathrm{kg}$ and the mass of the trolley is $10\ \mathrm{kg}$. He has two sandbags, each of mass $20\ \mathrm{kg}$, on the trolley with him. Initially, the trolley and the man are at rest.

(a) The man throws one bag off the trolley, and after this the trolley moves at a constant velocity. The bag is thrown so that it has a horizontal velocity of $2\ \mathrm{m\ s^{-1}}$. Find the speed of the trolley, man and the remaining bag.

[3 marks]

(b) After the first bag has been thrown, the man then throws the second bag, in the same direction as the first. Immediately after the bag is thrown, it has a horizontal velocity of $2\ \mathrm{m\ s^{-1}}$ relative to the trolley. Find the speed of the trolley and the man after the second bag has been thrown.

[4 marks]

QUESTION PART REFERENCE	Answer space for question 2

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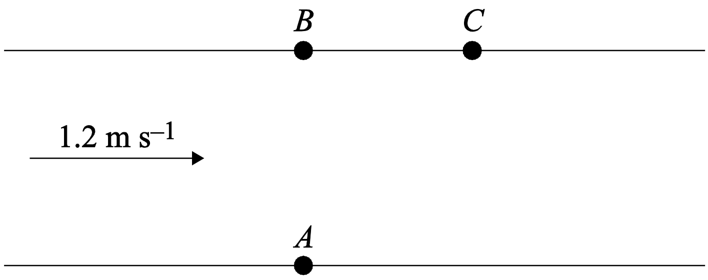
QUESTION PART REFERENCE	Answer space for question 2

Turn over ►

3 The water in a river flows at 1.2 m s^{-1} between two parallel banks that are 30 metres apart. The point A is on one bank. The point B is on the other bank directly opposite A, and the point C is downstream from B. The points are shown in the diagram below.



A boat, which moves at 2 m s^{-1} relative to the water, crosses the river.

Model the boat as a particle.

(a) On one crossing the boat travels so that its velocity, relative to the water, is perpendicular to the bank. It travels directly from the point A to the point C. Find the distance between B and C.

[3 marks]

(b) On another crossing, the boat heads in a different direction, so that it travels directly from A to B. Find the time it takes the boat to cross from A to B.

[4 marks]

QUESTION PART REFERENCE	**Answer space for question 3**

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QUESTION PART REFERENCE	Answer space for question 3

Turn over ►

4 A block, of mass $2\ \mathrm{kg}$, is placed on a rough horizontal surface and struck with a hammer so that it starts to move at $4\ \mathrm{m\ s^{-1}}$. The block comes to rest when it has travelled 3.2 metres from its starting point. The coefficient of friction between the block and the surface is μ, where μ is a constant.

Assume that there is no air resistance.

(a) Find the acceleration of the block as it slides on the surface.

[3 marks]

(b) Find the magnitude of the normal reaction force acting on the block.

[1 mark]

(c) Find μ.

[3 marks]

(d) If air resistance had been taken into account, how would the value for μ change compared to your answer to part **(c)**? Explain why.

[2 marks]

QUESTION PART REFERENCE	**Answer space for question 4**

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QUESTION PART REFERENCE	Answer space for question 4

Turn over ►

5 A car of mass $1600\ \mathrm{kg}$ tows a trailer of mass $400\ \mathrm{kg}$ on a straight horizontal road. The car starts from rest and accelerates uniformly. The car travels 45 metres in 12 seconds.

(a) Find the acceleration of the car.

[3 marks]

(b) A resistance force of magnitude 500 newtons acts on the car, and a resistance force of magnitude 80 newtons acts on the trailer. The trailer is connected to the car by a horizontal tow bar. A driving force of magnitude P newtons acts on the car.

(i) Find the tension in the tow bar.

[3 marks]

(ii) Find P.

[3 marks]

QUESTION PART REFERENCE	**Answer space for question 5**

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QUESTION PART REFERENCE	**Answer space for question 5**

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6 A box of mass $20\ \mathrm{kg}$ is placed on a rough horizontal surface. The coefficient of friction between the box and the surface is 0.4 . A rope is attached to the box and used to pull the box across the surface. The angle between the rope and the horizontal is $30°$. The tension in the rope is 80 newtons.

(a) Draw a diagram to show the forces acting on the box.

[1 mark]

(b) Find the magnitude of the normal reaction force acting on the box.

[3 marks]

(c) Assuming that no air resistance acts on the box as it moves, find the acceleration of the box.

[3 marks]

(d) (i) Assuming that a constant air resistance force of magnitude 5 newtons acts on the box as it moves, find the acceleration of the box.

[2 marks]

(ii) Comment on this assumption that the air resistance is constant.

[1 mark]

QUESTION PART REFERENCE	**Answer space for question 6**

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QUESTION PART REFERENCE	Answer space for question 6

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7 A jet ski moves on a lake, with an acceleration of $(0.25\mathbf{i} + 1.2\mathbf{j})\ \mathrm{m\ s^{-2}}$. At the point A, the jet ski has velocity $(4\mathbf{i} - 1.6\mathbf{j})\ \mathrm{m\ s^{-1}}$.

The unit vectors $\mathbf{i}$ and $\mathbf{j}$ are directed east and north respectively.

(a) Find the speed of the jet ski 2 seconds after it leaves A.

[4 marks]

(b) At the point B, the jet ski has speed $10\ \mathrm{m\ s^{-1}}$. Find the average velocity of the jet ski as it travels from A to B.

[9 marks]

QUESTION PART REFERENCE	Answer space for question 7

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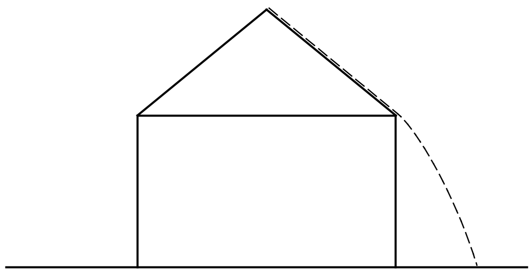
8 A builder is working at the top of a roof of a house when his mobile phone rings and he takes a call. After the call he places his phone on the roof, but it slides down the roof and then falls to the ground. The diagram shows the path of the phone.



Model the phone as a particle that is initially at rest when placed on the roof. Also assume that no air resistance acts on the phone as it moves.

The angle between the roof and the horizontal is α, where $\tan\alpha = \dfrac{3}{4}$.

The phone is travelling at $4\ \mathrm{m\,s^{-1}}$ and is at a height of 8 metres above the ground when it leaves the roof.

(a) Find the distance of the phone from the house when it hits the ground.

[7 marks]

(b) Find the speed at which the phone hits the ground.

[5 marks]

(c) What can be deduced about μ, the coefficient of friction between the roof and the phone?

[2 marks]

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END OF QUESTIONS

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