AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

AS MATHEMATICS

Unit Mechanics 1B

Tuesday 19 June 2018 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	
Examiner's Initials	
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.

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Answer **all** questions.

Answer each question in the space provided for that question.

1 Three forces, $\mathbf{F}_1 = (3\mathbf{i} - 7\mathbf{j})\,\text{N}$, $\mathbf{F}_2 = (-6\mathbf{i} + 14\mathbf{j})\,\text{N}$ and $\mathbf{F}_3 = (\mathbf{i} - \mathbf{j})\,\text{N}$ act on a particle of mass $4\,\text{kg}$. No other forces act on the particle.

(a) Find the resultant of the three forces.

[2 marks]

(b) Find the magnitude of the acceleration of the particle.

[3 marks]

QUESTION PART REFERENCE

Answer space for question 1

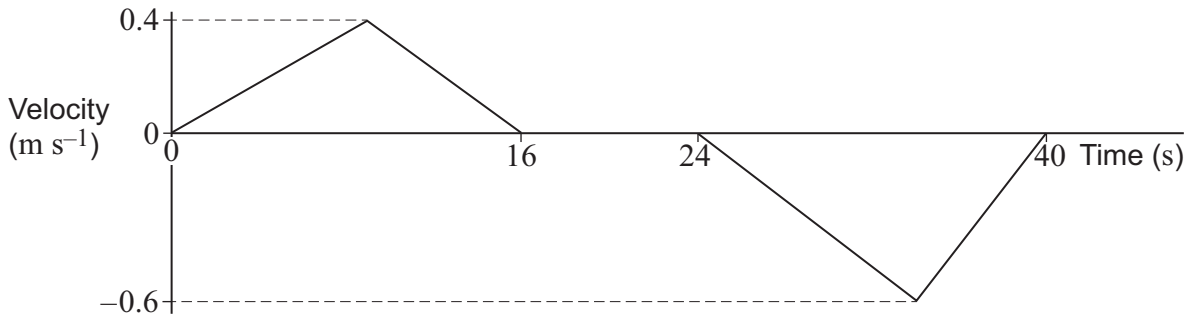
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QUESTION PART REFERENCE

Answer space for question 1

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2 The graph below shows how the velocity of a lift varies during a 40 second period.



(a) Find the distance travelled by the lift in the first 16 seconds of the motion.

[2 marks]

(b) Find the total distance travelled by the lift in the 40 second period.

[3 marks]

(c) Find the average velocity of the lift during the 40 second period.

[3 marks]

QUESTION PART REFERENCE

Answer space for question 2

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QUESTION PART REFERENCE

Answer space for question 2

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3 Two particles, A and B, are moving on a smooth horizontal surface when they collide. During the collision, the particles coalesce to form a single particle. Particle A has mass $2\,\text{kg}$ and particle B has mass $m\,\text{kg}$. Immediately before the collision, their velocities are $(4\mathbf{i} + 2\mathbf{j})\,\text{m s}^{-1}$ and $(3\mathbf{i} + U\mathbf{j})\,\text{m s}^{-1}$ respectively, where U is a constant. Immediately after the collision, the combined particle moves with velocity $(3.4\mathbf{i} + 2\mathbf{j})\,\text{m s}^{-1}$.

(a) Find m.

[3 marks]

(b) Find U.

[3 marks]

QUESTION PART REFERENCE

Answer space for question 3

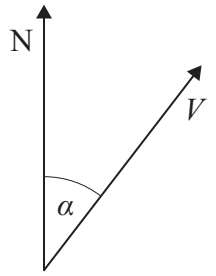
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QUESTION PART REFERENCE

Answer space for question 3

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4 Relative to the air, an aeroplane flies with velocity V on a bearing α, as shown in the diagram.



The air is moving due east at $20\,\text{m s}^{-1}$. The aeroplane travels at $120\,\text{m s}^{-1}$ on a bearing of $040°$.

(a) Find V.

[3 marks]

(b) Find α, giving your answer to the nearest degree.

[4 marks]

QUESTION PART REFERENCE

Answer space for question 4

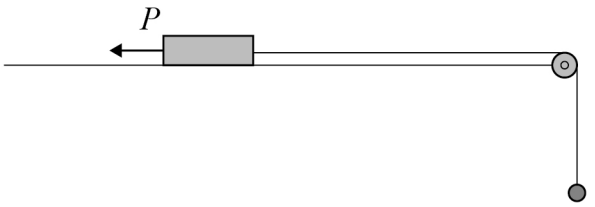
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QUESTION PART REFERENCE

Answer space for question 4

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5 A block, of mass $4\,\text{kg}$, is on a smooth horizontal surface. It is attached to a light inextensible string that passes over a smooth peg. A particle of mass $6\,\text{kg}$ is attached to the other end of the string. The section of the string between the peg and the particle is vertical. A horizontal force of magnitude P newtons acts on the block, as shown in the diagram.



(a) P is such that the system remains at rest. By forming two equations, find P.

[3 marks]

(b) P is changed so that the block accelerates away from the peg at $0.6\,\text{m s}^{-2}$. By forming two equations of motion, find P.

[4 marks]

(c) When the block is moving away from the peg at $2\,\text{m s}^{-1}$, the force of magnitude P newtons is removed. Find the distance that the block travels as its speed reduces from $2\,\text{m s}^{-1}$ to $0\,\text{m s}^{-1}$.

[6 marks]

(d) Explain fully how your answer to part **(c)** would change if the effects of air resistance were included.

[2 marks]

QUESTION PART REFERENCE

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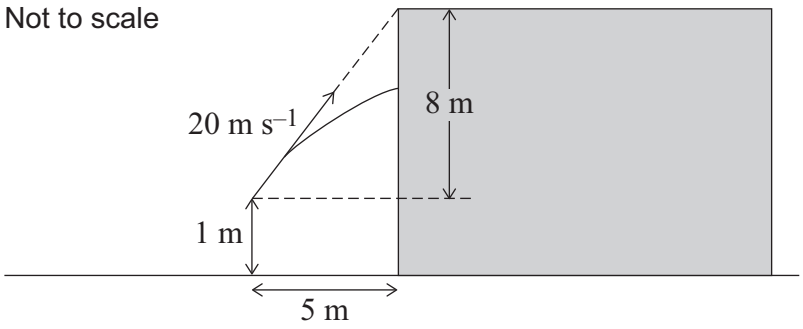
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QUESTION PART REFERENCE

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6 A fire fighter points the nozzle of a hose at the top of a building. The water leaves the hose with a velocity of $20\,\text{m}\,\text{s}^{-1}$ directed towards the top of the vertical wall of the building. The building has a height of 9 metres and the nozzle is a horizontal distance of 5 metres from the vertical wall of the building. Assume that the nozzle is 1 metre above ground level.



Consider one particle of water that leaves the nozzle of the hose and assume that the only force acting on this particle is its weight.

(a) Find the time that it takes for the particle of water to travel from the nozzle to the building.

[4 marks]

(b) Find the height of the particle of water, above the ground, when it hits the wall of the building.

[3 marks]

(c) Find the speed of the particle of water just before it hits the wall of the building.

[5 marks]

QUESTION PART REFERENCE

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7 A coin is struck so that it starts to slide up a rough slope inclined at an angle of $30°$ to the horizontal. The coin initially moves at $4\,\text{m}\,\text{s}^{-1}$. It slides up the slope until it comes to rest and then slides back down the slope. The coefficient of friction between the coin and the slope is 0.2.

(a) Find the magnitude of the deceleration of the coin as it slides up the slope.

[5 marks]

(b) Find the distance that the coin has travelled when it comes to rest.

[2 marks]

(c) Find the total time taken for the coin to slide up the slope and return to its original position.

[7 marks]

QUESTION PART REFERENCE

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8 Two particles, A and B, move on a horizontal surface with constant accelerations of $(8\mathbf{i} + 4\mathbf{j})\,\mathrm{m\,s^{-2}}$ and $(6\mathbf{i} + 10\mathbf{j})\,\mathrm{m\,s^{-2}}$ respectively. The unit vectors **i** and **j** are perpendicular.

At time $t = 0$, A has position $(7\mathbf{i} + 8\mathbf{j})\,\mathrm{m}$ and velocity $(4\mathbf{i} + 3\mathbf{j})\,\mathrm{m\,s^{-1}}$.

At time $t = 0$, B has position $(70\mathbf{i} + k\mathbf{j})\,\mathrm{m}$ and velocity $(2\mathbf{i} - 1\mathbf{j})\,\mathrm{m\,s^{-1}}$, where k is a constant.

The particles collide.

(a) Find the time when the particles collide.

[5 marks]

(b) Find k.

[3 marks]

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END OF QUESTIONS

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