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INTERNATIONAL A LEVEL MATHEMATICS • MECHANICS 1 (WME01)

Mechanics 1 Practice Paper 3

Edexcel IAL Mechanics 1

AIMING FOR A/A*

Written in the style of the Pearson Edexcel International Advanced Level paper (WME01/01) • Calculator allowed

A full 75-mark paper set above the hardest recent series: long questions, no route given and a trap in every question

Time	Total	You must have
1 hour 30 minutes	**75 marks**	**Mathematical Formulae and Statistical Tables, calculator**

Instructions

- Use black ink or ball-point pen. Pencil may be used for diagrams and sketches.
- Answer **all** questions, in the spaces provided.
- Show enough working to make your method clear. Answers without working may not gain full credit.
- Whenever a numerical value of g is required, take $g = 9.8\,\text{m s}^{-2}$, and give your answer to either **two or three significant figures**.

Information

- There are 6 questions in this paper. The total mark is 75.
- The marks for each question are shown in brackets.

Advice

- Sit the paper in one go, in 1 hour 30 minutes, with the mark scheme closed.
- Read each question carefully and try every question. Check your answers if you have time.
- Then mark it line by line with the mark scheme and fill in your score.

Track your score

Q	Topic	Marks	Score
1	Three particles and a second collision	12	
2	A car overtaking a van	12	
3	A string at an angle to a rough slope	13	
4	A non-uniform rod hanging from two strings	13	
5	A pulley and a string jerked taut	12	
6	A particle under two constant forces	13	
	Total	**75**	

Rough grade guide (out of 75): A **50** • B **42** • C **34**

Based on recent WME01 grade boundaries. Real boundaries change every series, so treat this as a guide, not a grade.

Mark scheme **Exam questions by topic** **More practice papers**

Name ..... Date .....

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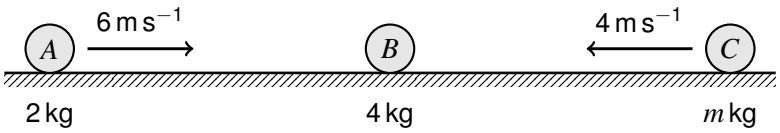

Figure 1

Three particles A, B and C, of masses 2 kg, 4 kg and m kg respectively, move in the same straight line on a smooth horizontal floor, with B between A and C. Particle B is at rest. Particle A moves towards B with speed 6 m s^{-1} and particle C moves towards B with speed 4 m s^{-1}, as shown in Figure 1.

A collides with B. Immediately after this collision, A moves with speed 1 m s^{-1} and its direction of motion is reversed.

(a) Find the speed of B immediately after the collision.

(3)

(b) Find the magnitude of the impulse exerted on B by A in the collision.

(2)

B then collides with C, and the two particles coalesce to form a single particle D

(c) Find the range of values of m for which D moves towards A

(4)

(d) Given that there is a second collision between A and D, find the range of possible values of m

(3)

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Question 1 continued

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(Total for Question 1 is 12 marks)

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2. A van moves along a straight horizontal road at a constant speed of $8\,\text{m s}^{-1}$. At time $t = 0$ the van passes a point O, where a car is at rest. At time $t = 5\,\text{s}$ the car sets off from O in the same direction as the van. The car accelerates uniformly at $1\,\text{m s}^{-2}$ until it reaches a speed of $24\,\text{m s}^{-1}$, and then moves at a constant speed of $24\,\text{m s}^{-1}$

(a) On the same axes, sketch speed-time graphs for the motion of the van and the car for $0 \leqslant t \leqslant 35$

(3)

(b) Find the greatest distance between the van and the car before the car overtakes the van.

(3)

(c) Find the value of t at which the car overtakes the van.

(5)

(d) Find the distance from O at which the car overtakes the van.

(1)

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Question 2 continued

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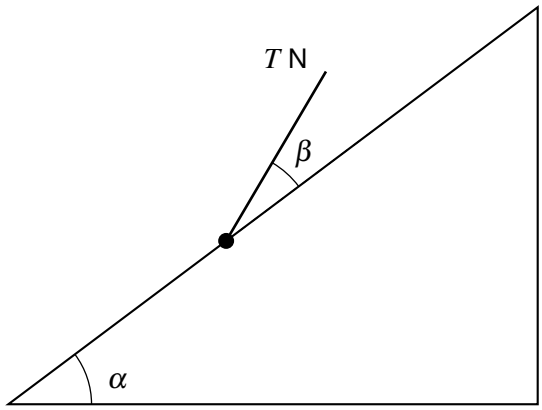

Figure 2

A particle of mass 4 kg is held in equilibrium on a rough plane inclined at an angle α to the horizontal, where $\tan\alpha = \frac{3}{4}$. The coefficient of friction between the particle and the plane is 0.5

The particle is held by a light string, which lies in the vertical plane containing a line of greatest slope of the plane. The string is inclined at an angle β to the line of greatest slope, where $\tan\beta = \frac{5}{12}$, and the tension in the string is T newtons, as shown in Figure 2.

(a) Find, in terms of T, the magnitude of the normal reaction between the particle and the plane.

(2)

(b) Find the least possible value of T

(4)

(c) Find the greatest possible value of T

(3)

(d) Given that $T = 20$, find the magnitude and direction of the friction acting on the particle.

(2)

The string is now cut.

(e) Find the acceleration of the particle.

(2)

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Question 3 continued

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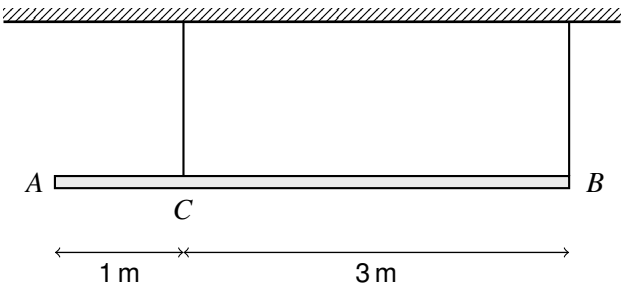

Figure 3

A non-uniform rod AB has mass 4 kg and length 4 m. The rod hangs in equilibrium in a horizontal position from two light inextensible vertical strings. One string is attached to the rod at C, where $AC = 1$ m, and the other string is attached to the rod at B, as shown in Figure 3.

When nothing else is attached to the rod, the tension in the string at C is five times the tension in the string at B

(a) Find the distance of the centre of mass of the rod from A

(4)

A particle of mass 4 kg is now attached to the rod at the point P, where $AP = x$ m. The rod still hangs in equilibrium in a horizontal position.

(b) Given that $x = 3$, find the tension in each string.

(3)

The string at B will break if its tension exceeds 39.2 N. The string at C will not break.

(c) Find the range of possible values of x

(6)

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Question 4 continued

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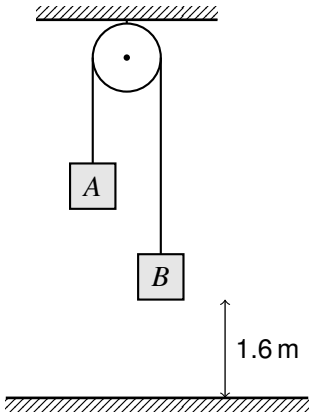

Figure 4

Two particles A and B, of masses 2 kg and 3 kg respectively, are attached to the ends of a light inextensible string. The string passes over a small smooth fixed pulley. The particles hang with the string taut and the hanging parts of the string vertical. B is 1.6 m above horizontal ground, as shown in Figure 4. The system is released from rest. A does not reach the pulley.

(a) Find the acceleration of B and the tension in the string while B is falling.

(4)

(b) Find the speed of B just before it hits the ground.

(2)

B does not rebound. After B hits the ground, A continues to move and the string becomes slack. Later, the string becomes taut again and B is jerked off the ground.

(c) Find the time between B hitting the ground and the string becoming taut again.

(2)

(d) Find the speed with which B starts to rise.

(3)

(e) Find the magnitude of the impulse exerted on B by the string when it becomes taut.

(1)

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Question 5 continued

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(Total for Question 5 is 12 marks)

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6. *In this question,* $\mathbf{i}$ *and* $\mathbf{j}$ *are perpendicular horizontal unit vectors, and position vectors are given relative to a fixed origin* O

A particle P of mass 2 kg moves on a smooth horizontal surface under the action of a constant force $\mathbf{F} = (6\mathbf{i} - 8\mathbf{j})$ N. At time $t = 0$, P passes through O with velocity $(-4\mathbf{i} + 10\mathbf{j})$ m s^{-1}

At time $t = 2$ s, the force $\mathbf{F}$ is removed and replaced by a constant force $\mathbf{G}$. From $t = 2$, P moves in a straight line and comes to instantaneous rest at time $t = 4$ s.

(a) Find the velocity of P at time t seconds, for $0 \leqslant t \leqslant 2$

(2)

(b) Find the least speed of P for $0 \leqslant t \leqslant 2$

(4)

(c) Find $\mathbf{G}$

(3)

(d) Find the position vector of P when it comes to rest.

(4)

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Question 6 continued

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(Total for Question 6 is 13 marks)

TOTAL FOR PAPER IS 75 MARKS

END

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