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INTERNATIONAL A LEVEL MATHEMATICS • MECHANICS 2 (WME02)

Mechanics 2 Practice Paper 3

Edexcel IAL Mechanics 2

AIMING FOR A/A*

Written in the style of the Pearson Edexcel International Advanced Level paper (WME02/01) • 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	A projectile over a wall	12	
2	Acceleration in two stages	12	
3	A lamina with a hole on a slope	13	
4	A ladder against a rough wall	13	
5	A collision and a wall	12	
6	A car on a hill at constant power	13	
	Total	**75**	

Rough grade guide (out of 75): A* **56** • A **49** • B **41** • C **33**

Based on recent WME02 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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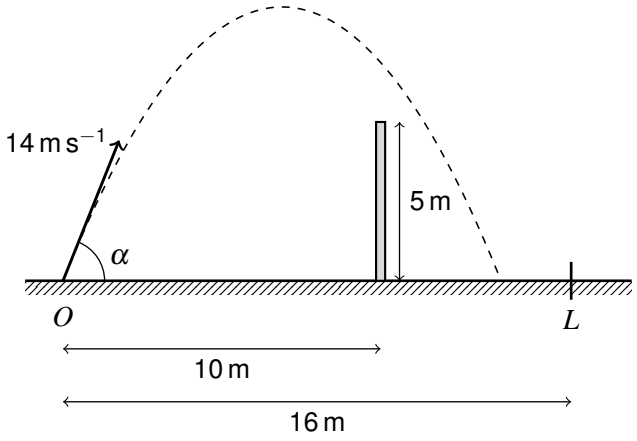

Figure 1

A ball is projected from a point O on horizontal ground with speed 14 m s^{-1} at an angle α above the horizontal. A thin vertical wall of height 5 m stands on the ground at a horizontal distance of 10 m from O. The point L on the ground is 16 m from O, beyond the wall, as shown in Figure 1. The ball moves freely under gravity in a vertical plane perpendicular to the wall.

(a) Find the range of values of $\tan\alpha$ for which the ball passes over the wall.

(6)

(b) Find the range of values of α for which the ball passes over the wall and hits the ground between the wall and L

(6)

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Question 1 continued

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(Total for Question 1 is 12 marks)

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2. A particle P moves along a straight line. At time $t = 0$, P is at rest at the point O. At time t seconds, the velocity of P is $v\,\text{m s}^{-1}$, where

$$v = t^2 + 2t, \qquad 0 \leqslant t \leqslant 2$$

For $t \geqslant 2$, the acceleration of P is $(2t - 10)\,\text{m s}^{-2}$. The velocity of P is continuous at $t = 2$

(a) Find v in terms of t for $t \geqslant 2$

(3)

(b) Find the values of t, for $t > 0$, at which P is instantaneously at rest.

(2)

(c) Find the total distance travelled by P in the interval $0 \leqslant t \leqslant 7$

(7)

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Question 2 continued

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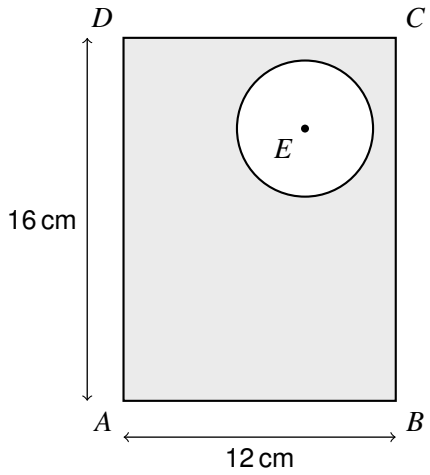

Figure 2

A uniform rectangular lamina $ABCD$ has $AB = 12$ cm and $AD = 16$ cm. A circular hole of radius 3 cm is cut from the lamina. The centre E of the hole is 8 cm from AD and 12 cm from AB, as shown in Figure 2.

(a) Find the distance of the centre of mass of the lamina from **(i)** AD **(ii)** AB

(6)

The lamina stands in a vertical plane with AB in contact with a rough plane inclined at an angle θ to the horizontal. The edge AB lies along a line of greatest slope, with A below B. The coefficient of friction between the lamina and the plane is 0.75. The angle θ is gradually increased from zero.

(b) Determine whether the lamina first slides or first topples, and find the value of θ at which this happens.

(5)

The lamina is now freely suspended from D and hangs in equilibrium.

(c) Find the angle between DA and the vertical.

(2)

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Question 3 continued

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(Total for Question 3 is 13 marks)

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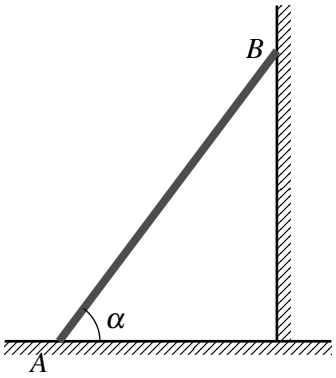

Figure 3

A uniform ladder AB, of mass 30 kg and length 8 m, rests with its end A on rough horizontal ground and its end B against a rough vertical wall. The ladder lies in a vertical plane perpendicular to the wall and makes an angle α with the ground, where $\tan\alpha = \frac{4}{3}$, as shown in Figure 3. The coefficient of friction between the ladder and the ground is 0.4, and the coefficient of friction between the ladder and the wall is 0.5

A man of mass 70 kg climbs up the ladder. The ladder is modelled as a uniform rod and the man as a particle.

(a) Find the greatest distance the man can climb up the ladder before it slips.

(10)

(b) Find the magnitude of the total force exerted on the ladder by the ground when the ladder is about to slip.

(3)

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Question 4 continued

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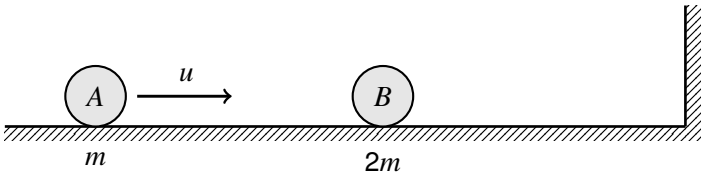

Figure 4

Two small smooth spheres A and B, of equal radius and of masses m and $2m$ respectively, lie on a smooth horizontal floor. Sphere B is at rest between A and a fixed smooth vertical wall. Sphere A is projected towards B with speed u and collides directly with B, as shown in Figure 4. The coefficient of restitution between A and B is e

After the collision, B hits the wall, which is perpendicular to its direction of motion. The coefficient of restitution between B and the wall is $\frac{1}{4}$

(a) Find, in terms of u and e, the velocity of A and the velocity of B immediately after they collide.

(5)

(b) Given that B collides with A again after rebounding from the wall, find the range of possible values of e

(5)

(c) Given instead that $e = \frac{1}{2}$, find, in terms of m and u, the kinetic energy lost when B hits the wall.

(2)

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Question 5 continued

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(Total for Question 5 is 12 marks)

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6. A car of mass 800 kg has an engine working at a constant rate of 20 kW. The resistance to the motion of the car from non-gravitational forces has magnitude kv newtons, where v m s^{-1} is the speed of the car and k is a constant. The maximum speed of the car on a straight horizontal road is 40 m s^{-1}

(a) Find the value of k

(3)

The car now travels on a straight road inclined at an angle α to the horizontal, where $\sin\alpha = \frac{1}{16}$. The engine still works at 20 kW.

(b) Find the maximum speed of the car up the road.

(4)

(c) Find the maximum speed of the car down the road.

(4)

(d) Find the rate at which the engine must work for the car to move up the road at a constant speed of 20 m s^{-1}

(2)

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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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