eClassroom

INTERNATIONAL A LEVEL MATHEMATICS • MECHANICS 2 (WME02)

Mechanics 2 Practice Paper 1

Edexcel IAL Mechanics 2

AIMING FOR B

Written in the style of the Pearson Edexcel International Advanced Level paper (WME02/01) • Calculator allowed

A full 75-mark paper of multi-step exam questions covering every Mechanics 2 chapter, with a separate mark scheme

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 8 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	Variable acceleration in a straight line	7	
2	An impulse in vector form	8	
3	A car working at constant power	9	
4	A composite lamina	9	
5	A projectile from a cliff	9	
6	A direct collision and a wall	10	
7	A ladder against a smooth wall	10	
8	Work and energy on a rough slope	13	
	Total	**75**	

Rough grade guide (out of 75): A* **66** • A **59** • B **51** • C **43**

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 .....

★★★★★

Join students already acing their exams.

Book your FREE lesson at www.eclassroom.org.uk

1. A particle P moves along a straight line. At time t seconds, $t \geqslant 0$, the acceleration of P is $(6t - 14)\,\text{m s}^{-2}$, in the positive x direction. At time $t = 0$, P passes through the point O with velocity $8\,\text{m s}^{-1}$, in the positive x direction.

(a) Find the velocity of P at time t seconds.

(2)

(b) Find the values of t at which P is instantaneously at rest.

(2)

(c) Find the total distance travelled by P in the interval $0 \leqslant t \leqslant 4$

(3)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

★★★★★
Join students already acing their exams.
Book your FREE lesson at www.eclassroom.org.uk

Question 1 continued

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(Total for Question 1 is 7 marks)

★★★★★
Join students already acing their exams.
Book your FREE lesson at www.eclassroom.org.uk

2. *In this question,* $\mathbf{i}$ *and* $\mathbf{j}$ *are perpendicular unit vectors in a horizontal plane.*

A ball of mass 0.4 kg is moving with velocity $(5\mathbf{i}+2\mathbf{j})\,\text{m s}^{-1}$ when it is struck by a bat. The impulse exerted on the ball by the bat is $(-3\mathbf{i}+2\mathbf{j})\,\text{N s}$

(a) Find the speed of the ball immediately after it is struck.

(5)

(b) Find the kinetic energy gained by the ball as a result of being struck.

(3)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 2 continued

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(Total for Question 2 is 8 marks)

★★★★★
Join students already acing their exams.
Book your FREE lesson at www.eclassroom.org.uk

3. A car of mass 1000 kg moves up a straight road which is inclined at an angle α to the horizontal, where $\sin\alpha = \frac{1}{14}$. The resistance to the motion of the car from non-gravitational forces is modelled as a constant force of magnitude 500 N. The engine of the car is working at a constant rate of 24 kW.

(a) Show that the maximum speed of the car up the road is $20\,\text{m}\,\text{s}^{-1}$

(4)

(b) Find the acceleration of the car at the instant when its speed is $12\,\text{m}\,\text{s}^{-1}$

(3)

Later the car moves along a straight horizontal road at a constant speed of $30\,\text{m}\,\text{s}^{-1}$. The resistance to motion is unchanged.

(c) Find, in kW, the rate at which the engine of the car is now working.

(2)

DO NOT WRITE IN THIS AREA

Question 3 continued

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(Total for Question 3 is 9 marks)

★★★★★
Join students already acing their exams.
Book your FREE lesson at www.eclassroom.org.uk

4.

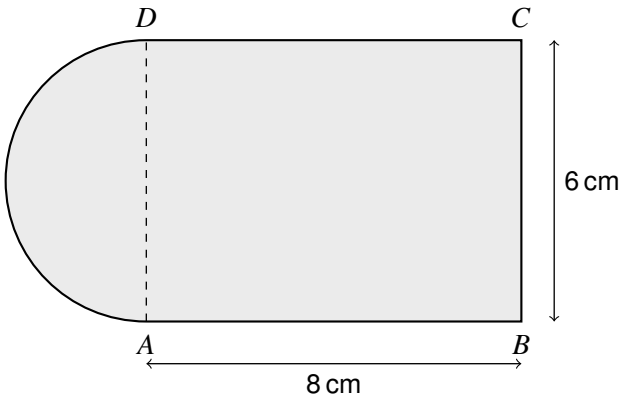

Figure 1

A uniform lamina is formed by joining a rectangle $ABCD$ to a semicircle with diameter AD, as shown in Figure 1. The rectangle has $AB = 8$ cm and $AD = 6$ cm, and the semicircle lies outside the rectangle.

(a) Find the distance of the centre of mass of the lamina from AD

(5)

The lamina is freely suspended from B and hangs in equilibrium.

(b) Find the angle between AB and the vertical.

(4)

DO NOT WRITE IN THIS AREA

Question 4 continued

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(Total for Question 4 is 9 marks)

★★★★★
Join students already acing their exams.
Book your FREE lesson at www.eclassroom.org.uk

5.

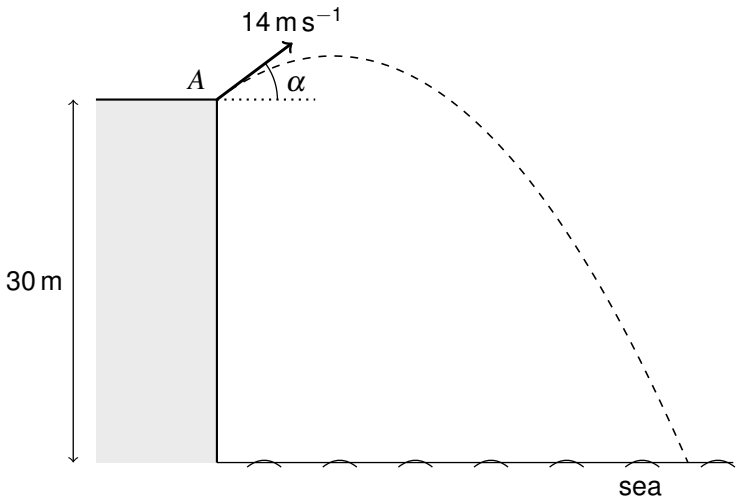

Figure 2

A ball is projected from a point A at the top of a vertical cliff. The point A is 30 m vertically above the sea. The ball is projected with speed 14 m s^{-1} at an angle α above the horizontal, where $\tan\alpha = \frac{3}{4}$, as shown in Figure 2. The ball moves freely under gravity and hits the sea.

(a) Find the time taken for the ball to reach the sea.

(4)

(b) Find the horizontal distance from the foot of the cliff to the point where the ball hits the sea.

(2)

(c) Find the speed of the ball as it hits the sea.

(3)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

★★★★★
Join students already acing their exams.
Book your FREE lesson at www.eclassroom.org.uk

Question 5 continued

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(Total for Question 5 is 9 marks)

★★★★★
Join students already acing their exams.
Book your FREE lesson at www.eclassroom.org.uk

6. Two particles, A and B, of masses $3m$ and m respectively, are moving in opposite directions along the same straight line on a smooth horizontal surface. Just before they collide directly, A has speed $2u$ and B has speed u. The coefficient of restitution between A and B is e

(a) Show that the speed of B immediately after the collision is $\frac{u(5+9e)}{4}$

(5)

Given that $e = \frac{1}{3}$

(b) find, in terms of m and u, the kinetic energy lost in the collision.

(3)

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

(c) Find, in terms of m and u, the magnitude of the impulse exerted on B by the wall.

(2)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 6 continued

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(Total for Question 6 is 10 marks)

★★★★★
Join students already acing their exams.
Book your FREE lesson at www.eclassroom.org.uk

7.

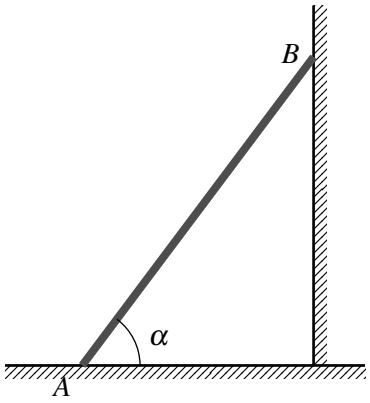

Figure 3

A uniform ladder AB, of mass 20 kg and length 6 m, has its end A on rough horizontal ground and its end B against a smooth vertical wall. The ladder rests in equilibrium in a vertical plane perpendicular to the wall, at an angle α to the ground, where $\tan\alpha = \frac{4}{3}$, as shown in Figure 3. The coefficient of friction between the ladder and the ground is μ

(a) Show that $\mu \geqslant \frac{3}{8}$

(5)

The ladder is modelled as a uniform rod. Given that $\mu = 0.5$, a man of mass 80 kg climbs the ladder from A. The man is modelled as a particle.

(b) Find the distance the man can climb up the ladder before it is about to slip.

(5)

DO NOT WRITE IN THIS AREA

Question 7 continued

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(Total for Question 7 is 10 marks)

★★★★★
Join students already acing their exams.
Book your FREE lesson at www.eclassroom.org.uk

8.

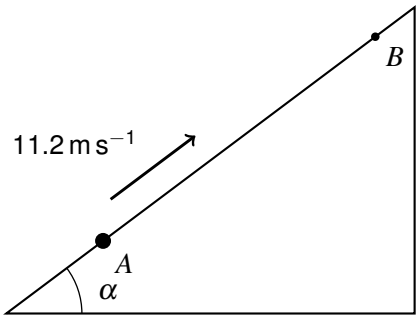

Figure 4

A particle of mass 2 kg is projected with speed 11.2 m s^{-1} from a point A up a line of greatest slope of a rough plane. The plane is inclined at an angle α to the horizontal, where $\sin\alpha = \frac{3}{5}$. The particle comes to instantaneous rest at the point B, where $AB = 8$ m, as shown in Figure 4. The coefficient of friction between the particle and the plane is μ

(a) Use the work-energy principle to show that $\mu = \frac{1}{4}$

(5)

(b) Show that the particle does not remain at rest at B

(2)

(c) Use the work-energy principle to find the speed of the particle when it returns to A

(4)

(d) Find the total work done against friction as the particle moves from A to B and back to A

(2)

DO NOT WRITE IN THIS AREA

Question 8 continued

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(Total for Question 8 is 13 marks)

TOTAL FOR PAPER IS 75 MARKS

END

★★★★★
Join students already acing their exams.
Book your FREE lesson at www.eclassroom.org.uk