Practice Paper B

MECHANICS ONE

crashMATHS

Name	

Duration	**1 HOUR & 30 MINUTES**
Total Marks Available	**75 MARKS**

Targets

For examiner's use only

Question Number	*Leave Blank*
1	
2	
3	
4	
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7	
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Total marks	

1 A delivery van is driving on the motorway at a constant speed of 60 mph for 20 minutes. As it passes the point P_1, the van then decelerates uniformly for 5 minutes reaching a speed x mph at the point P_2.

(a) Sketch a speed-time graph to illustrate the motion of the van. **(3)**

The total distance travelled by the van in the 25 minutes is 35 miles.

(b) Work out the value of x. **(4)**

(c) Calculate the deceleration of the van between the points P_1 and P_2. **(2)**

Question 1 continued

TOTAL 9 MARKS

2 Two particles A and B have masses 1 kg and 3 kg respectively. The particles are moving towards each other on a smooth horizontal plane and collide directly. The speeds of A and B before the collision are $2u$ and $6u$ respectively. After the collision, the direction of motion of A is reversed and A moves with a speed x.

Given that A receives an impulse of $\frac{13}{2}u$ from B,

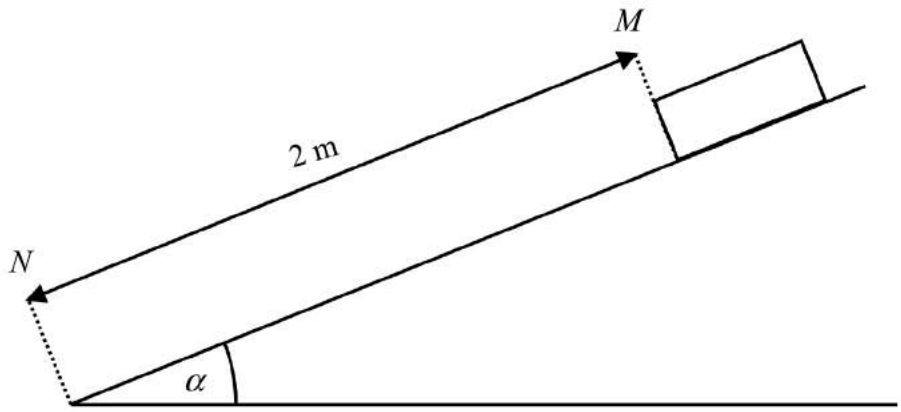
(a) Show that $x = \frac{9}{2}u$. **(3)**

(b) Find the speed and direction of motion of B after the collision. **(4)**

Question 2 continued

TOTAL 7 MARKS

3



Items on a delivery chute are released from the point M and are collected at the point N. A box is held in place at M on the conveyer belt which is inclined at an angle α to the horizontal, where $\sin\alpha = \frac{3}{5}$. The mass of the box is $45\,\text{kg}$ and the distance between M and N is $2\,\text{m}$. The box is released from rest and is moving with a speed $3.2\ \text{m s}^{-1}$ when it reaches N. By modelling the box as a particle and the conveyer belt as a rough inclined plane,

(a) Find the coefficient of friction between the box and conveyer belt. **(9)**

Another item of mass $90\,\text{kg}$ is to be released from rest at M t seconds after the box is released. Given that the item will reach N with a speed of $4.6\ \text{m s}^{-1}$,

(b) Find the minimum value of t so that the item doesn't collide with the box. **(5)**

Question 3 continued

Question 3 continued

Question 3 continued

TOTAL 14 MARKS

4 A particle P is thrown vertically upwards with a speed of 18 m s^{-1} at a height h_1 m above the ground. The particle hits the ground 5s after projection.

(a) Find h_1. **(2)**

P is then dropped vertically downwards from rest at another point that is h_2 m above the ground. At the same time, another particle Q is thrown vertically upwards from the ground at a speed of 9 m s^{-1}. The two particles collide at a time t and height h_3 above the ground.

(b) Show that $h_2 = 9t$. **(4)**

Given that immediately before the collision, Q had a speed of 4 m s^{-1},

(c) (i) Find h_2.

(ii) Find h_3. **(4)**

Question 4 continued

Question 4 continued

Question 4 continued

TOTAL 10 MARKS

5 A uniform rod AB of mass 16kg has length 8m. The rod is held in equilibrium by two strings at positions C and D on the rod, such that $AC = 2$ m and $AD = x$ m. The tension in the string attached to D is greater than the tension in the string attached to C by a factor of $\frac{3}{2}$.

Find

(i) the tension in the strings.

(ii) x. **(8)**

Question 5 continued

TOTAL 8 MARKS

6 *[In this question,* **i** *and* **j** *are unit vectors due east and due north respectively and position vectors are given with respect to a fixed origin.]*

A boat B is moving with constant velocity. The position vector of B at time t seconds $(t \geq 0)$ is given by **r** metres, relative to a fixed origin O.

At time $t = 0$, the position vector of B is $3\mathbf{i} - 4\mathbf{j}$. After 5 seconds, B passes through the point with position vector $8\mathbf{i} + 6\mathbf{j}$.

(a) Show that

$$\mathbf{r} = (3 + t)\mathbf{i} + (2t - 4)\mathbf{j} \quad \textbf{(4)}$$

A lighthouse L has position vector $\frac{5}{2}\mathbf{i} + 10\mathbf{j}$.

(b) Find the distance of B from L at time $t = 3$. **(4)**

(c) Find the distance of B from L when the B is due south of L. **(4)**

(d) Find the time at which B is $\frac{5}{4}$ m from L. **(5)**

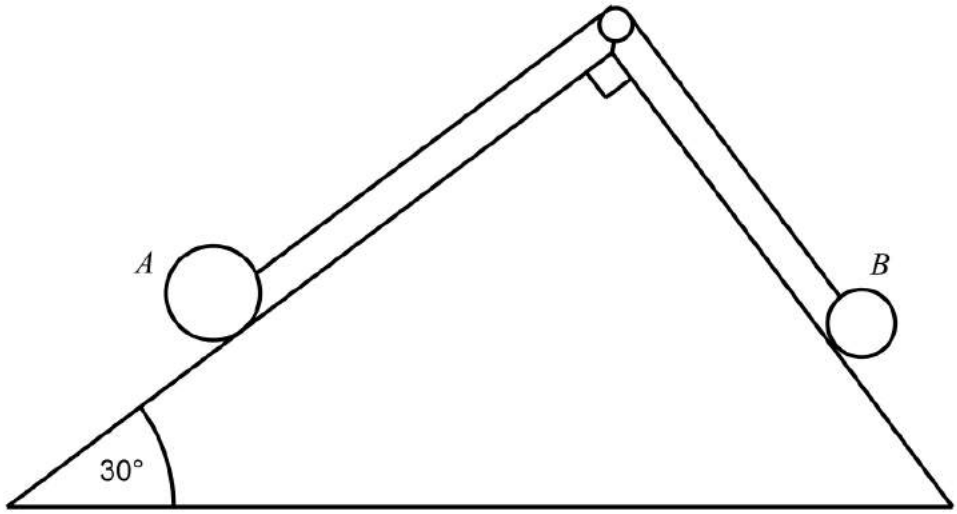
Question 6 continued

Question 6 continued

Question 6 continued

TOTAL 17 MARKS

7



The diagram shows two particles, A and B, that are connected by a light inextensible string passing over a smooth pulley. The two particles rest on two different rough surfaces of a triangular wedge. A has mass 6kg and B has mass 4kg. The coefficient of friction between A and the surface of the wedge is $\frac{1}{3}$. The frictional force that acts on B from the surface is 10N. The coefficient friction between B and the surface of the wedge is μ.

(a) Show that $\mu = 0.29$. **(3)**

The system is released from rest.

(b) Find the acceleration of the particles and the tension in the string. **(7)**

Question 7 continued

Question 7 continued

Question 7 continued

TOTAL 10 MARKS