Practice Paper A

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	
5	
6	
7	
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/	
Total marks	

1 A particle P is projected vertically upwards with a speed of 3 ms^{-1}. P moves upwards before reaching a maximum height and falling back to the ground. Find the times after projection at which the particle is 0.1m above the point of projection. **(5)**

Question 1 continued

TOTAL 5 MARKS

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

A sailer S has position vector $(3\mathbf{i}+6\mathbf{j})$m at time $t=0$. After 4 s, the boat is at the point with position vector $(\mathbf{i}-\mathbf{j})$ m. The position vector of S at a time t s is $\mathbf{r}$ m.

(a) Show that

$$\mathbf{r}=(3-0.5t)\mathbf{i}+(6-3.5t)\mathbf{j}$$

(4)

(b) Find the position vector of S when it is travelling north of O. **(3)**

The sailor travels for 20s and then stops to await further signals.

(c) Calculate the total distance travelled by the sailor in the first 20s of his motion. **(4)**

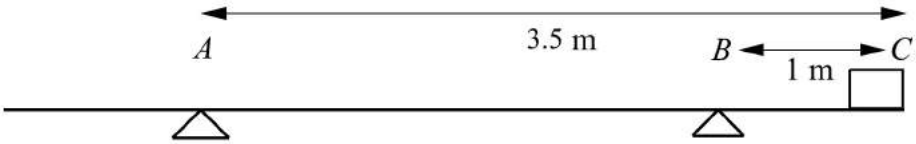
Question 2 continued

Question 2 continued

Question 2 continued

TOTAL 11 MARKS

3 A uniform rod of length 5 m and mass 20 kg is supported by two pivots, A and B. A mass of M kg is placed on the edge of the rod at the point C, such that $BC = 1\,\text{m}$ and $AC = 3.5\,\text{m}$, as shown in the diagram below. The magnitude of the normal reaction force at B is 294 N.



By modelling the mass attached at C as a particle, find

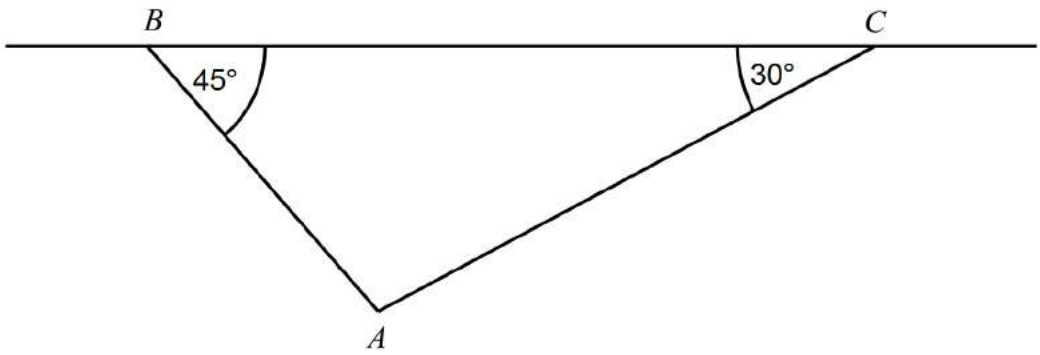
(i) the value of M

(ii) the magnitude of the normal reaction at A. **(7)**

Question 3 continued

TOTAL 7 MARKS

4



The points B and C lie on a horizontal ceiling. A particle P of mass $(10+k)$ kg is attached at A to two light inextensible strings AB and AC. B and C are fixed points attached to a horizontal ceiling. The tension in AB is 5 N. The system is in equilibirum.

(a) Find the tension in the string AC. **(3)**

(b) Find the value of k. **(3)**

Question 4 continued

TOTAL 6 MARKS

5 A child of mass 20 kg is sitting in a light sledge on a hill inclined at α° to the horizontal. His brother is trying to pull the sledge up the hill with a rope that is parallel to the slope of the hill. When the tension in the string is $100\cos\alpha$ N, the sledge is on the point of moving up the hill. The coefficient of friction between the hill and the sledge is $\frac{1}{5}$. By modelling the child in the sledge as a particle, the hill as a rough inclined plane and the rope as a light inextensible string, find the value of α.

(8)

Question 5 continued

TOTAL 8 MARKS

6 Three identical particles, A, B and C, of mass m kg lie at rest on a smooth horizontal table.

A is given an impulse of $3m$ Ns in the direction AB and collides directly with B.

Immediately after the collision, B moves with a speed of 2 ms^{-1} in the direction ABC.

B then collides directly with C and its direction of motion is reversed. After the collision, C moves with double the speed of B.

(a) Find the speed of A after its collision with B. **(4)**

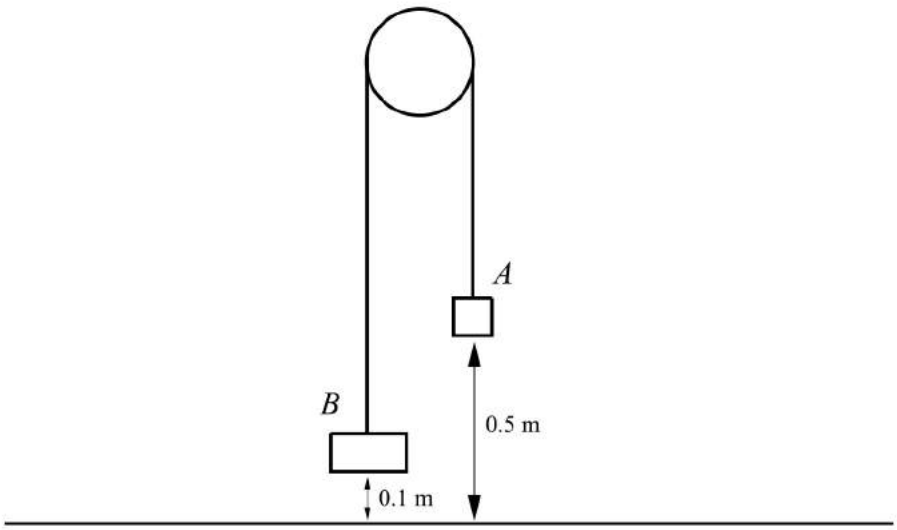
(b) Find the speed of B after it collides with C. **(3)**

(c) Explain whether or not B will have a subsequent collision with A. **(1)**

Question 6 continued

TOTAL 8 MARKS

7 Two masses, A and B, are connected by a light inextensible string that passes over a smooth pulley with the string taut. A and B have masses 3 kg and 7 kg respectively. The system is held in equilibrium. Initially, A and B are at a height of 0.5 m and 0.1 m above the table respectively, which is shown in the diagram below.



The system is released from rest.

(a) Find the acceleration of the particles and tension in the string. **(4)**

(b) Calculate the magnitude of the resultant force of the string on the pulley. **(2)**

When B hits the ground, the string is no longer taut and A continues to move until it reaches a height x m above the ground.

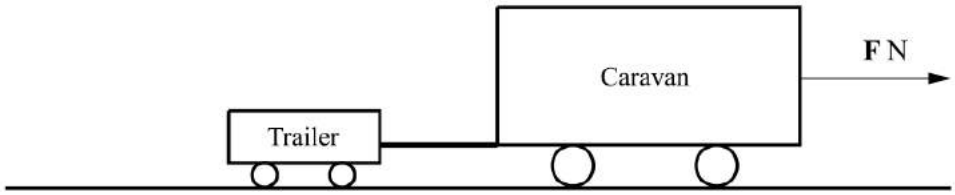
(c) Find the value of x. **(6)**

Question 7 continued

Question 6 continued

Question 7 continued

8



A light horizontal rod connects a caravan, of mass 2400 kg, and trailer, of mass 1000kg. The caravan starts to move at time $t = 0$ with a constant driving force **F** of 5400 N, as shown in the diagram above. The system moves under the influence of **F** for 30s before **F** is removed and the systems starts to decelerate as it approaches a set of traffic lights. During this motion, the resistances to the motions of the caravan and the trailer are 750 N and 500 N respectively.

By modelling the caravan and trailer as particles,

(a) Find the acceleration of the system under the influence of **F**. **(3)**

(b) Find the speed of the system at time $t = 10$. **(2)**

(c) Calculate the tension in the rod as the system moves under the influence of **F**. **(3)**

Given that the resistances to motion are unchanged when the system decelerates,

(d) Find the total distance moved until the system comes to rest. **(4)**

(e) Determine the force in the rod as the system decelerates and if the rod is in tension or thrust. **(3)**

(f) Draw a speed-time graph to represent the motion of the system. **(3)**

Question 8 continued

Question 8 continued

Question 8 continued

END OF PAPER **TOTAL 18 MARKS**