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Question 1 continued

Lined writing area for question 1.

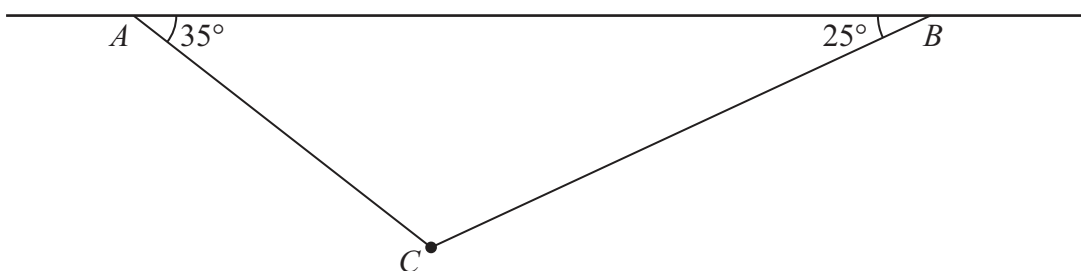
Q1

(Total 6 marks)



P 4 2 9 5 8 A 0 3 3 2

2.



**Figure 1**

A particle of weight 8 N is attached at  $C$  to the ends of two light inextensible strings  $AC$  and  $BC$ . The other ends,  $A$  and  $B$ , are attached to a fixed horizontal ceiling. The particle hangs at rest in equilibrium, with the strings in a vertical plane. The string  $AC$  is inclined at  $35^\circ$  to the horizontal and the string  $BC$  is inclined at  $25^\circ$  to the horizontal, as shown in Figure 1. Find

- (i) the tension in the string  $AC$ ,
- (ii) the tension in the string  $BC$ .

**(8)**

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3.

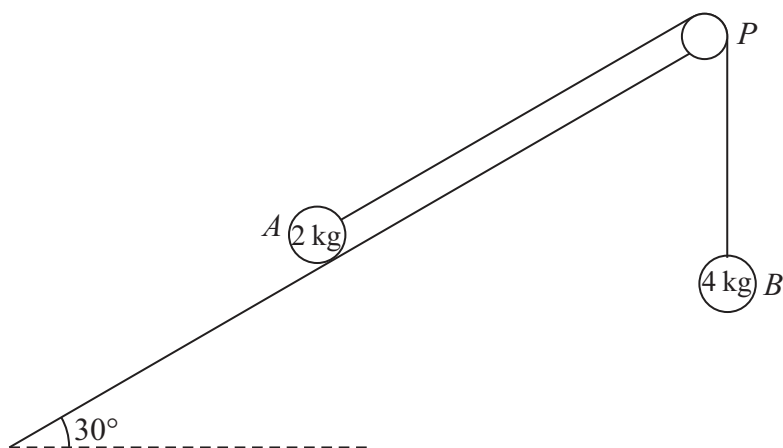


Figure 2

A fixed rough plane is inclined at  $30^\circ$  to the horizontal. A small smooth pulley  $P$  is fixed at the top of the plane. Two particles  $A$  and  $B$ , of mass  $2\text{ kg}$  and  $4\text{ kg}$  respectively, are attached to the ends of a light inextensible string which passes over the pulley  $P$ . The part of the string from  $A$  to  $P$  is parallel to a line of greatest slope of the plane and  $B$  hangs freely below  $P$ , as shown in Figure 2. The coefficient of friction between  $A$  and the plane is  $\frac{1}{\sqrt{3}}$ . Initially  $A$  is held at rest on the plane. The particles are released from rest with the string taut and  $A$  moves up the plane.

Find the tension in the string immediately after the particles are released.

**(9)**

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**Question 3 continued**

Lined writing area for the answer to Question 3.



P 4 2 9 5 8 A 0 9 3 2



Question 3 continued

Lined writing area for the answer to Question 3 continued.

(Total 9 marks)

Q3



4. At time  $t = 0$ , two balls  $A$  and  $B$  are projected vertically upwards. The ball  $A$  is projected vertically upwards with speed  $2 \text{ m s}^{-1}$  from a point  $50 \text{ m}$  above the horizontal ground. The ball  $B$  is projected vertically upwards from the ground with speed  $20 \text{ m s}^{-1}$ . At time  $t = T$  seconds, the two balls are at the same vertical height,  $h$  metres, above the ground. The balls are modelled as particles moving freely under gravity. Find

(a) the value of  $T$ , **(5)**

(b) the value of  $h$ . **(2)**

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5.

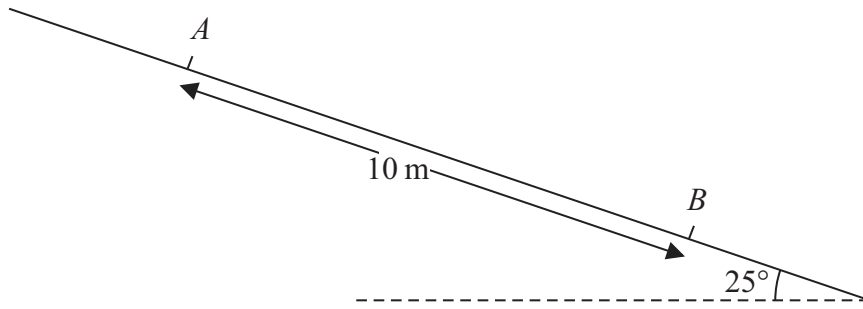


Figure 3

A particle  $P$  of mass  $0.6 \text{ kg}$  slides with constant acceleration down a line of greatest slope of a rough plane, which is inclined at  $25^\circ$  to the horizontal. The particle passes through two points  $A$  and  $B$ , where  $AB = 10 \text{ m}$ , as shown in Figure 3. The speed of  $P$  at  $A$  is  $2 \text{ m s}^{-1}$ . The particle  $P$  takes  $3.5 \text{ s}$  to move from  $A$  to  $B$ . Find

- (a) the speed of  $P$  at  $B$ , (3)
- (b) the acceleration of  $P$ , (2)
- (c) the coefficient of friction between  $P$  and the plane. (5)

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**Question 5 continued**

*(Lined area for writing answer)*

**Q5**

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**(Total 10 marks)**



6. [In this question  $\mathbf{i}$  and  $\mathbf{j}$  are horizontal unit vectors due east and due north respectively. Position vectors are given with respect to a fixed origin  $O$ .]

A ship  $S$  is moving with constant velocity  $(3\mathbf{i} + 3\mathbf{j}) \text{ km h}^{-1}$ . At time  $t = 0$ , the position vector of  $S$  is  $(-4\mathbf{i} + 2\mathbf{j}) \text{ km}$ .

- (a) Find the position vector of  $S$  at time  $t$  hours. (2)

A ship  $T$  is moving with constant velocity  $(-2\mathbf{i} + n\mathbf{j}) \text{ km h}^{-1}$ . At time  $t = 0$ , the position vector of  $T$  is  $(6\mathbf{i} + \mathbf{j}) \text{ km}$ . The two ships meet at the point  $P$ .

- (b) Find the value of  $n$ . (5)

- (c) Find the distance  $OP$ . (4)

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Question 6 continued

Lined area for writing the answer to Question 6.

(Total 11 marks)

Q6



7.

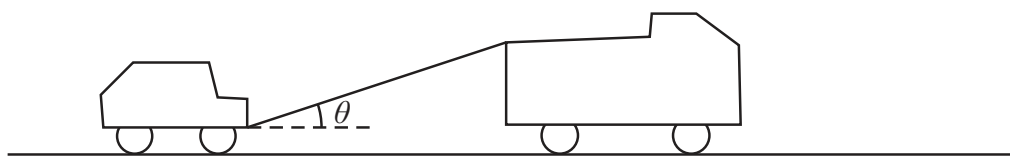


Figure 4

A truck of mass 1750 kg is towing a car of mass 750 kg along a straight horizontal road. The two vehicles are joined by a light towbar which is inclined at an angle  $\theta$  to the road, as shown in Figure 4. The vehicles are travelling at  $20 \text{ m s}^{-1}$  as they enter a zone where the speed limit is  $14 \text{ m s}^{-1}$ . The truck's brakes are applied to give a constant braking force on the truck. The distance travelled between the instant when the brakes are applied and the instant when the speed of each vehicle is  $14 \text{ m s}^{-1}$  is 100 m.

- (a) Find the deceleration of the truck and the car. (3)

The constant braking force on the truck has magnitude  $R$  newtons. The truck and the car also experience constant resistances to motion of 500 N and 300 N respectively. Given that  $\cos \theta = 0.9$ , find

- (b) the force in the towbar, (4)
- (c) the value of  $R$ . (4)

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Question 7 continued

A series of horizontal lines for writing, with a total of 34 lines.

(Total 11 marks)

Q7

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8.

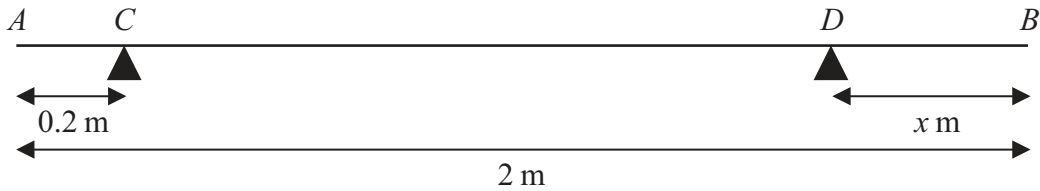


Figure 5

A uniform rod  $AB$  has length 2 m and mass 50 kg. The rod is in equilibrium in a horizontal position, resting on two smooth supports at  $C$  and  $D$ , where  $AC = 0.2$  metres and  $DB = x$  metres, as shown in Figure 5. Given that the magnitude of the reaction on the rod at  $D$  is twice the magnitude of the reaction on the rod at  $C$ ,

(a) find the value of  $x$ .

(6)

The support at  $D$  is now moved to the point  $E$  on the rod, where  $EB = 0.4$  metres. A particle of mass  $m$  kg is placed on the rod at  $B$ , and the rod remains in equilibrium in a horizontal position. Given that the magnitude of the reaction on the rod at  $E$  is four times the magnitude of the reaction on the rod at  $C$ ,

(b) find the value of  $m$ .

(7)

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