



1. In taking off, an aircraft moves on a straight runway  $AB$  of length 1.2 km. The aircraft moves from  $A$  with initial speed  $2 \text{ m s}^{-1}$ . It moves with constant acceleration and 20 s later it leaves the runway at  $C$  with speed  $74 \text{ m s}^{-1}$ . Find

(a) the acceleration of the aircraft, (2)

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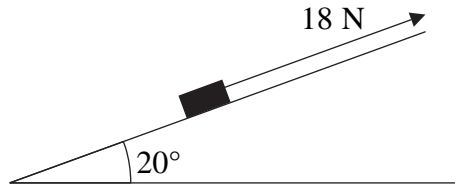






4.

Figure 2



A box of mass 2 kg is pulled up a rough plane face by means of a light rope. The plane is inclined at an angle of  $20^\circ$  to the horizontal, as shown in Figure 2. The rope is parallel to a line of greatest slope of the plane. The tension in the rope is 18 N. The coefficient of friction between the box and the plane is 0.6. By modelling the box as a particle, find

(a) the normal reaction of the plane on the box, (3)

(b) the acceleration of the box. (5)

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5. A train is travelling at  $10 \text{ m s}^{-1}$  on a straight horizontal track. The driver sees a red signal  $135 \text{ m}$  ahead and immediately applies the brakes. The train immediately decelerates with constant deceleration for  $12 \text{ s}$ , reducing its speed to  $3 \text{ m s}^{-1}$ . The driver then releases the brakes and allows the train to travel at a constant speed of  $3 \text{ m s}^{-1}$  for a further  $15 \text{ s}$ . He then applies the brakes again and the train slows down with constant deceleration, coming to rest as it reaches the signal.

(a) Sketch a speed-time graph to show the motion of the train, (3)

(b) Find the distance travelled by the train from the moment when the brakes are first applied to the moment when its speed first reaches  $3 \text{ m s}^{-1}$ . (2)

(c) Find the total time from the moment when the brakes are first applied to the moment when the train comes to rest. (5)

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**Question 5 continued**

Lined area for answer continuation.

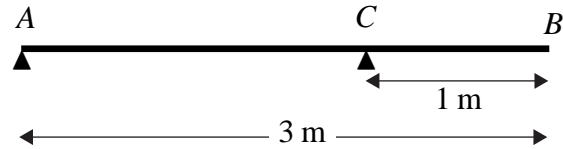
**Q5**

**(Total 10 marks)**



6.

Figure 3



A uniform beam  $AB$  has mass 12 kg and length 3 m. The beam rests in equilibrium in a horizontal position, resting on two smooth supports. One support is at the end  $A$ , the other at a point  $C$  on the beam, where  $BC = 1$  m, as shown in Figure 3. The beam is modelled as a uniform rod.

(a) Find the reaction on the beam at  $C$ .

(3)

A woman of mass 48 kg stands on the beam at the point  $D$ . The beam remains in equilibrium. The reactions on the beam at  $A$  and  $C$  are now equal.

(b) Find the distance  $AD$ .

(7)

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Figure 4

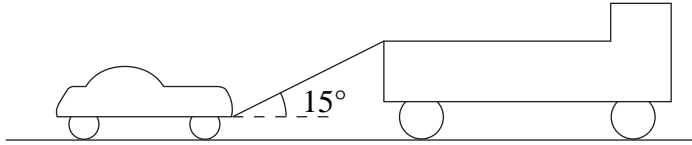


Figure 4 shows a lorry of mass  $1600\text{ kg}$  towing a car of mass  $900\text{ kg}$  along a straight horizontal road. The two vehicles are joined by a light towbar which is at an angle of  $15^\circ$  to the road. The lorry and the car experience constant resistances to motion of magnitude  $600\text{ N}$  and  $300\text{ N}$  respectively. The lorry’s engine produces a constant horizontal force on the lorry of magnitude  $1500\text{ N}$ . Find

- (a) the acceleration of the lorry and the car, (3)
- (b) the tension in the towbar. (4)

When the speed of the vehicles is  $6\text{ m s}^{-1}$ , the towbar breaks. Assuming that the resistance to the motion of the car remains of constant magnitude  $300\text{ N}$ ,

- (c) find the distance moved by the car from the moment the towbar breaks to the moment when the car comes to rest. (4)
- (d) State whether, when the towbar breaks, the normal reaction of the road on the car is increased, decreased or remains constant. Give a reason for your answer. (2)

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8. [In this question, the unit vectors  $\mathbf{i}$  and  $\mathbf{j}$  are horizontal vectors due east and north respectively.]

At time  $t = 0$ , a football player kicks a ball from the point  $A$  with position vector  $(2\mathbf{i} + \mathbf{j})$  m on a horizontal football field. The motion of the ball is modelled as that of a particle moving horizontally with constant velocity  $(5\mathbf{i} + 8\mathbf{j})$  m s<sup>-1</sup>. Find

(a) the speed of the ball, (2)

(b) the position vector of the ball after  $t$  seconds. (2)

The point  $B$  on the field has position vector  $(10\mathbf{i} + 7\mathbf{j})$  m.

(c) Find the time when the ball is due north of  $B$ . (2)

At time  $t = 0$ , another player starts running due north from  $B$  and moves with constant speed  $v$  m s<sup>-1</sup>. Given that he intercepts the ball,

(d) find the value of  $v$ . (6)

(e) State one physical factor, other than air resistance, which would be needed in a refinement of the model of the ball's motion to make the model more realistic. (1)

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**Question 8 continued**

Lined writing area for Question 8.

**Q8**

**(Total 13 marks)**

**TOTAL FOR PAPER: 75 MARKS**

**END**

