Topic X4 Mechanics (Post-TT) [55]

1.

A man of mass 70 kg stands on the floor of a lift which is moving with an upward acceleration of $0.3\,\text{m s}^{-2}$. Calculate the magnitude of the force exerted by the floor on the man. [4]

(Total 4 marks)

2.

An object is projected vertically upwards with speed $7\,\text{m s}^{-1}$. Calculate

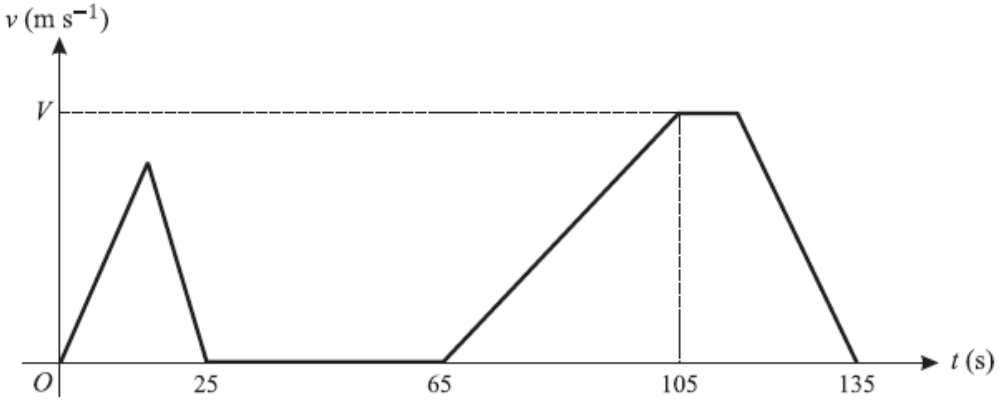
(i) the speed of the object when it is 2.1 m above the point of projection, **[3]**

(ii) the greatest height above the point of projection reached by the object, **[3]**

(iii) the time after projection when the object is travelling downwards with speed $5.7\,\text{m s}^{-1}$. **[3]**

(Total 9 marks)

3.



The diagram shows the (t, v) graph for the motion of a hoist used to deliver materials to different levels at a building site. The hoist moves vertically. The graph consists of straight line segments. In the first stage the hoist travels upwards from ground level for 25 s, coming to rest 8 m above ground level.

(i) Find the greatest speed reached by the hoist during this stage. [2]

The second stage consists of a 40 s wait at the level reached during the first stage. In the third stage the hoist continues upwards until it comes to rest 40 m above ground level, arriving 135 s after leaving ground level. The hoist accelerates at $0.02\,\text{m s}^{-2}$ for the first 40 s of the third stage, reaching a speed of $V\,\text{m s}^{-1}$. Find

(ii) the value of V, [3]

(iii) the length of time during the third stage for which the hoist is moving at constant speed, [4]

(iv) the deceleration of the hoist in the final part of the third stage. [3]

(Total 12 marks)

4.

A particle, of mass 400 grams, is initially at rest at the point O.

The particle starts to move in a straight line so that its velocity, v m s^{-1}, at time t seconds is given by

$$v = 6t^2 - 12t^3 \text{ for } t > 0$$

(a) Find an expression, in terms of t, for the force acting on the particle.

[3 marks]

(b) Find the time when the particle next passes through O.

[5 marks]

(Total 8 marks)

5.

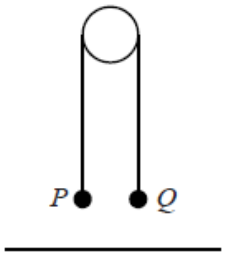
A trailer of mass 500 kg is attached to a car of mass 1250 kg by a light rigid horizontal tow-bar. The car and trailer are travelling along a horizontal straight road. The resistance to motion of the trailer is 400 N and the resistance to motion of the car is 900 N. Find both the tension in the tow-bar and the driving force of the car in each of the following cases.

(i) The car and trailer are travelling at constant speed. **[3]**

(ii) The car and trailer have acceleration 0.6 m s^{-2}. **[6]**

(Total 9 marks)

6.



Particles P and Q, of masses 0.4 kg and m kg respectively, are joined by a light inextensible string which passes over a smooth pulley. The particles are released from rest at the same height above a horizontal surface; the string is taut and the portions of the string not in contact with the pulley are vertical (see diagram). Q begins to descend with acceleration 2.45 m s^{-2} and reaches the surface 0.3 s after being released. Subsequently, Q remains at rest and P never reaches the pulley.

(i) Calculate the tension in the string while Q is in motion. **[3]**

(ii) Calculate the momentum lost by Q when it reaches the surface. **[5]**

(iii) Calculate the greatest height of P above the surface. **[5]**

(Total 13 marks)