

## 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

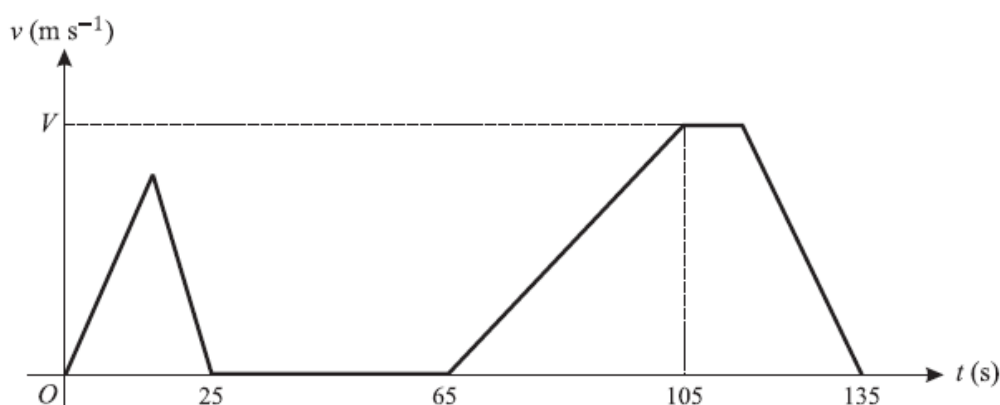
(i) the speed of the object when it is 2.1 m above the point of projection, [3]

(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,  $v \text{ m s}^{-1}$ , 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)

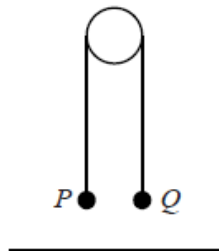
5.

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  $0.6 \text{ m s}^{-2}$ . [6]

(Total 9 marks)

6. **Do not do Qu 6(ii)**



Particles  $P$  and  $Q$ , of masses  $0.4 \text{ kg}$  and  $m \text{ kg}$  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  $2.45 \text{ m s}^{-2}$  and reaches the surface  $0.3 \text{ s}$  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)