

## Exam Questions – SUVAT (Mechanics Chapter 8 and 9)

Q1.

A car starts from rest and moves with constant acceleration along a straight horizontal road. The car reaches a speed of  $V \text{ m s}^{-1}$  in 20 seconds. It moves at constant speed  $V \text{ m s}^{-1}$  for the next 30 seconds, then moves with constant deceleration  $\frac{1}{2} \text{ m s}^{-2}$  until it has speed  $8 \text{ m s}^{-1}$ . It moves at speed  $8 \text{ m s}^{-1}$  for the next 15 seconds and then moves with constant deceleration  $\frac{1}{3} \text{ m s}^{-2}$  until it comes to rest.

(a) Sketch, in the space below, a speed-time graph for this journey.

(3)

In the first 20 seconds of this journey the car travels 140 m.

Find

(b) the value of  $V$ ,

(2)

(c) the total time for this journey,

(4)

(d) the total distance travelled by the car.

(4)

**(Total 13 marks)**

Q2.

An athlete runs along a straight road. She starts from rest and moves with constant acceleration for 5 seconds, reaching a speed of  $8 \text{ m s}^{-1}$ . This speed is then maintained for  $T$  seconds. She then decelerates at a constant rate until she stops. She has run a total of 500 m in 75 s.

(a) In the space below, sketch a speed-time graph to illustrate the motion of the athlete.

(b) Calculate the value of  $T$ .

**(3)**

**(5)**

**(Total 8 marks)**

Q3.

A particle  $P$  is projected vertically upwards from a point  $A$  with speed  $u \text{ m s}^{-1}$ . The point  $A$  is 17.5 m above horizontal ground. The particle  $P$  moves freely under gravity until it reaches the ground with speed  $28 \text{ m s}^{-1}$ .

(a) Show that  $u = 21$

(3)

At time  $t$  seconds after projection,  $P$  is 19 m above  $A$ .

(b) Find the possible values of  $t$ .

(5)

The ground is soft and, after  $P$  reaches the ground,  $P$  sinks vertically downwards into the ground before coming to rest. The mass of  $P$  is 4 kg and the ground is assumed to exert a constant resistive force of magnitude 5000 N on  $P$ .

(c) Find the vertical distance that  $P$  sinks into the ground before coming to rest.

(4)

**(Total 12 marks)**

Q4.

A small stone is projected vertically upwards with speed  $39.2 \text{ m s}^{-1}$  from a point  $O$ .

The stone is modelled as a particle moving freely under gravity from when it is projected until it hits the ground 10 s later.

Using the model, find

(a) the height of  $O$  above the ground,

(3)

(b) the total length of time for which the speed of the stone is less than or equal to  $24.5 \text{ m s}^{-1}$

(3)

(c) State one refinement that could be made to the model that would make your answer to part (a) more accurate.

(1)

**(Total for question = 7 marks)**

Q5.

At time  $t = 0$ , a small stone is thrown vertically upwards with speed  $14.7 \text{ m s}^{-1}$  from a point  $A$ .

At time  $t = T$  seconds, the stone passes through  $A$ , moving downwards.

The stone is modelled as a particle moving freely under gravity throughout its motion.

Using the model,

(a) find the value of  $T$ ,

(2)

(b) find the total distance travelled by the stone in the first 4 seconds of its motion.

(4)

(c) State one refinement that could be made to the model, apart from air resistance, that would make the model more realistic.

(1)

**(Total for question = 7 marks)**