Kinematics 2

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 m s^{-1}. It moves with constant acceleration and 20 s later it leaves the runway at C with speed 74 m s^{-1}. Find

(a) the acceleration of the aircraft,

(2)

(b) the distance BC.

(4)

2.

A stone is thrown vertically upwards with speed 16 m s^{-1} from a point h metres above the ground. The stone hits the ground 4 s later. Find

(a) the value of h,

(3)

(b) the speed of the stone as it hits the ground.

(3)

3.

A ball is projected vertically upwards with speed 21 m s^{-1} from a point A, which is 1.5 m above the ground. After projection, the ball moves freely under gravity until it reaches the ground. Modelling the ball as a particle, find

(a) the greatest height above A reached by the ball,

(3)

(b) the speed of the ball as it reaches the ground,

(3)

(c) the time between the instant when the ball is projected from A and the instant when the ball reaches the ground.

(4)

4.

A firework rocket starts from rest at ground level and moves vertically. In the first 3 s of its motion, the rocket rises 27 m. The rocket is modelled as a particle moving with constant acceleration a m s^{-2}. Find

(a) the value of a,

(2)

(b) the speed of the rocket 3 s after it has left the ground.

(2)

After 3 s, the rocket burns out. The motion of the rocket is now modelled as that of a particle moving freely under gravity.

(c) Find the height of the rocket above the ground 5 s after it has left the ground.

(4)

5.

At time $t = 0$, a particle is projected vertically upwards with speed u m s^{-1} from a point 10 m above the ground. At time T seconds, the particle hits the ground with speed 17.5 m s^{-1} . Find

(a) the value of u,

(3)

(b) the value of T.

(4)

6.

Three posts P, Q and R, are fixed in that order at the side of a straight horizontal road. The distance from P to Q is 45 m and the distance from Q to R is 120 m. A car is moving along the road with constant acceleration a m s^{-2}. The speed of the car, as it passes P, is u m s^{-1}. The car passes Q two seconds after passing P, and the car passes R four seconds after passing Q. Find

(i) the value of u,

(ii) the value of a.

(7)

7.

A ball is thrown vertically upwards with speed u m s^{-1} from a point P at height h metres above the ground. The ball hits the ground 0.75 s later. The speed of the ball immediately before it hits the ground is 6.45 m s^{-1}. The ball is modelled as a particle.

(a) Show that $u = 0.9$

(3)

(b) Find the height above P to which the ball rises before it starts to fall towards the ground again.

(2)

(c) Find the value of h.

(3)

8.

At time $t = 0$ a ball is projected vertically upwards from a point O and rises to a maximum height of 40 m above O. The ball is modelled as a particle moving freely under gravity.

(a) Show that the speed of projection is 28 m s^{-1}.

(3)

(b) Find the times, in seconds, when the ball is 33.6 m above O.

(5)

9.

A particle is projected vertically upwards from a point O at $21\,\text{m s}^{-1}$.

(i) Calculate the greatest height reached by the particle. [2]

When this particle is at its highest point, a second particle is projected vertically upwards from O at $15\,\text{m s}^{-1}$.

(ii) Show that the particles collide 1.5 seconds later and determine the height above O at which the collision takes place. [6]

10.

A car is driven with constant acceleration, a m s^{-2}, along a straight road. Its speed when it passes a road sign is u m s^{-1}. The car travels 14 m in the 2 seconds after passing the sign; 5 seconds after passing the sign it has a speed of 19 m s^{-1}.

(i) Write down two equations connecting a and u. Hence find the values of a and u. [5]

(ii) What distance does the car travel in the 5 seconds after passing the road sign? [2]
