Kinematics – 2021/20 GCE Mechanics Mathematics A

1. Nov/2021/Paper_H240/03/No.9

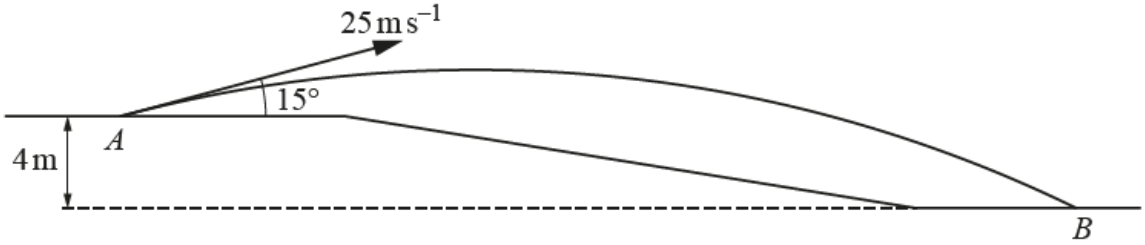
There are three checkpoints, A, B and C, in that order, on a straight horizontal road. A car travels along the road, in the direction from A to C, with constant acceleration. The car takes 20 s to travel from B to C. The speed of the car at B is $14\,\text{m s}^{-1}$ and the speed of the car at C is $18\,\text{m s}^{-1}$.

(a) Find the acceleration of the car. **[1]**

It is given that the distance between A and B is 330 m.

(b) Determine the speed of the car at A. **[2]**

2. Nov/2021/Paper_H240/03/No.11



A golfer hits a ball from a point A with a speed of $25\,\text{m s}^{-1}$ at an angle of 15° above the horizontal. While the ball is in the air, it is modelled as a particle moving under the influence of gravity. Take the acceleration due to gravity to be $10\,\text{m s}^{-2}$.

The ball first lands at a point B which is 4 m below the level of A (see diagram).

(a) Determine the time taken for the ball to travel from A to B. **[3]**

(b) Determine the horizontal distance of B from A. **[2]**

(c) Determine the direction of motion of the ball 1.5 seconds after the golfer hits the ball. **[4]**

The horizontal distance from A to B is found to be greater than the answer to part **(b)**.

(d) State one factor that could account for this difference. **[1]**

3. Nov/2020/Paper_H240/03/No.7

A particle P moves with constant acceleration $(-4\mathbf{i}+2\mathbf{j})\,\text{m s}^{-2}$. At time $t = 0$ seconds, P is moving with velocity $(7\mathbf{i}+6\mathbf{j})\,\text{m s}^{-1}$.

(a) Determine the speed of P when $t = 3$. **[4]**

(b) Determine the change in displacement of P between $t = 0$ and $t = 3$. **[2]**

4. Nov/2020/Paper_H240/03/No.8

A car is travelling on a straight horizontal road. The velocity of the car, $v\,\text{m s}^{-1}$, at time t seconds as it travels past three points, P, Q and R, is modelled by the equation

$$v = at^2 + bt + c,$$

where a, b and c are constants.

The car passes P at time $t = 0$ with velocity $8\,\text{m s}^{-1}$.

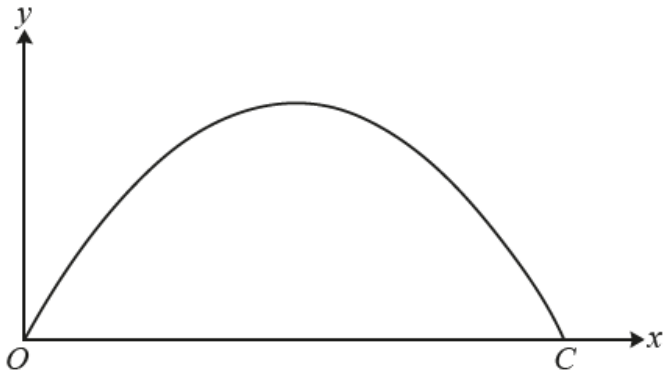
(a) State the value of c. **[1]**

The car passes Q at time $t = 5$ and at that instant its deceleration is $0.12\,\text{m s}^{-2}$. The car passes R at time $t = 18$ with velocity $2.96\,\text{m s}^{-1}$.

(b) Determine the values of a and b. **[4]**

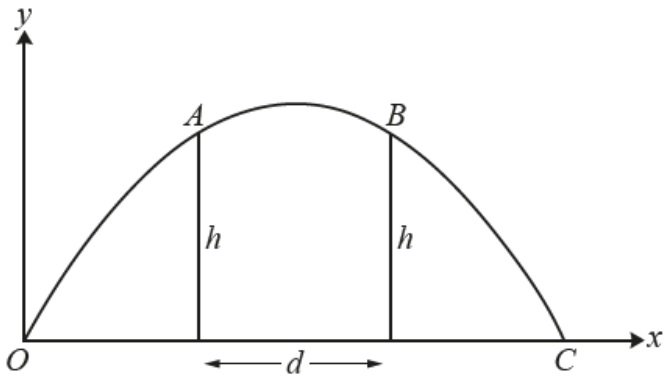
(c) Find, to the nearest metre, the distance between points P and R. **[2]**

5. Nov/2020/Paper_H240/03/No.11



A particle P moves freely under gravity in the plane of a fixed horizontal axis Ox, which lies on horizontal ground, and a fixed vertical axis Oy. P is projected from O with a velocity whose components along Ox and Oy are U and V, respectively. P returns to the ground at a point C.

(a) Determine, in terms of U, V and g, the distance OC. **[4]**



P passes through two points A and B, each at a height h above the ground and a distance d apart, as shown in the diagram.

(b) Write down the horizontal and vertical components of the velocity of P at A. **[2]**

(c) Hence determine an expression for d in terms of U, V, g and h. **[3]**

(d) Given that the direction of motion of P as it passes through A is inclined to the horizontal at an angle θ, where $\tan\theta = \frac{1}{2}$, determine an expression for V in terms of g, d and h. **[4]**