Kinematics – 2018 November

1. 9702/21/O/N/18/No.1

(a) Define

(i) *displacement*,

.....

..... [1]

(ii) *acceleration*.

.....

..... [1]

(b) A remote-controlled toy car moves up a ramp and travels across a gap to land on another ramp, as illustrated in Fig. 1.1.

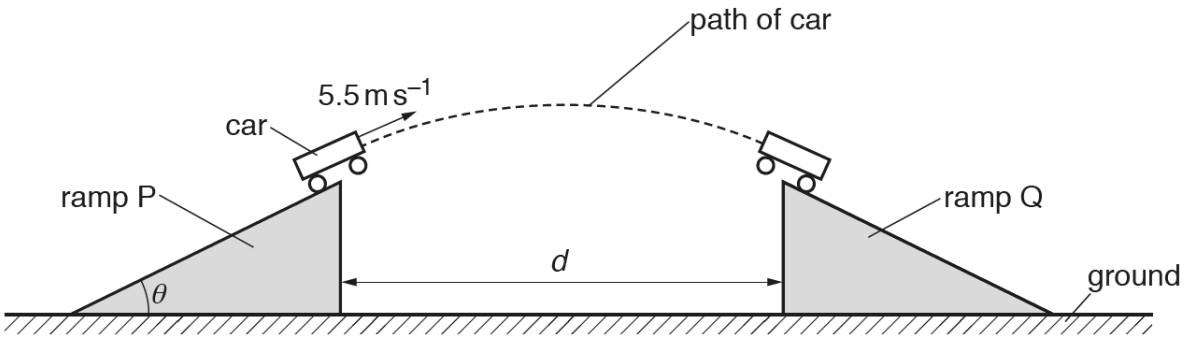

Fig. 1.1

The car leaves ramp P with a velocity of $5.5\,m\,s^{-1}$ at an angle θ to the horizontal. The horizontal component of the car's velocity as it leaves the ramp is $4.6\,m\,s^{-1}$. The car lands at the top of ramp Q. The tops of both ramps are at the same height and are distance *d* apart. Air resistance is negligible.

(i) Show that the car leaves ramp P with a vertical component of velocity of $3.0\,m\,s^{-1}$.

[1]

(ii) Determine the time taken for the car to travel between the ramps.

time taken = ... s [2]

(iii) Calculate the horizontal distance *d* between the tops of the ramps.

d = ... m [1]

(iv) Calculate the ratio

$$\frac{\text{kinetic energy of the car at its maximum height}}{\text{kinetic energy of the car as it leaves ramp P}}.$$

ratio = ... [3]

(c) Ramp Q is removed. The car again leaves ramp P as in **(b)** and now lands directly on the ground. The car leaves ramp P at time $t = 0$ and lands on the ground at time $t = T$.

On Fig. 1.2, sketch the variation with time t of the vertical component v_y of the car's velocity from $t = 0$ to $t = T$. Numerical values of v_y and t are not required.

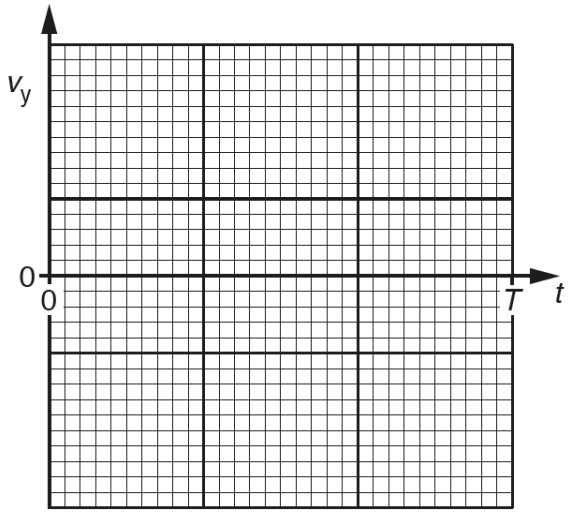

Fig. 1.2

[2]

[Total: 11]

2. 9702/22/O/N/18/No.1

A golfer strikes a ball so that it leaves horizontal ground with a velocity of $6.0\,m\,s^{-1}$ at an angle θ to the horizontal, as illustrated in Fig. 1.1.

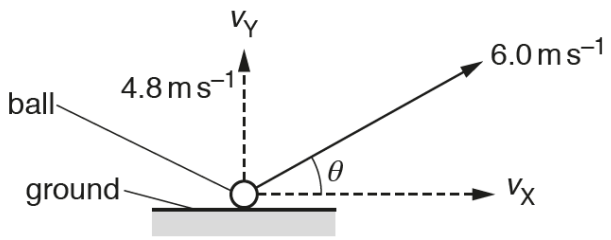

Fig. 1.1 (not to scale)

The magnitude of the initial vertical component v_Y of the velocity is $4.8\,m\,s^{-1}$.
Assume that air resistance is negligible.

(a) Show that the magnitude of the initial horizontal component v_X of the velocity is $3.6\,m\,s^{-1}$.

[1]

(b) The ball leaves the ground at time $t = 0$ and reaches its maximum height at $t = 0.49$ s.

On Fig. 1.2, sketch separate lines to show the variation with time t, until the ball returns to the ground, of

(i) the vertical component v_Y of the velocity (label this line Y), [2]

(ii) the horizontal component v_X of the velocity (label this line X). [2]

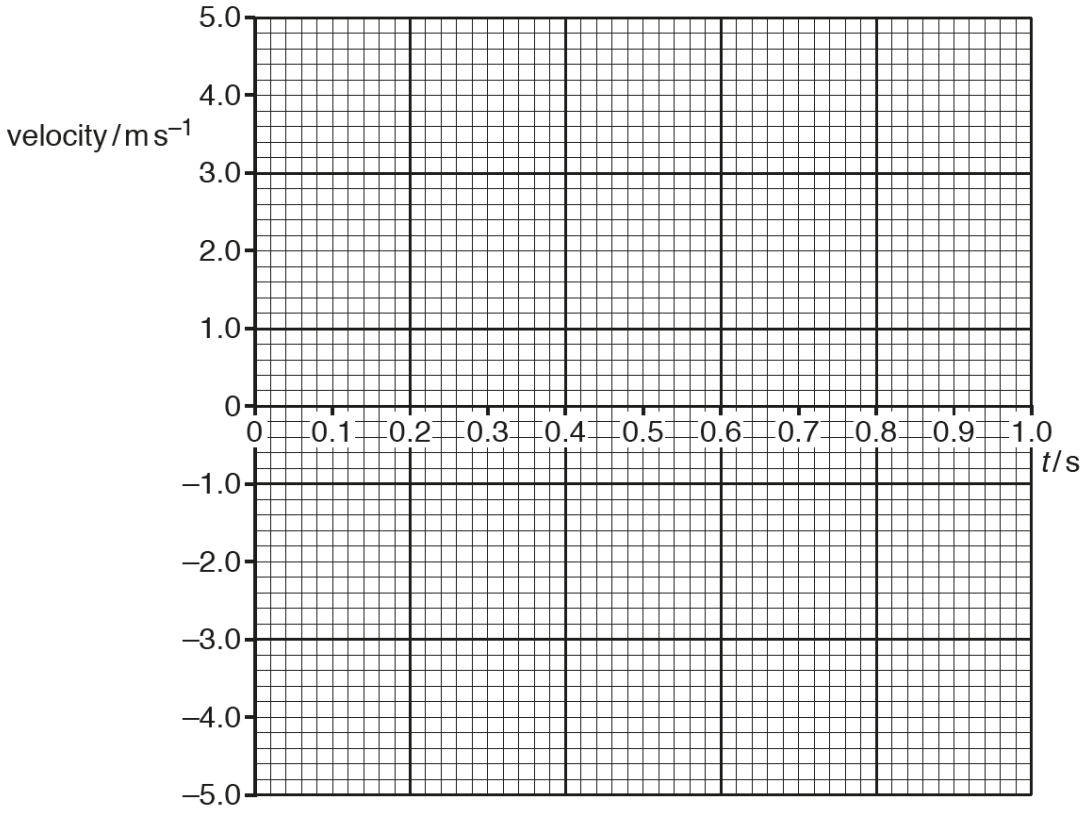

Fig. 1.2

(c) Calculate the maximum height reached by the ball.

maximum height = ... m [2]

(d) For the movement of the ball from the ground to its maximum height, determine the ratio

$$\frac{\text{kinetic energy at maximum height}}{\text{change in gravitational potential energy}}.$$

ratio = ...[4]

(e) In practice, significant air resistance acts on the ball. Explain why the actual time taken for the ball to reach maximum height is less than the time calculated when air resistance is assumed to be negligible.

.....

.....

.....[1]

[Total: 12]