H2 Physics Revision Topic : Kinematicss

Structured Questions Name: ______________________

1 A ball is kicked from horizontal ground towards a vertical wall as shown in Fig. 2.1.

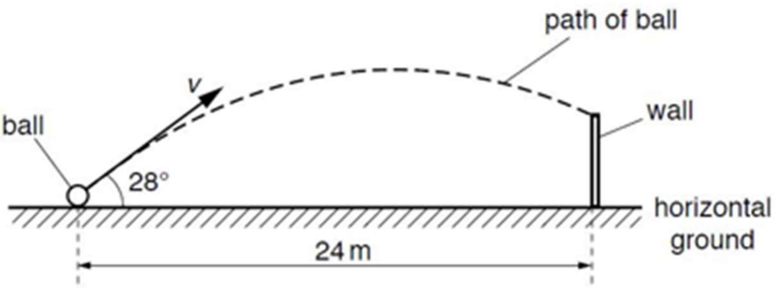


Fig 2.1 (not to scale)

The horizontal distance between the initial position of the ball and the base of the wall is 24 m. The ball is kicked with an initial velocity v at an angle of 28° to the horizontal. The ball just hits the top of the wall after a time of 1.5 s.

(a) Calculate the horizontal component v_X of the velocity of the ball.

v_X = ... m s^{-1} [1]

(b) Hence or otherwise, show that the initial vertical component v_Y of the velocity of the ball is 8.5 m s^{-1}.

[1]

1 **(c)** The ball is kicked at time t = 0. Assume that the vertical component v_Y of the velocity of the ball is positive in the upwards direction.

(i) On Fig. 2.2, sketch the variation with time t of v_Y for the time until the ball hits the wall.

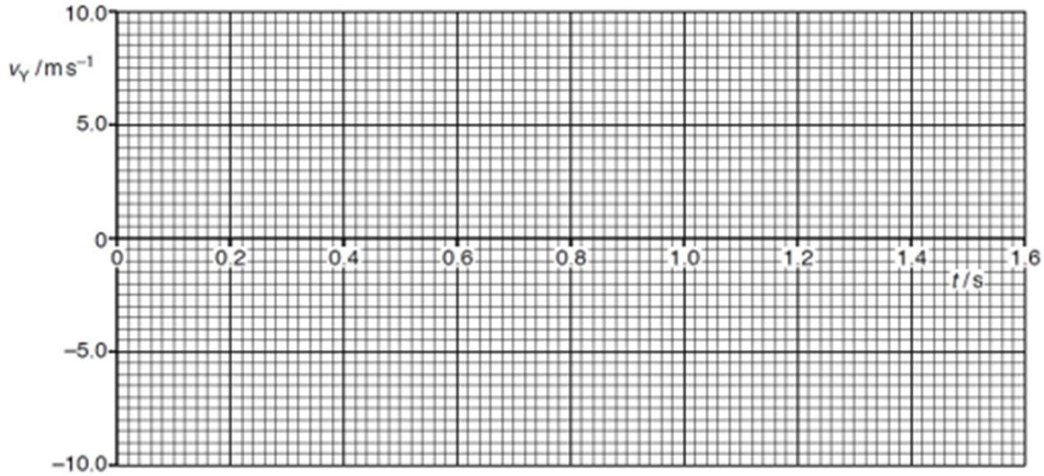


Fig. 2.2

[3]

(ii) Using Fig. 2.2, determine the maximum height above the ground that the ball reached.

maximum height = ... m [2]

(iii) Hence or otherwise, determine the ratio of its $\dfrac{\text{kinetic energy}}{\text{gravitational potential energy}}$ when the ball is at its maximum height.

ratio = ... [2]

(iv) If air resistance is not negligible, on Fig 2.2, sketch the variation with time t of v_Y for the time until the ball hits the ground.

Label this line W. [2]

2 **(a)** A delivery company suggests using a remote-controlled aircraft to drop a parcel into the garden of a customer. When the aircraft is vertically above point P on the ground, it releases the parcel with a velocity that is horizontal and of magnitude 5.40 m s^{-1}. The path of the parcel is shown in Fig. 1.1.

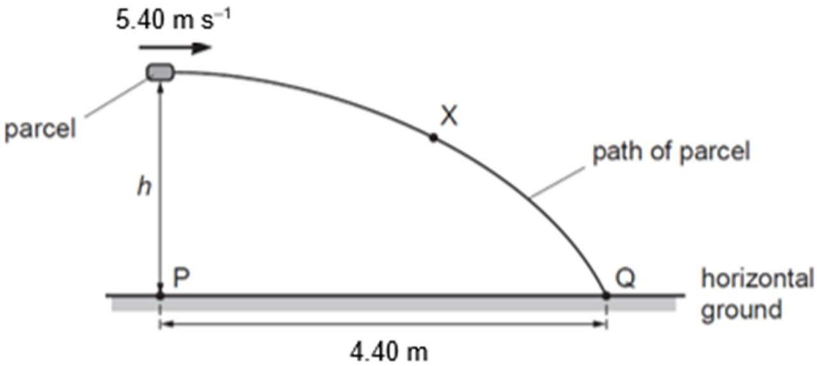


Fig. 1.1 (not to scale)

The parcel travels a horizontal distance of 4.40 m after its release to reach point Q on the horizontal ground.
Assume air resistance is negligible.

Determine the height h of the parcel above the ground when it is released.

h = ...m [2]

(b) Another parcel is accidentally released from rest by a different aircraft when it is hovering at a great height above the ground. Air resistance is now significant.

(i) On Fig. 1.2, draw arrows to show the directions of the forces acting on the parcel as it falls vertically downwards. Label each arrow with the name of the force.

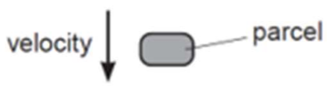


Fig. 1.2

[1]

2

(ii) By considering the forces acting on the parcel, state and explain the variation, if any, of the acceleration of the parcel as it moves downwards before it reaches constant (terminal) speed.

....

....

....

....

....

.... [3]

(iii) State and explain the effect of having a larger mass on the terminal velocity of the parcel.

....

....

....

....

....

.... [2]

(iv) Describe the energy conversion(s) that occur(s) when the parcel is falling through the air

1. before it reaches constant speed

....

....

2. after it reaches constant speed.

....

....

[2]

[Total: 10]

3 **(a)** Explain what is meant by *acceleration*.

....[1]

(b) A ball is kicked from horizontal ground towards the top of a vertical wall, as shown in Fig. 1.1.

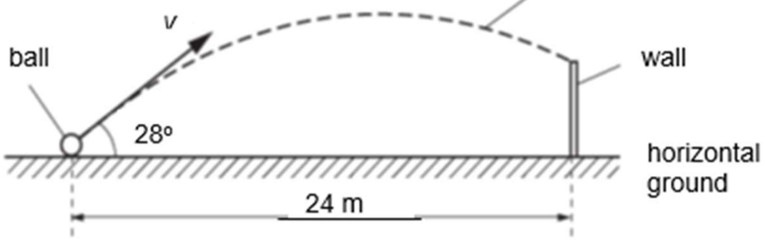


Fig. 1.1 (not to scale)

The horizontal distance between the initial position of the ball and the base of the wall is 24 m. The ball is kicked with an initial velocity v at an angle of 28° to the horizontal. The ball hits the top of the wall after a time of 1.5 s. Air resistance may be assumed to be negligible.

(i) Calculate the initial horizontal component v_X of the velocity of the ball.

v_X = ...m s^{-1} [1]

(ii) Show that the initial vertical component v_Y of the velocity of the ball is 8.5 m s^{-1}.

[1]

3 **(iii)** Calculate the time taken for the ball to reach its maximum height above the ground.

time = …………………… s [2]

(iv) The ball is kicked at time $t = 0$. On Fig. 1.2, sketch the variation with time t of the vertical component v_Y of the velocity of the ball until it hits the wall. It may be assumed that velocity is positive when in the upward direction. [2]

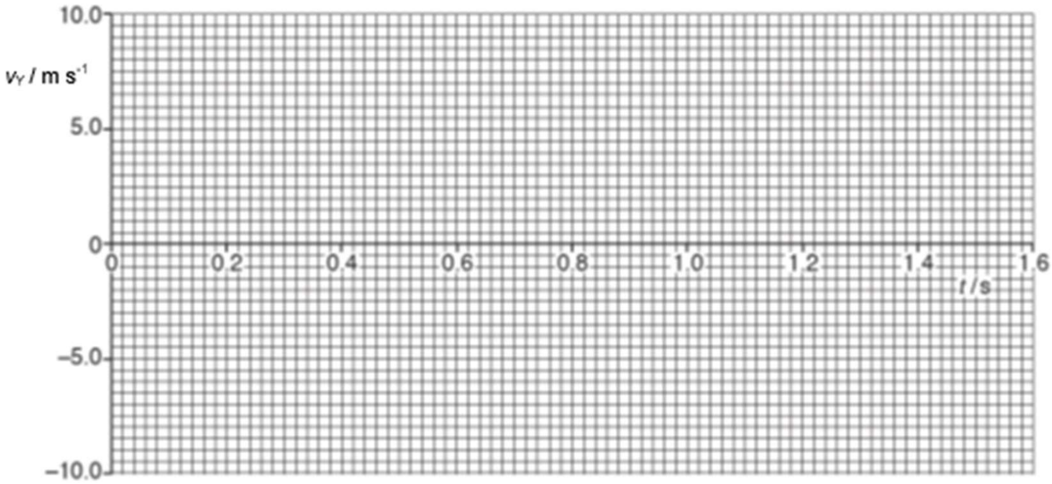


Fig. 1.2

(c) Determine the maximum height of the ball above the ground.

maximum height = …………………… m [2]

3

(d) A ball of greater mass is kicked with the same velocity as the ball in **(b)**.
State and explain the effect, if any, of the increased mass on the maximum height reached by the ball. Air resistance is still assumed to be negligible.

....

.... [1]

4

An object is launched at a speed of 30 m s^{-1} at an angle of 30° from a horizontal surface, as shown in Fig. 1.1.

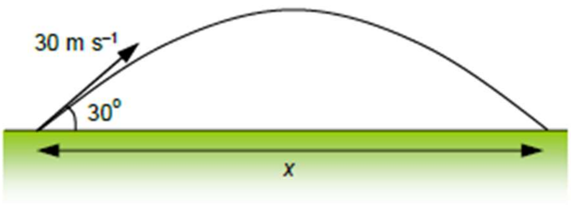


Fig. 1.1

Assume air resistance is negligible.

(a) **(i)** Determine the time taken for the object's entire journey.

time = ... s [2]

(ii) Hence, determine the range x of the launch.

x = ... m [1]

4

(b) On Fig. 1.2 below, sketch the graphs that show the variation with time of the vertical component of the velocity when

(i) air resistance is negligible and label it as **A**, [3]

(ii) air resistance is **not** negligible and label it as **B**. [2]

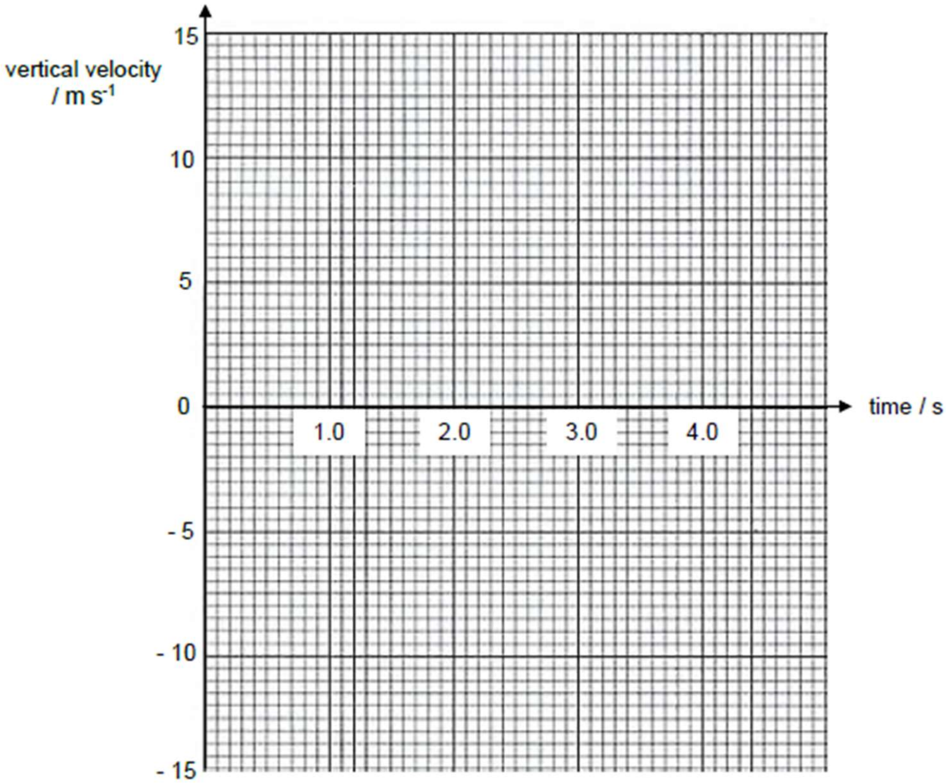


Fig. 1.2

[Total: 8]

5 **(a)** A body has an initial velocity *u* and an acceleration *a*. After a time *t*, the body has moved a displacement *s* and has a final velocity *v*. One of the equations of motion of this body is

$$s = ut + \frac{1}{2}at^2$$

State the conditions that must be satisfied for the above equation to be valid.

....

....[2]

(b) A hot air balloon is moving at a constant velocity of 11.7 m s^{-1}, at an angle of 59° from the horizontal, as shown in Fig. 1.1 below.

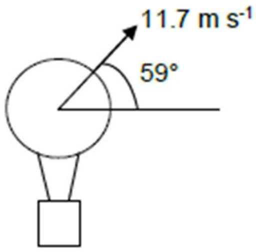


Fig. 1.1

(i) Determine the vertical component of the velocity of the balloon.

vertical component of the velocity = ... m s^{-1} [1]

(ii) A slotted mass is released from the balloon. Fig. 1.2 shows the subsequent path of the slotted mass. The dotted figure shows the position of the hot air balloon at the instant when the slotted mass is released.

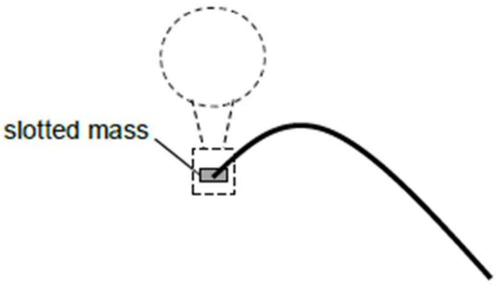


Fig. 1.2

5

1. Throughout the motion, the slotted mass is observed to be directly below the hot air balloon. Explain why this is so.

....

....[1]

2. Determine how far below the balloon would the slotted mass be after 3.0 s. You may assume that the slotted mass has not yet landed on the ground and that air resistance on the slotted mass is negligible.

distance = ... m [3]

3. Describe qualitatively the changes, if any, to the answer in **(b)(ii)2** if a 100 kg cargo was dropped from the balloon instead of the slotted mass. Assume air resistance on the cargo is negligible too.

....

....[1]

[Total: 8]

6 **(a)** A body has an initial velocity u and a constant acceleration a in the same direction. After time t, the body has moved a distance s and has a final velocity v. The motion can be summarised by the following equations

$$v = u + at$$

$$s = \frac{1}{2}(u + v)t$$

Using the above equations, derive an expression for v in terms of u, a and s.

[1]

(b) Fig. 1.1 shows a basketball player practicing a layup where the basketball of diameter 0.23 m is tossed vertically upwards close to the rim of the hoop into the hoop.

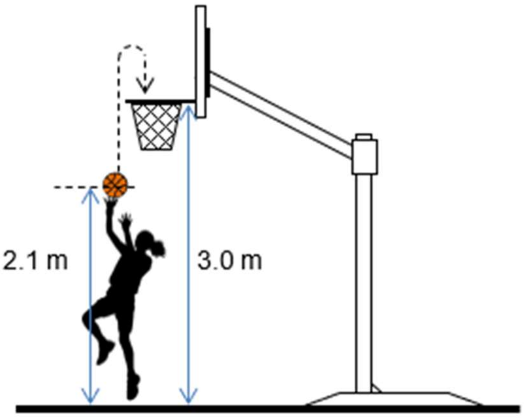


Fig. 1.1

Determine the minimum vertical velocity of release required in order for the basketball to enter the basket when it is thrown upwards from a height of 2.1 m.

minimum vertical velocity = ... m s^{-1} [3]

6 **(c)** Fig. 1.2 shows another basketball player taking a jumpshot from the three-point line of a basketball court. He releases the basketball at an angle of 50° above the horizontal with speed *u* at line A at a height of 2.5 m above the ground. The hoop is at line B, 3.0 m above the ground and 6.7 m from line A.

The basketball takes 1.3 s to travel from line A to line B.

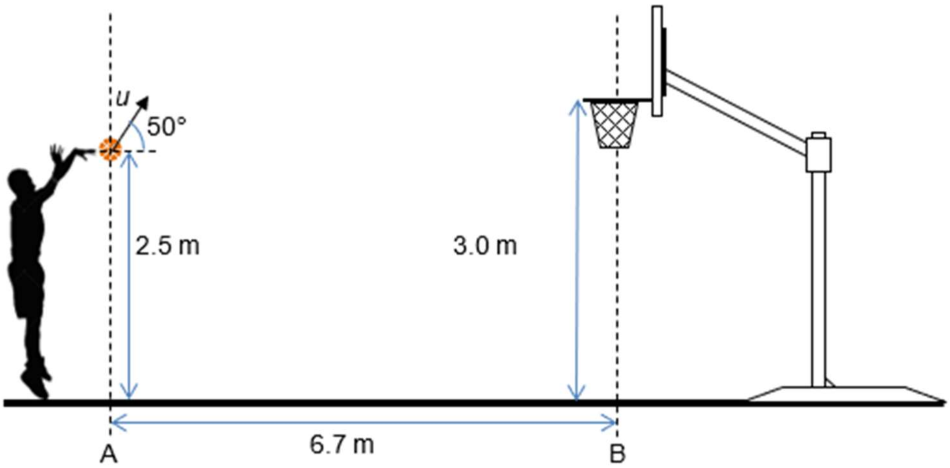


Fig. 1.2

(i) Show that the speed *u* is 8.0 m s^{-1}.

[1]

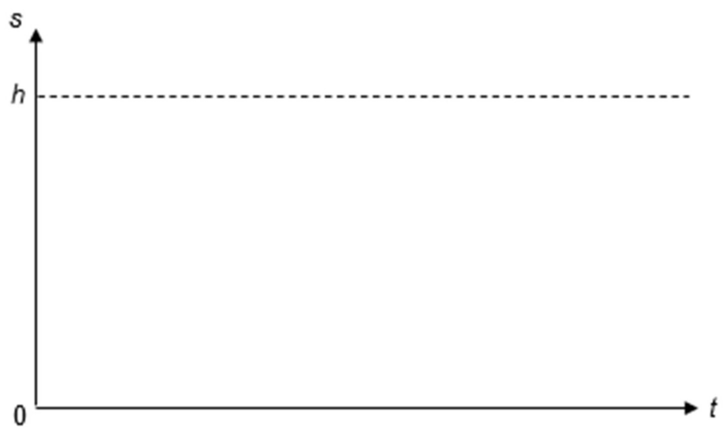
(ii) Hence, calculate the height of the basketball above the ground at line B.

height = ... m [3]

7 **(a)** A ball is released from rest a distance h above a rigid horizontal surface and it rebounds along its original path inelastically.

Taking air resistance as negligible and downwards as positive, sketch on the axes provided, for at least 2 bounces, its corresponding graph representing the variation with time t of

(i) its displacement, s



[2]

(ii) its velocity, v

[2]

7

(b) When the ball is released at height *h* above the ground, it reaches the ground with speed 3.8 m s^{-1}. The ball is then in contact with the floor for a time of 0.081 s before leaving it with speed 1.7 m s^{-1}. The mass of the ball is 0.062 kg.

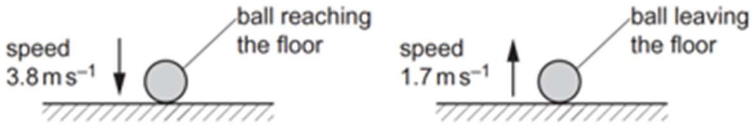


Fig. 2.1

(i) Calculate height *h*.

h = ... m [1]

(ii) Calculate the magnitude of the average force the ground acts on the ball during the collision.

magnitude of the average force = ... N [2]

7 **(c)** Two parallel metal plates, each of length 20.0 cm, are separated by 10.0 cm, as illustrated in Fig. 2.2 below that is not drawn to scale.

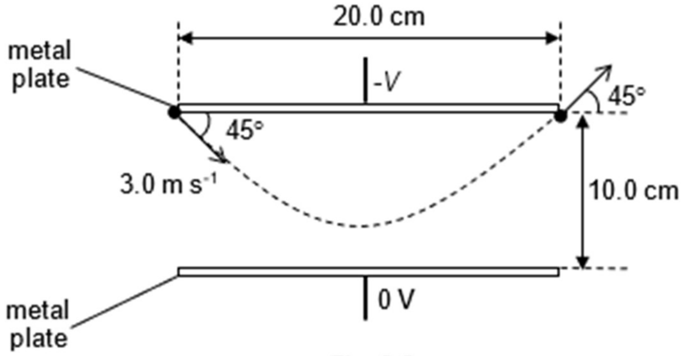


Fig. 2.2

The plates are in a vacuum.

A small ball bearing of charge $+4.4 \times 10^{-7}$ C and mass 1.0×10^{-4} kg with an initial speed 3.0 m s^{-1} enters the plates at an angle of 45° below the horizontal, and just leave the plates at an angle of 45° above the horizontal, as shown in Fig. 2.2.

Calculate the potential *V* of the plate at the top.

V = ... V [3]