VERTICAL MOTION UNDER GRAVITY

5. A ball is thrown vertically **downwards** with initial speed $3.2\,ms^{-1}$ from a point A which is $8.1\,m$ above the horizontal ground. The coefficient of restitution between the ball and the ground is $\frac{1}{4}$.

(a) Show that the speed of the ball immediately after it first rebounds from the ground is $3.25\,ms^{-1}$. [5]

(b) Find the time that elapses between the first bounce and the instant when the ball is next $0.4\,m$ above the ground. [4]

1. A small object, of mass $0.02kg$ at the top of a building $160\,m$ high, is dropped from rest.

(a) Ignoring air resistance, calculate

 (i) the speed of the object as it hits the ground,

 (ii) the time taken for the object to reach the ground. [6]

(b) Assuming that the air resistance has magnitude $0.096\,N$, calculate

 (i) the magnitude of the acceleration of the object,

 (ii) the height of the object above the ground $4\,s$ after it was dropped. [6]

5. A particle is projected vertically upwards with speed $22.05\,ms^{-1}$.

(a) Calculate the time that elapses before the particle returns to the point of projection and the speed of the particle at that time. [4]

(b) Find the greatest height of the particle above the point of projection. [3]

(c) Determine the speed and direction of motion of the particle $3\,s$ after projection. [4]

(980-01)

— 1. A pebble is projected vertically upwards with speed $10.5\,ms^{-1}$ from a point A at the top of a cliff.

(a) Find the greatest height above A reached by the pebble. [3]

(b) The pebble reached the bottom of the cliff $5\,s$ after being projected. Calculate the height of the cliff. [3]

2. A ball is hit vertically up into the air from a point A, which is $1.75\,m$ above the ground. The ball hits the ground for the first time after $2.5\,s$. Ignoring air resistance,

(a) show that the initial speed of the ball is $11.55\,ms^{-1}$, [2]

(b) find the greatest height above the ground reached by the ball, [3]

(c) calculate the speed of the ball as it hits the ground, [3]

(d) calculate the speed of the ball immediately after the first bounce if the coefficient of restitution between the ball and the ground is 0.8. [2]

2. A ball is dropped from rest from a height of 3·6 m above a horizontal floor. The coefficient of restitution between the ball and the floor is 0·3. Calculate the speed of the ball immediately after it rebounds from the floor. [5]

2. A stone is projected vertically upwards from a point A at the top of a tower 70 m high. It reaches the highest point of its path after 2·5 s.

(a) Show that the speed of projection of the stone is 24·5 ms⁻¹. [2]

(b) Find the height of the stone above A 4 s after projection. [3]

(c) Calculate the speed of the stone when it reaches the ground. [3]

2. A paratrooper jumps out of a stationary helicopter so that his initial velocity is 2 ms⁻¹ vertically downwards. He falls freely under gravity for 1·5 s, then his parachute opens and he descends vertically with uniform retardation for a further 22·5 s. His speed is zero as he reaches the ground.

(a) Calculate the speed of the paratrooper just before his parachute opens. [3]

(b) Draw a sketch of the velocity-time graph for the paratrooper's descent. [3]

(c) Calculate the height of the paratrooper above the ground when he jumped out of the helicopter. [3]

1. A boy throws a pebble from the top of a cliff 70·2 m high with an initial velocity of 14·7 ms⁻¹ vertically upwards.

(a) Calculate the speed of the pebble 2 s after it has been thrown. [3]

(b) Calculate the speed of the pebble when it hits the ground at the foot of the cliff. [3]

(c) For how long is the pebble at least 3·969 m above the top of the cliff? [4]