

Old Exam Questions – Old Course
Rectilinear Motion

(M1 Winter 2006)

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]

(M1 Summer 2006)

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]

(M1 Winter 2007)

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]

(M1 Summer 2007)

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]

(M1 Summer 2008)

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]

(M1 Winter 2009)

1. A train travels along a straight horizontal track with constant acceleration. Points A , B and C are on the track with B between A and C . The distance AB is 1200 m and the distance BC is 2500 m. As the train passes B , its speed is 26 ms^{-1} . The train takes 60 s to travel from A to B .
- (a) Find the speed of the train as it passes A . [3]
- (b) Determine the acceleration of the train. [3]
- (c) Calculate the speed of the train as it passes C , giving your answer correct to one decimal place. [3]

(M1 Summer 2009)

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]

(M1 Winter 2010)

1. A boy throws a ball vertically upwards from a point A with an initial speed of 18.2 ms^{-1} .
- (a) Find the greatest height above A reached by the ball. [3]
- (b) Calculate the time taken for the ball to return to point A . [3]
- (c) Find the speed of the ball 2.5 s after it was thrown. State clearly the direction of motion of the ball at this time. [3]

(M1 Summer 2010)

1. A pebble is projected vertically downwards with speed 2.1 ms^{-1} from the top of a well, which is 15.4 m deep.
- (a) Calculate the speed of the pebble when it hits the bottom of the well. [3]
- (b) Find the time taken by the pebble to reach the bottom of the well. [3]

(M1 Summer 2011)

1. A stone is thrown vertically **downwards** from the top of a cliff with an initial velocity of 1 ms^{-1} and hits the sea 2.5 seconds later.
- (a) Find the speed with which the stone hits the sea. [3]
- (b) Calculate the height of the cliff. [3]
3. The points A , B and C lie, in that order, on a straight horizontal road. A car travels on the road with constant acceleration $a \text{ ms}^{-2}$. When the car is at A , its speed is $u \text{ ms}^{-1}$. The distance AB is 10 m and the car takes 2 s to travel from A to B . The car takes 7 s to travel from A to C and its speed at C is 17 ms^{-1} .
- (a) Find the value of u and the value of a . [7]
- (b) Draw a velocity-time graph for the motion of the car between A and C . [2]
- (c) Calculate the distance AC . [2]

(M1 Winter 2012)

4. A stone is thrown vertically upwards with a speed of 14.7 ms^{-1} from a point A which is 49 m above the ground.
- (a) Find the time taken for the stone to reach the ground. [3]
- (b) Calculate the speed of the stone when it hits the ground. [3]

(M1 Summer 2012)

7. A skydiver drops from rest from a hot air balloon and falls vertically under gravity for 5 s before his parachute opens. After the parachute has opened, his speed of descent reduces with uniform retardation for a further 10 s until his speed is 4 ms^{-1} . He then continues to travel at a constant speed of 4 ms^{-1} until he reaches the ground 2 minutes after he left the hot air balloon.
- (a) Calculate the speed of the skydiver just before his parachute opens. [3]
- (b) Draw a sketch of the velocity-time graph for the skydiver's descent. [4]
- (c) Determine the height of the skydiver above the ground when he drops from the hot air balloon. [3]

(M1 Winter 2013)

1. A car moves with constant acceleration along a straight horizontal road. It passes the point O with speed 12 ms^{-1} . It then passes point A , 4 seconds later, with speed 32 ms^{-1} .
- (a) Show that the acceleration of the car is 5 ms^{-2} . [3]
- (b) Determine the distance OA . [3]
- (c) The point M is the midpoint of OA . Calculate the speed of the car as it passes M . Give your answer correct to one decimal place. [3]
3. A particle is projected vertically upwards with an initial speed of 15 ms^{-1} from a point A , which is 1.2 m above horizontal ground.
- (a) Determine the time taken for the particle to reach the ground. Give your answer correct to one decimal place. [4]
- (b) Suppose a heavier particle is projected vertically upwards from the same point A and with the same initial speed of 15 ms^{-1} . Would the time taken for the particle to reach the ground be greater, the same, or less than your answer in (a)? Give a reason for your answer. [1]

(M1 Summer 2013)

3. An object is projected vertically upwards with speed $u \text{ ms}^{-1}$ from a point A which is 2.8 m above horizontal ground. The object reaches its greatest height of 18.225 m above A before falling to the ground.
- (a) Show that the value of u is 18.9 . [3]
- (b) Find the time between the object being projected and the object hitting the ground. [4]

(M1 Winter 2014)

2. A pebble is projected vertically upwards with a speed of 7 ms^{-1} from the top of a cliff. It hits the ground at the bottom of the cliff 4 seconds later.
- (a) Calculate the time for the pebble to reach its maximum height. [3]
- (b) Determine the height of the cliff. [3]

(M1 Summer 2015)

8. An object is projected vertically downwards from a point A with an initial speed of 2.1 ms^{-1} towards a horizontal surface. The point A is at a height of 4 m above the surface. The coefficient of restitution between the object and the surface is $\frac{4}{7}$.
- (a) Show that the speed of the object immediately after it has rebounded from the surface is 5.2 ms^{-1} . [5]
- (b) Determine the smallest number of bounces after which the speed of the object immediately after rebound is less than 1 ms^{-1} . [2]

(M1 Summer 2016)

8. A car is travelling along a straight road ABC with uniform acceleration $a \text{ ms}^{-2}$. The distance AC is 460 m. The time taken by the car to travel from A to B is 6 s and the time taken to travel from B to C is 14 s. At A the speed of the car is $u \text{ ms}^{-1}$ and at B , the speed of the car is 17 ms^{-1} . Find the value of a and the value of u . [7]

(M1 Summer 2017)

4. A car of mass 800 kg is travelling on a horizontal road. It experiences a resistance to motion which is constant throughout the journey. The car accelerates from rest under a constant tractive force of 300 N exerted by its engine. After 50 seconds, the car reaches a speed of 15 ms^{-1} .
- (a) Determine the magnitude of the acceleration of the car. [3]
- (b) Calculate the magnitude of the constant resistance to motion. [3]
- (c) When the car reaches the speed of 15 ms^{-1} , the engine is switched off and the car is brought to rest by a constant braking force. The total distance covered by the car for the **whole** journey is 500 m. Find the constant force exerted by the brakes. [7]

(M1 Summer 2018)

6. A raindrop A falls freely from rest from the top of a cliff. After it has fallen a distance 0.1 m, a second raindrop B begins to fall from rest from the top of the same cliff. The height of the cliff is 40 m.
- (a) Find the velocity of A at the instant B begins to fall. [3]
- (b) Find the velocity of A at the instant it reaches the ground. [2]
- (c) Calculate the distance between the raindrops when the first raindrop A hits the ground. [7]