PHYSICAL SCIENCES
Grade 12

VERTICAL PROJECTILE MOTION & MOMENTUM

01 JULY 2014

Check List

Make sure you ….

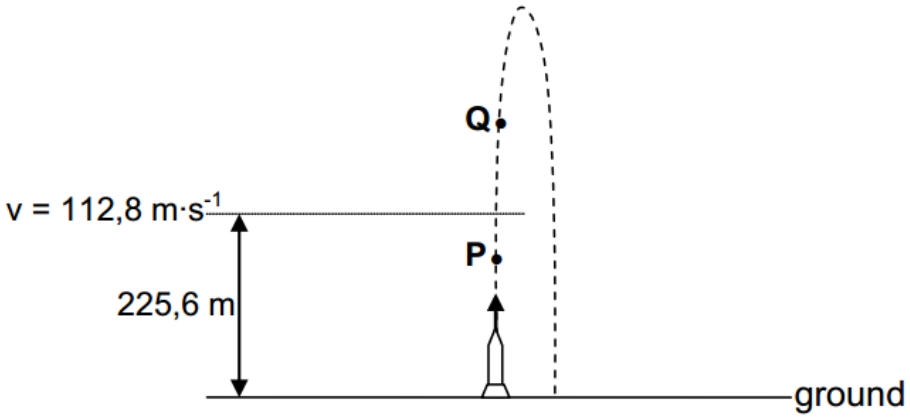
- can sketch and interpret graphs of motion
- are able to use the equations of motion to solve problems
- remember that the acceleration due to gravity is a constant and on Earth is 9,8 $m.s^{-2}$ downwards
- can define momentum
- calculate the change in momentum
- recall that momentum and change in momentum are both vector quantities
- know how to use the impulse – momentum theorem to calculate :
  - The force applied
  - The time for which the force is applied
  - The change in momentum
- can state and apply the law of conservation of momentum
- can identify elastic and inelastic collisions

Exam Questions

Question 1

(Adapted from DBE Feb 2014 Paper 1 Question 3)

A stationary rocket on the ground is launched vertically upwards. After 4 s, the rocket's fuel is used up and it is 225,6 m above the ground. At this instant the velocity of the rocket is 112,8 $m \cdot s^{-1}$. The diagram below shows the path followed by the rocket. Ignore the effects of air friction. Assume that g does not change during the entire motion of the rocket.



1.1 Write down the direction of the acceleration of the rocket at point:

1.1.1 P (1)

1.1.2 Q (1)

1.2 At which point (P or Q) is the rocket in free fall? Give a reason for the answer. (2)

1.3 Calculate the time taken from the moment the rocket is launched until it strikes the ground. (6)

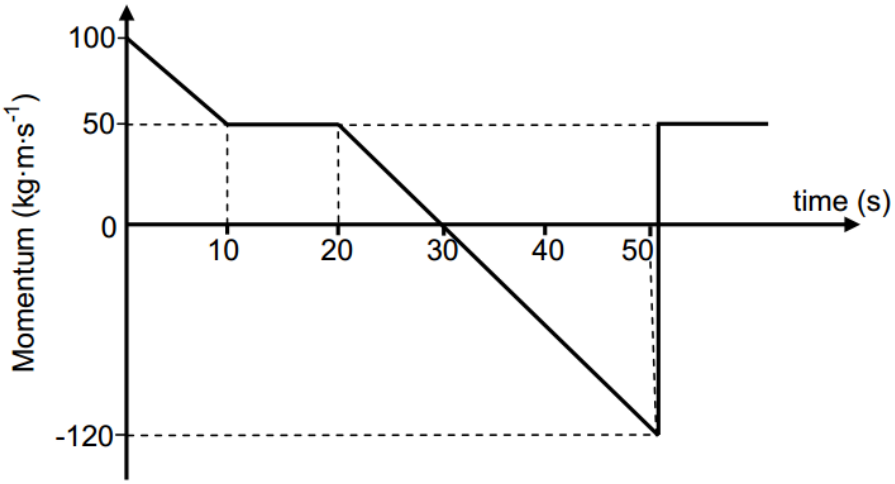
1.4 Sketch a velocity versus time graph for the motion of the rocket from the moment it runs out of fuel until it strikes the ground. Take the time when the rocket runs out of fuel as t = 0 s.
Indicate the following values on the graph:

- Velocity of the rocket when it runs out of fuel
- Time at which the rocket strikes the ground (5)

Question 2

(Adapted from DBE Feb 2014 Paper 1 Question 4)

The momentum versus time graph of object A, originally moving horizontally EAST, is shown below.



2.1 Write down the definition of momentum in words. (2)

2.2 The net force acting on object A is zero between t = 10 s and t = 20 s.
Use the graph and a relevant equation to explain why this statement is TRUE. (2)

2.3 Calculate the magnitude of the impulse that object A experiences between t = 20 s and t = 50 s. (3)

2.4 At t = 50 s, object A collides with another object, B, which has a momentum of 70 kg·m·s^{-1} EAST.
Use the information from the graph and the relevant principle to calculate the momentum of object B after the collision. (5)

2.5 How would you determine if the collision between object A and object B is elastic or inelastic (2)

Question 3

(Adapted from DBE Feb 2013 Paper 1 Question 3)

A ball of mass 0,2 kg is dropped from a height of 0,8 m onto a hard floor. It bounces to a maximum height of 0,6 m. The floor exerts a force of 50 N on the ball. Ignore the effects of friction.

3.1 Write down the magnitude and direction of the force that the ball exerts on the floor. (2)

3.2 Calculate the:

3.2.1 Velocity at which the ball strikes the floor (4)

3.2.2 Time that the ball is in contact with the floor if it bounces off the floor at a speed of 3,43 m·s^{-1} (4)

3.3 The ball takes 0,404 s from the moment it is dropped until it strikes the floor.
Sketch a graph (not to scale) of position versus time representing the entire motion of the ball.
USE THE GROUND AS ZERO REFERENCE.
Indicate the following on the graph:

- Height from which the ball is dropped
- Height reached by the ball after the bounce
- Time at which the ball bounces off the floor (5)