

Name of the Student: _____

Max. Marks : 24 Marks

Time : 24 Minutes

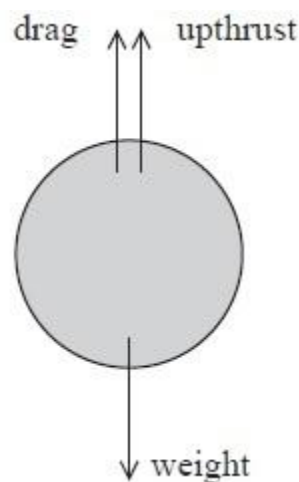
Q1.

The Greek philosopher Aristotle (4th Century BC) stated that heavy objects fall more quickly than lighter objects.

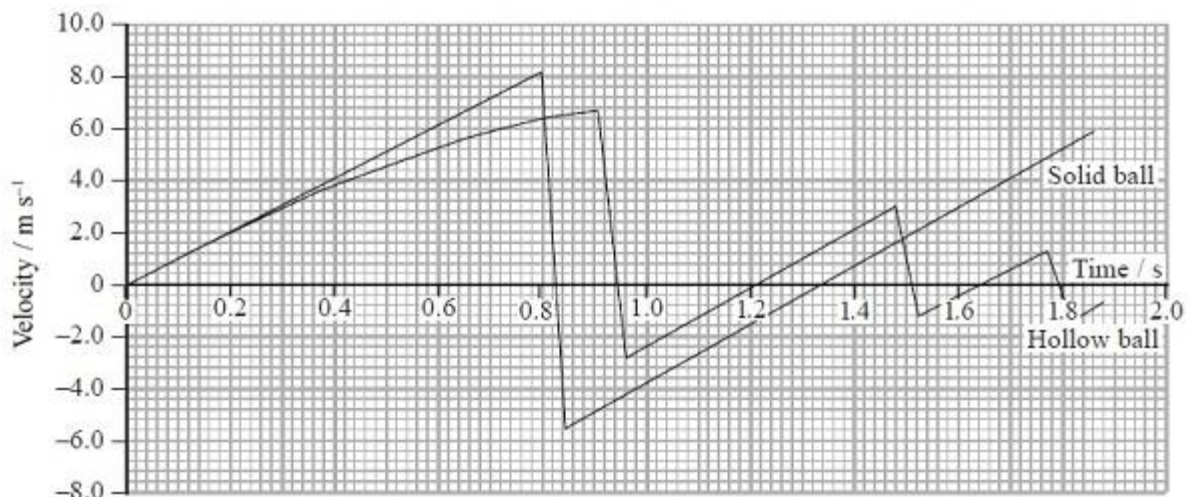
In the 17th Century Galileo reported that a cannon ball and a much smaller musket ball, dropped at the same time, reached the ground together.

A student carries out an experiment, dropping two balls of the same size at the same time. One of the balls is hollow and the other is solid.

The diagram shows the forces acting on each ball as it falls.



The velocity-time graph shows the motion of the two balls from the time they are dropped.



(a) State how the graphs show that neither ball reaches terminal velocity.

(1)

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(b) (i) By drawing a tangent to the graph, show that the acceleration of the hollow ball at time $t = 0.60$ s is about 7ms^{-2} .

(2)

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(ii) Show that the resultant force on the hollow ball at $t = 0.60$ s is about 0.02 N.

mass of hollow ball = 2.4 g

(2)

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(iii) Show that the drag force on the hollow ball at $t = 0.60$ s is about 0.01 N. You may neglect upthrust.

(2)

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(iv) Demonstrate that the Stokes' law force is **not** sufficient to produce this drag force.

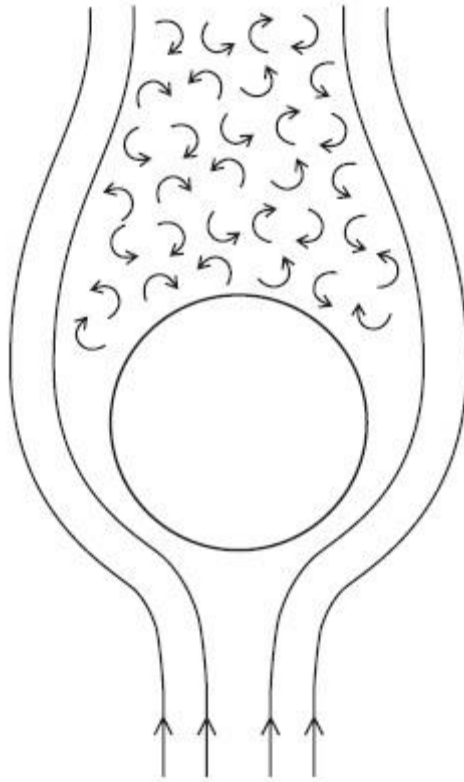
radius of hollow ball = 2.0 cm

viscosity of air = 1.8×10^{-5} Pa s

(2)

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(c) The diagram shows the air flow around the hollow ball as it falls.



(i) Add labels to show laminar flow and turbulent flow.

(1)

(ii) Suggest why the drag is much greater than the Stokes' law force.

(1)

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(d) Without further calculation, use the graph to describe the motion of the solid ball.

(3)

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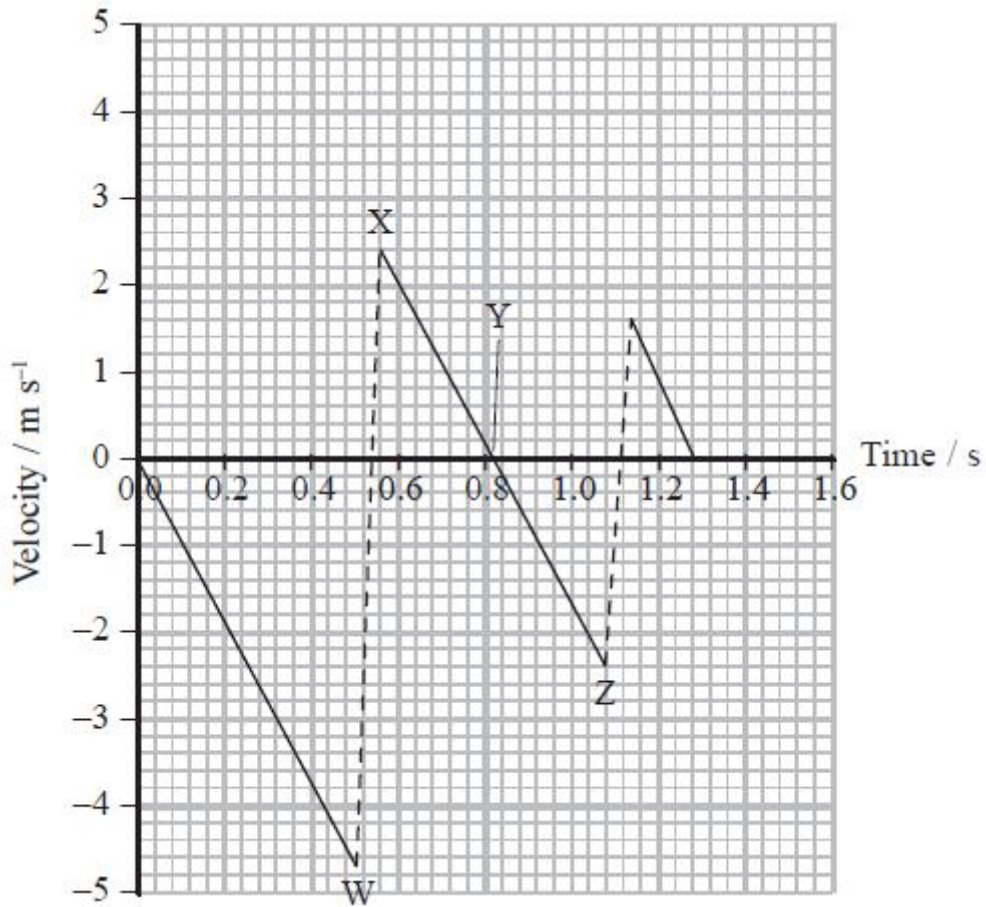
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(Total for Question = 14 marks)

Q2.

A basketball is dropped vertically onto the horizontal ground and bounces twice before being caught. The graph shows how the velocity of the basketball varies with time.



(a) Suggest why the downward sloping lines are all parallel.

(1)

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(b) (i) State the reason for the upwardly sloping dotted lines.

(1)

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(ii) Describe how the gradient of the dotted lines would change if the basketball was not fully inflated.

(1)

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(c) Calculate the initial height through which the basketball fell.

(2)

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Height =

(d) (i) Show that the kinetic energy of the basketball at X is about 1 J.

mass of ball = 0.4 kg

(2)

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(ii) Hence calculate the height of the basketball at Y.

(2)

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Height =

(e) The velocity of the basketball on impact at W is greater than the velocity on impact at Z.

State a reason for the difference in velocities at W and Z.

(1)

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(Total for question = 10 marks)