

Questions

Q1.

A student used two different methods to investigate the acceleration of a freely falling object.

(a) In the first method, the student dropped a ball from rest at a known height. He used a stopwatch to measure the time taken for the ball to reach the ground. He repeated this several times. He then calculated the mean acceleration of the ball.

Explain why there was a large uncertainty in the calculated value of acceleration.

(2)

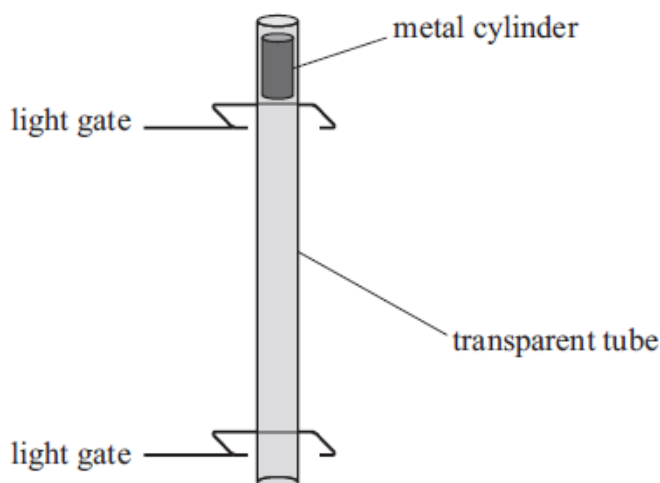
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(b) In the second method, the student positioned light gates near the top and bottom of a transparent vertical tube. He dropped a metal cylinder into the tube, as shown.



The time taken for the metal cylinder to pass through each light gate was recorded by a data logger.

The student measured the distance between the light gates.

(i) Give one other measurement needed to determine the acceleration of the metal cylinder.

(1)

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(ii) The speed of the metal cylinder through the first light gate was 1.39 ms^{-1} .

The speed of the metal cylinder through the second light gate was 2.96 ms^{-1} .

The distance between the light gates was 355 mm.

Calculate the acceleration of the metal cylinder.

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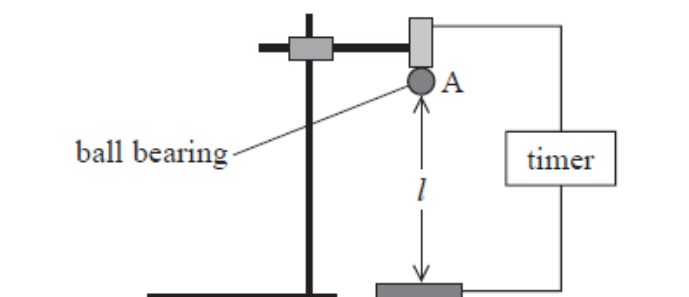
Acceleration =

(Total for question = 5 marks)

Q2.

A student carried out an experiment to measure the acceleration of free-fall g .

A ball bearing was released from position A. The time t for the ball bearing to fall a distance l was measured. This was repeated for decreasing values of l .



Explain how the measurements obtained can be used to determine a value for g in m s^{-2} . Your answer should include a sketch on the axes below of the graph that the student would expect to obtain.

(5)



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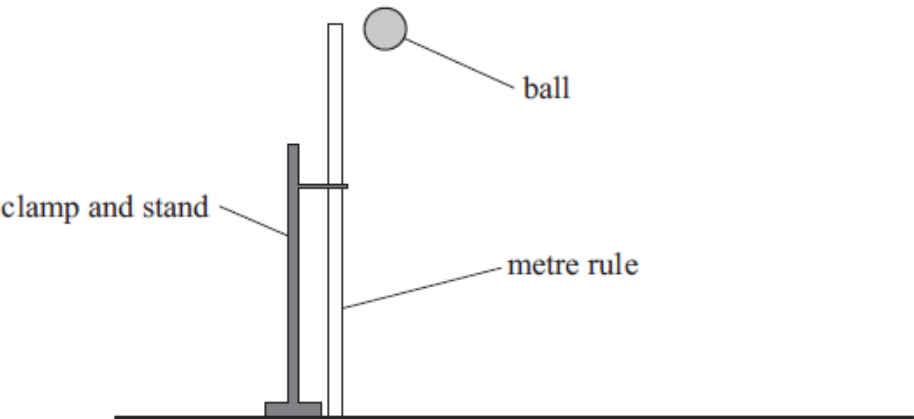
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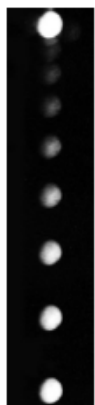
Q3.

A student clamped a metre rule so that it was vertical. She dropped a ball from rest near the top of the metre rule, as shown.



A strobe emits flashes of light. The time interval between flashes is constant.

The student photographed the falling ball using strobe lighting. The ball can be seen at different heights in the photograph, as shown.



(Source: © sciencephotos/Alamy Stock Photo)

For each flash of light, the student determined the distance fallen by the ball.

(a) She took one photograph using a strobe app on a mobile phone.

She took a second photograph using a laboratory strobe.

The time interval between flashes was the same for the strobe app and for the laboratory strobe. Each flash of light from the laboratory strobe has a smaller duration than each flash from the mobile phone.

Explain how the smaller duration of each flash from the laboratory strobe affected the uncertainty in the measurement of the distance fallen.

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(b) The student recorded the distances s fallen by the ball and corresponding values of the time t .

(i) Explain why a graph of s against t^2 gives a straight line.

(2)

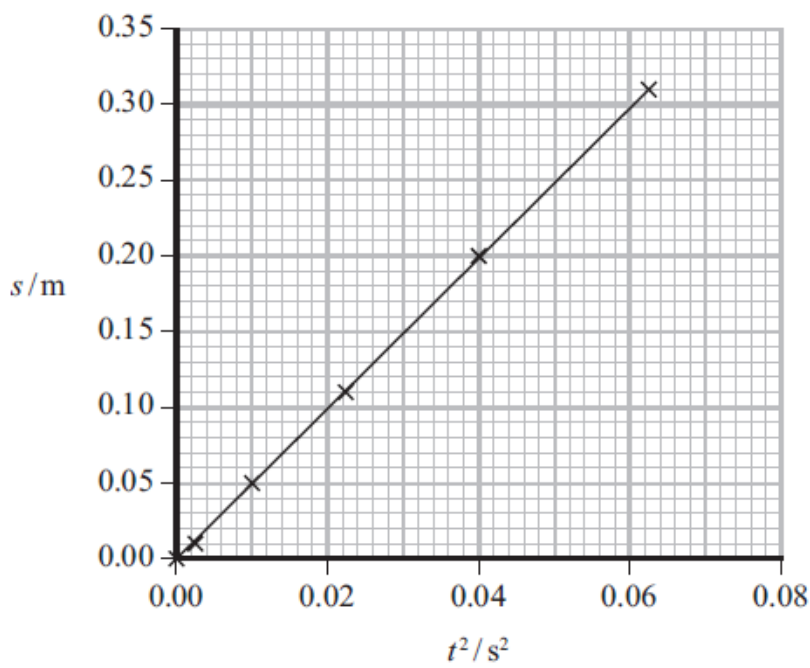
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(ii) The student plotted a graph of s against t^2 , as shown.



Determine the acceleration of free fall, g , using the student's graph.

(2)

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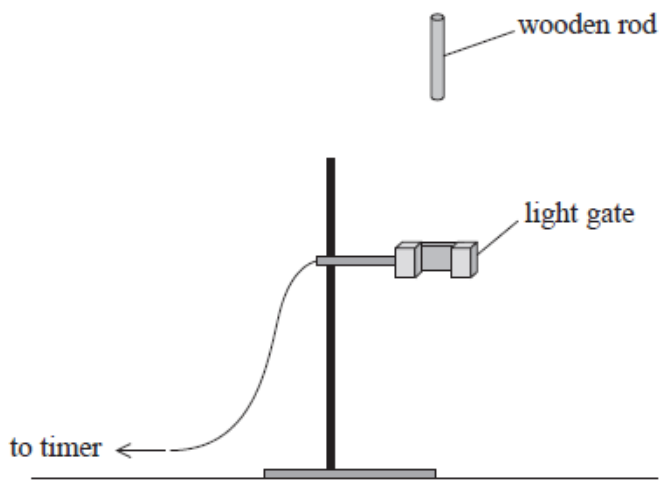
$g =$

(Total for question = 6 marks)

Q4.

A student carries out an experiment to determine a value for g , the acceleration of free fall. A short wooden rod is released above a light gate. A timer connected to the light gate is used to measure the time taken for the wooden rod to pass through the light gate.

The experimental arrangement is shown.



The student uses the equation $v^2 = u^2 + 2as$, where $u = 0$, and a graphical method to determine a value for g .

(a) State the additional measurements the student should take.

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(b) Describe how the velocity v of the wooden rod as it passes through the light gate can be determined accurately.

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(c) Describe how the student can determine a value for g using a graphical method.

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(Total for question = 7 marks)