

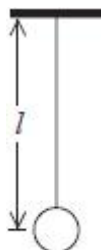
**Name of the Student:** \_\_\_\_\_

**Max. Marks : 22 Marks**

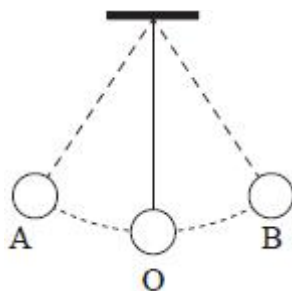
**Time : 22 Minutes**

**Q1.**

A student is using a simple pendulum to determine a value for the acceleration of free fall  $g$ .



She sets the pendulum into oscillations with small amplitude and uses a stopwatch to determine the time period.



The student releases the pendulum at A and simultaneously starts the stopwatch. She measures the time taken for 5 oscillations and divides the value by 5. She repeats the procedure twice and calculates a mean time period.

Explain **two** modifications to the student's method that would improve the value obtained for the time period.

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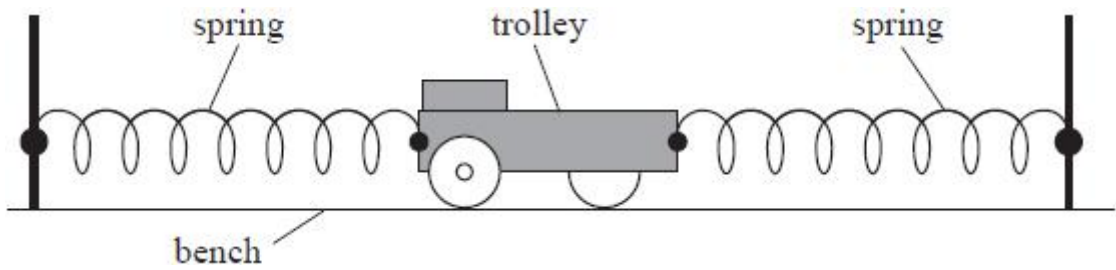
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**(Total for question = 4 marks)**

Q2.

A trolley is attached to the ends of two springs as shown. When displaced from its equilibrium position, the trolley moves with simple harmonic motion.



A student has a stopwatch and metre rule available.

(i) Explain the procedure that the student should follow to make an accurate determination of the time period  $T$  of the trolley.

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(ii) Describe how the student should use her value of  $T$  to determine the maximum speed of the trolley.

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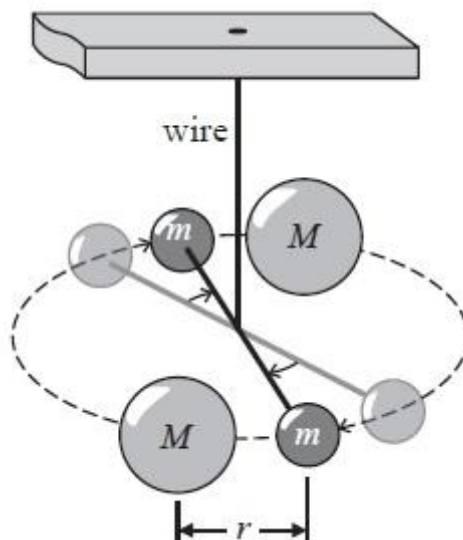
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(Total for question = 9 marks)

Q3.

In the 18th century Henry Cavendish devised an experiment to determine the average density of the Earth. This involved the first laboratory determination of the universal gravitational constant  $G$ .

A light horizontal rod with a small metal sphere at each end was hung from a fixed point by a very thin wire. Two large lead spheres were then brought close to the small spheres causing the rod to oscillate and then settle into a new position of equilibrium.



(a) In a modern version of the experiment the following data was obtained:

mass of large lead sphere  $M = 160 \text{ kg}$

mass of small sphere  $m = 0.75 \text{ kg}$

distance  $r = 0.23 \text{ m}$

gravitational force between adjacent large and small spheres  $F = 1.5 \times 10^{-7} \text{ N}$ .

Use this data to calculate a value for  $G$ .

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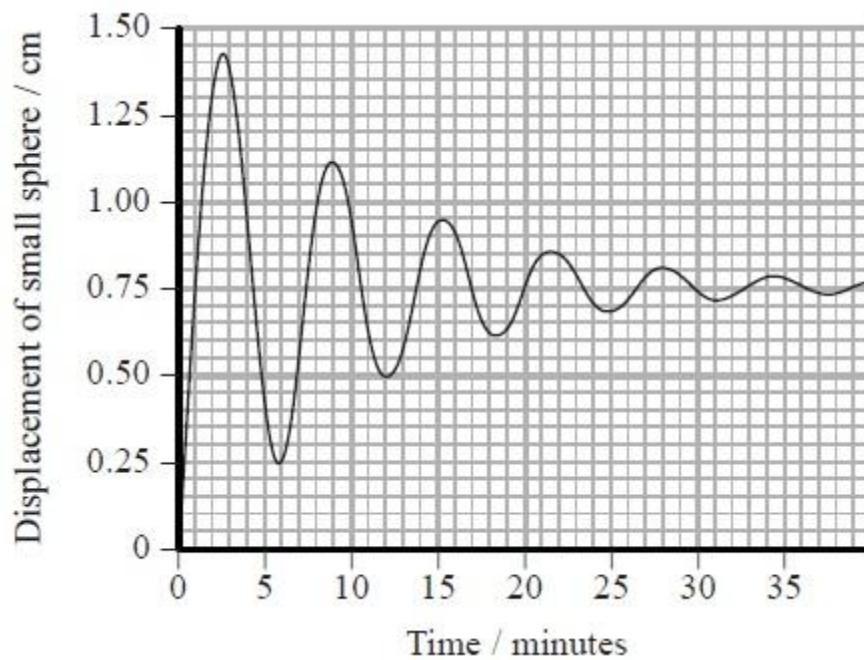
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$G = \dots\dots\dots \text{Nm}^2 \text{kg}^{-2}$

(b) The graph shows how the displacement of one of the small spheres varies with time.



(i) Use the graph to determine the period of oscillation of the sphere.

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Period = .....

(ii) The amplitude of the oscillation decreases with each cycle.

Explain why this effect is observed.

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(iii) It is suggested that the decrease in amplitude is exponential. Use the graph to determine if this is approximately true.

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**(Total for Question = 9 marks)**