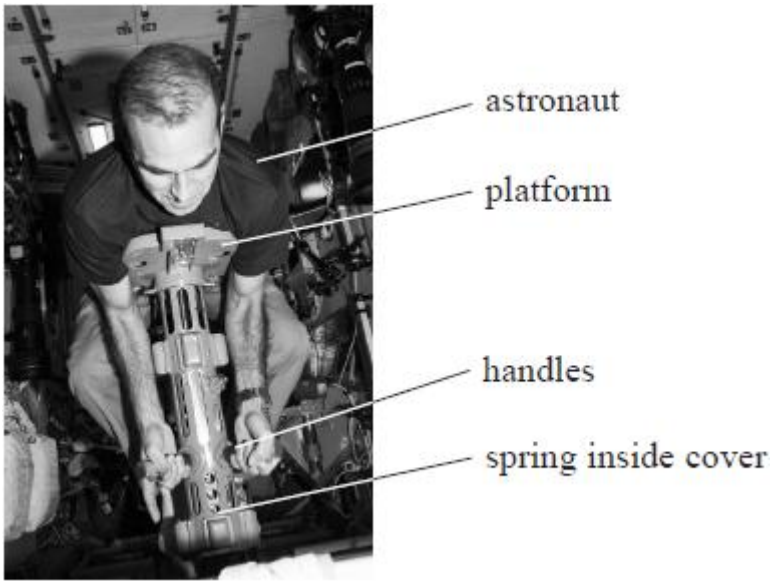
Name of the Student:_____
Max. Marks : 27 Marks **Time : 27 Minutes**

Q1.

On the International Space Station (ISS), astronauts measure their mass once a month using a Body Mass Measurement Device (BMMD).

The BMMD is constructed from a large spring attached to the floor of the ISS, with a platform and handles attached to the spring. The spring is compressed and the astronaut puts his body onto the platform and holds onto the handles, as shown.



(Source: https://www.nasa.gov/content/nasa-astronaut-rick-mastracchio-3)

The spring is released and the astronaut and platform oscillate with simple harmonic motion.

An astronaut used the BMMD. The frequency of oscillation was 0.34 Hz.

Determine the mass of the astronaut.

spring constant = 350 N m^{-1}
mass of platform = 5.7 kg

(4)

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Mass of astronaut = ...

(Total for question = 4 marks)

Q2.

The suspension system in a car includes a spring attached to each wheel as shown.



The car, of mass 1100 kg, is stationary. Each spring is compressed by 152 mm due to a quarter of the weight of the car. Each spring is well within both the limit of proportionality and the elastic limit.

(i) Show that the stiffness of each spring is about 18 000 N m^{-1}.

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(ii) A force is applied to the car which results in a further small compression of each spring. The force is then removed, and the body of the car oscillates with simple harmonic motion.

Determine the frequency of the oscillations.

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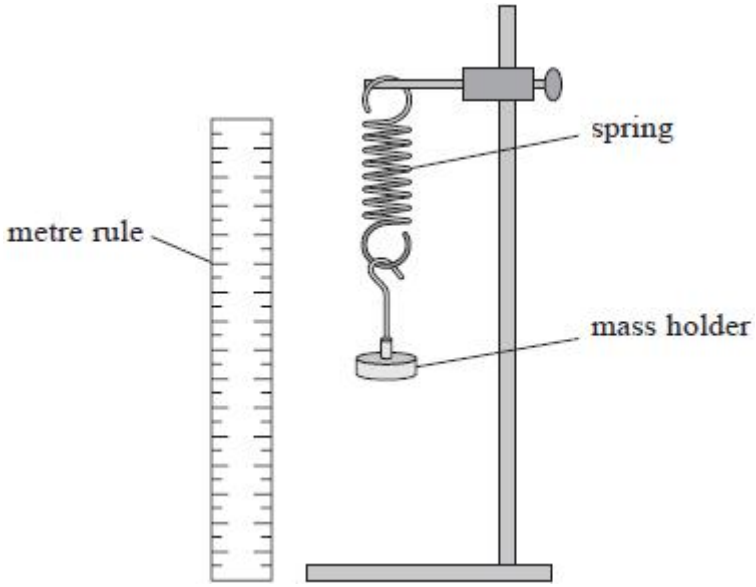
Frequency = ...

(Total for question = 6 marks)

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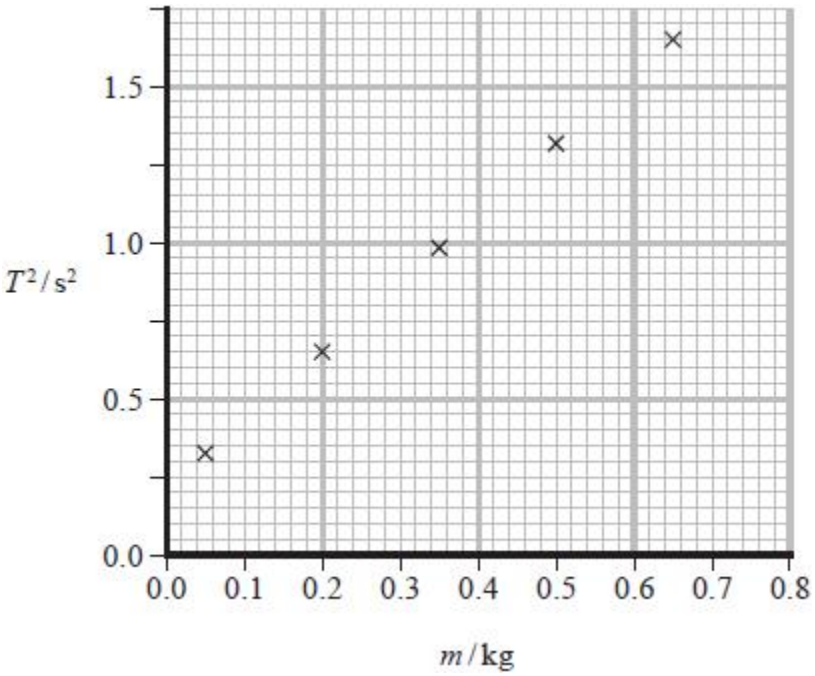
Q3.

A student investigated the behaviour of a spring under tension. The spring was hung vertically with a mass holder attached as shown.



In another experiment, the student displaced the mass vertically each time a mass was added to the spring. He used a stopwatch to determine the period of vertical oscillations of each mass.

The student used his data to plot a graph of T^2 against m as shown.



When determining the period of oscillation for each mass, the student measured the time for 20 oscillations. He repeated this measurement to obtain a mean time for 20 oscillations.

Explain how the student's procedure contributed to the accuracy of the measurement.

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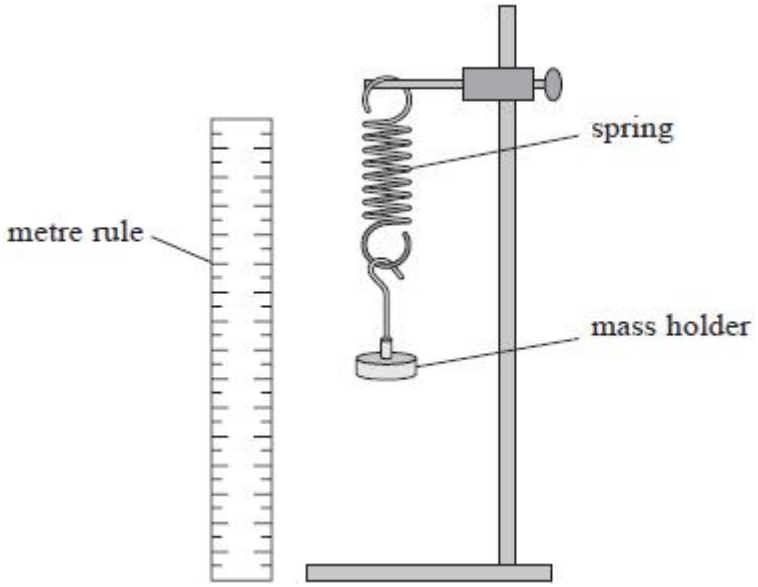
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(Total for question = 3 marks)

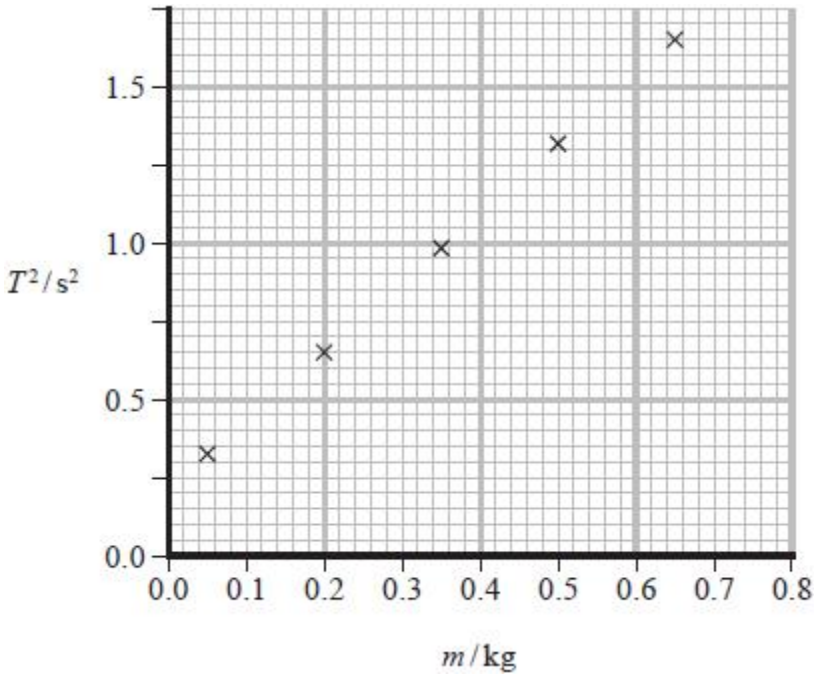
Q4.

A student investigated the behaviour of a spring under tension. The spring was hung vertically with a mass holder attached as shown.



In another experiment, the student displaced the mass vertically each time a mass was added to the spring. He used a stopwatch to determine the period of vertical oscillations of each mass.

The student used his data to plot a graph of T^2 against m as shown.



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The student expected the graph to be a straight line through the origin. He thought that there may be systematic error due to reaction time.

(i) Give an example of another possible systematic error in this experiment.

(1)

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(ii) Another student suggests that to reduce the uncertainty in the value for the period, a data logger connected to a light gate could be used to measure time.

Comment on the student's suggestion.

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(iii) Determine a value for the stiffness of the spring.

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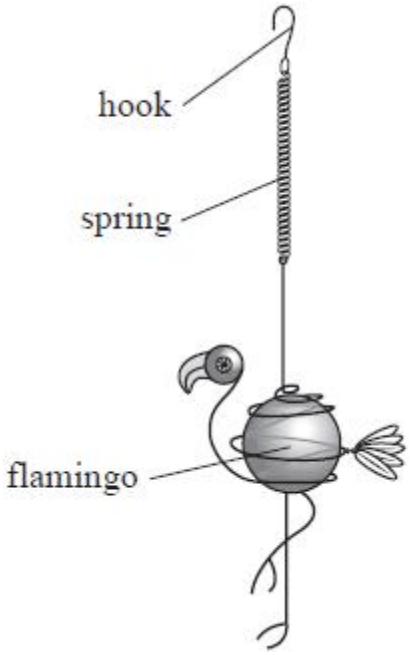
Stiffness of spring = ...

(Total for question = 7 marks)

Q5.

A garden ornament consists of a metal flamingo suspended from a spring as shown. The spring is hung from a support using the hook.

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After being set into vertical oscillation, the flamingo comes to rest after a short time.

Explain why the flamingo comes to rest.

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(Total for question = 2 marks)

Q6.

The International Space Station (ISS) is in a low Earth orbit. Astronauts in ISS have an apparent weight of zero. In order to determine their mass, the astronauts must secure themselves to a platform which is set into oscillation and moves with simple harmonic motion.





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Explain why the astronauts in the ISS have an apparent weight of zero.

(2)

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(Total for question = 2 marks)

Q7.

The photograph shows an example of a Foucault pendulum.



This is a pendulum that consists of a massive sphere, suspended by a long wire from a high ceiling. Over time the vertical plane through which the pendulum swings appears to rotate because of the rotation of the Earth.

mass of sphere = 28.0 kg

To show the rotation of the Earth, the pendulum needs to oscillate for several hours.

Explain how using a heavy sphere is better than using a light sphere of the same diameter.

(3)

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(Total for question = 3 marks)

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