Practice Question Set For A-Level
Subject : Physics
Paper-1 Topic: Further Mechanics

Name of the Student:_____
Max. Marks : 24 Marks **Time : 24 Minutes**

Q1.

The International Space Station (ISS) moves in a circular orbit around the Earth at a speed of 7.68 km s^{-1} and at a height of 380 km above the Earth's surface.

(a) Calculate the centripetal acceleration of the ISS, given that the radius of the Earth is 6380 km.

(3)

(b) Explain why a scientist working on board the ISS experiences "apparent weightlessness".

_____

_____

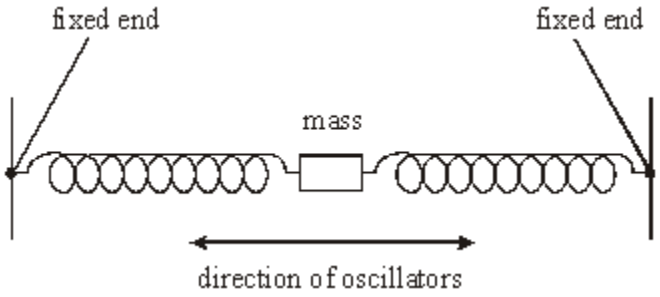
_____

_____

(2)

This state of apparent weightlessness makes the space station an ideal laboratory for experiments in "zero gravity" conditions. Examples are the study of lattice vibrations in solids and Brownian Motion in fluids.

(c) The figure below shows a mass-spring system which, in zero gravity, provides a good model of forces acting on an atom in a solid lattice.



When the mass is displaced and released it oscillates as shown. The motion is very similar to the motion in one dimension of an atom in a crystalline solid. The springs behave like the bonds between adjacent atoms.

(i) The mass in the model system is 2.0 kg and it oscillates with a period of 1.2 s. Show that the stiffness of the spring system is about 55 N m^{-1}.

(2)

(ii) The bonds between the atoms in a particular solid have the same stiffness as the model system and the mass of the oscillating atom is 4.7×10^{-26} kg. Calculate the frequency of oscillation of the atom.

(2)
(Total 9 marks)

Q2.

A simple pendulum was made by attaching a small mass to a 1.20 m length of thin string. The pendulum was displaced 10.0 cm sideways and released to swing in a vertical plane. The amplitude of the motion was then observed and recorded after each oscillation. **Figure 1** shows some of the results from the experiment.

Figure 1

Oscillation	0	1	2	3	4	5	6
Amplitude/cm	10.0	8.4	7.1	5.9	5.0	4.2	3.5

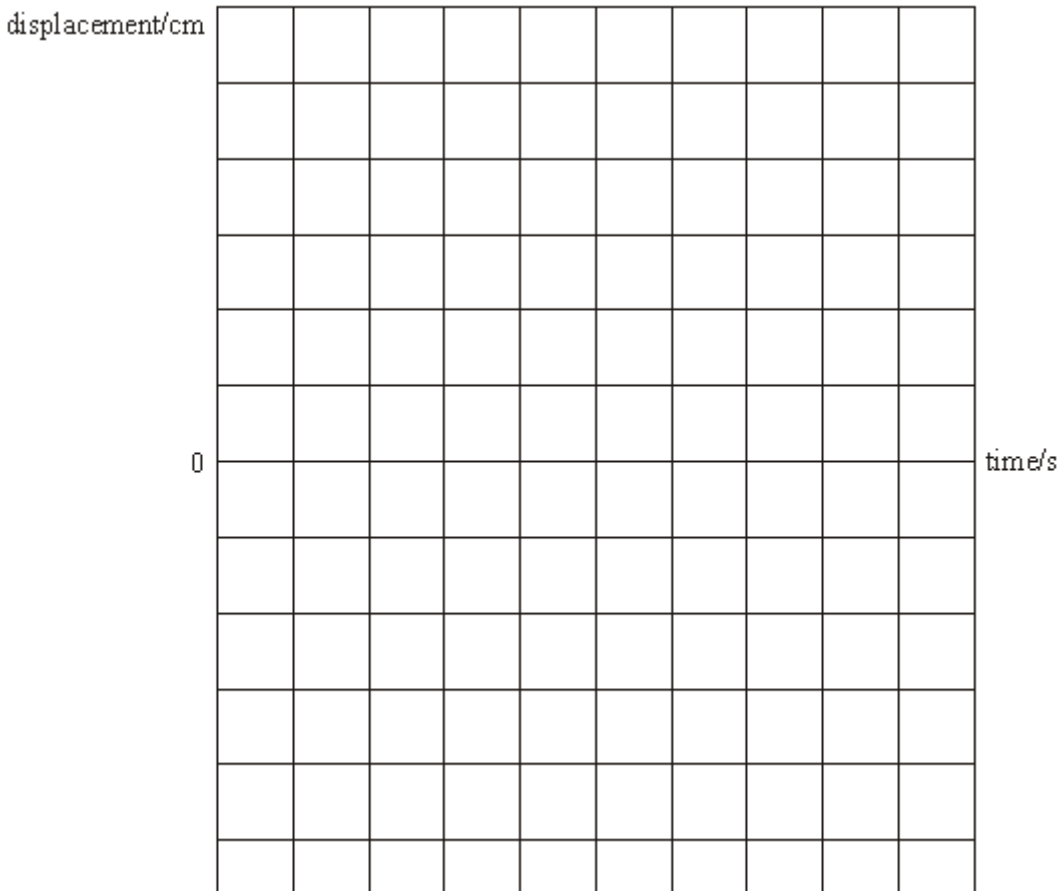
(a) The time for 6 oscillations was 13.2 s. Calculate the periodic time of the oscillations.

periodic time _____

(1)

(b) On the axes in **Figure 2**, carefully sketch a graph of displacement against time for the first two oscillations of the pendulum. Mark the scale on each axis.

Figure 2



(4)

(c) State the effect on the motion of the pendulum when

(i) a shorter string is used,

_____

(ii) a greater mass of the same size is used.

_____

(2)

(Total 7 marks)

Q3.

(a) **Figure 1** and **2** show a simple version of a sensor designed to measure acceleration. In **Figure 1**, which shows the sensor at rest, a mass, M, is held centrally between two identical springs. When the sensor is fixed to a body which is accelerating parallel to the dashed line AB the mass takes up a position to the right of centre, as shown by **Figure 2**.

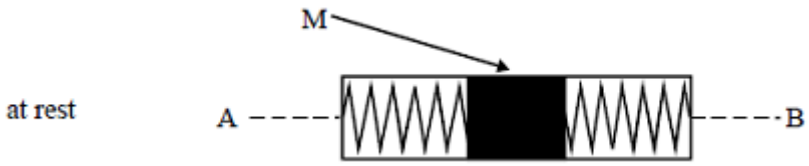


Figure 1

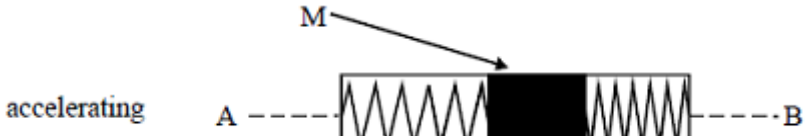


Figure 2

State the direction in which the body is accelerating and explain your answer.

_____

_____

_____

(2)

(b)

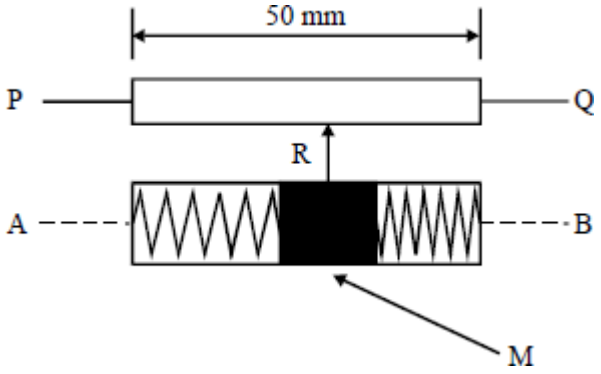


Figure 3

In practice, the mass in the sensor is connected to the slider, R, of a wire-wound potential divider across which there is a fixed potential difference of 5.0 V. At rest the slider is positioned midway along the **uniform** track of the potential divider. When accelerating, the slider moves a distance of 8.0 mm to the right of centre, as shown in **Figure 3**.

Calculate the change in potential difference between the points PR which result from this movement.

_____

_____

_____

_____

(4)

(c) On such devices, the sensor compartment is filled with oil and a hole is drilled in the mass to allow passage of oil between the two spring compartments. Explain why the oil is present.

_____

_____

(2)

(Total 8 marks)