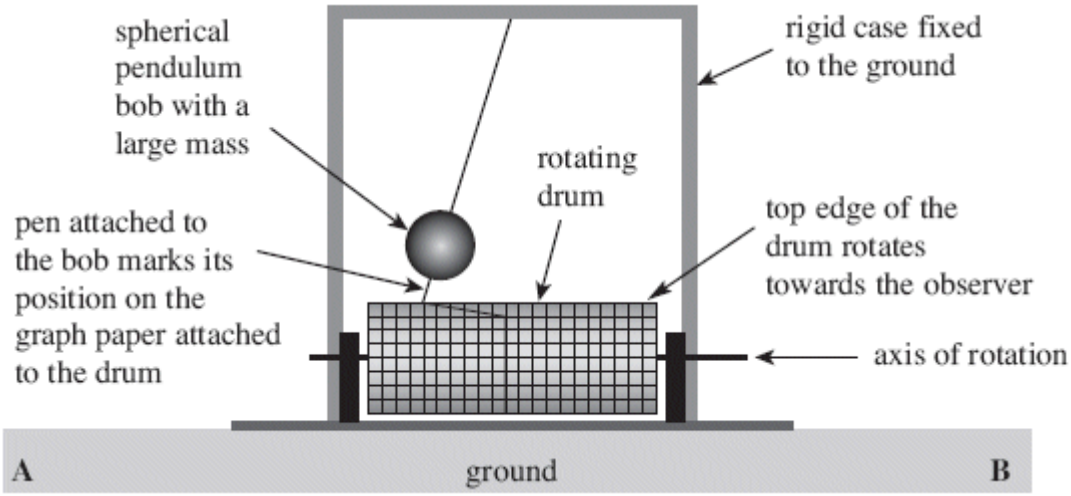
Name of the Student:_____
Max. Marks : 26 Marks **Time : 26 Minutes**

Q1.

Figure 1 shows a seismometer used for detecting the horizontal movement of the ground caused by an earthquake.

Figure 1

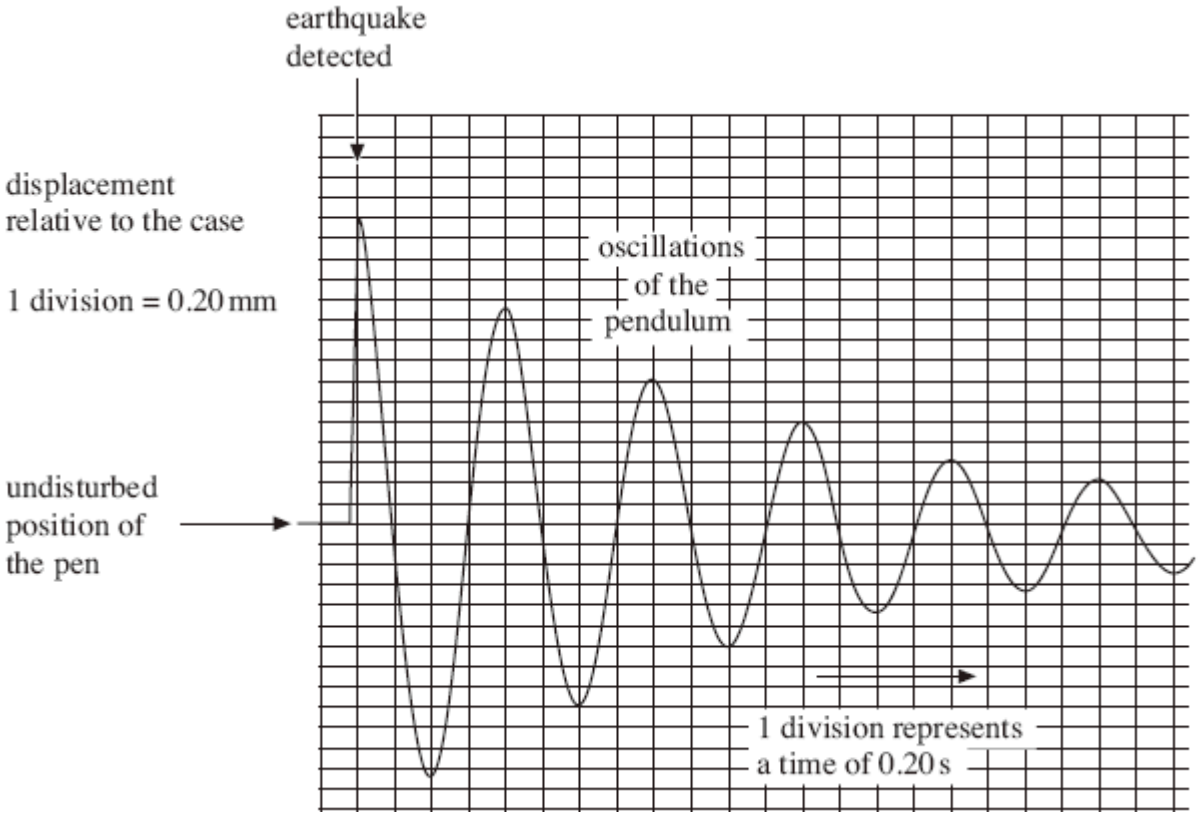


The rigid case is fixed to the ground. When an earthquake occurs, the ground moves horizontally so the rigid case also moves horizontally. Initially, the heavy pendulum bob remains in its original position due to its high inertia. **Figure 1** shows the pendulum immediately after an earthquake is detected.

The rotating drum moves at a steady speed. **Figure 2** shows the trace produced on the graph paper that is attached to the rotating drum following the earthquake.

Figure 2

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(a) (i) State whether the ground has moved towards **A** or **B** to produce the situation shown in **Figure 1**.

_____

(1)

(ii) Determine the magnitude of the initial displacement of the ground that caused the trace in **Figure 2**.

_____

(1)

(b) (i) Use data from **Figure 2** to calculate the distance between the point of suspension of the pendulum and the centre of mass of the bob. Assume that the arrangement is a simple pendulum.

_____

_____

_____

_____

_____

_____

_____

distance _____ m

(3)

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(ii) State and explain the effect of using a bob of the same radius but smaller mass on the initial displacement of the bob,

_____

_____

_____

the period of oscillation of the bob.

_____

_____

_____

(4)

(c) (i) Determine whether the amplitude of the oscillations shown in **Figure 2** decreases exponentially.

_____

_____

_____

_____

_____

_____

_____

(3)

(ii) Explain why the amplitude of the oscillations of the bob decreases following the initial displacement.

_____

_____

_____

_____

_____

(2)

(iii) State and explain the effect of using a bob with the same radius but smaller mass on the time taken for the bob to come to rest following the initial disturbance.

_____

_____

_____

_____

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(2)
(Total 16 marks)

Q2.

(a) Simple harmonic motion may be represented by the equation

$$a = -(2\pi f)^2 x$$

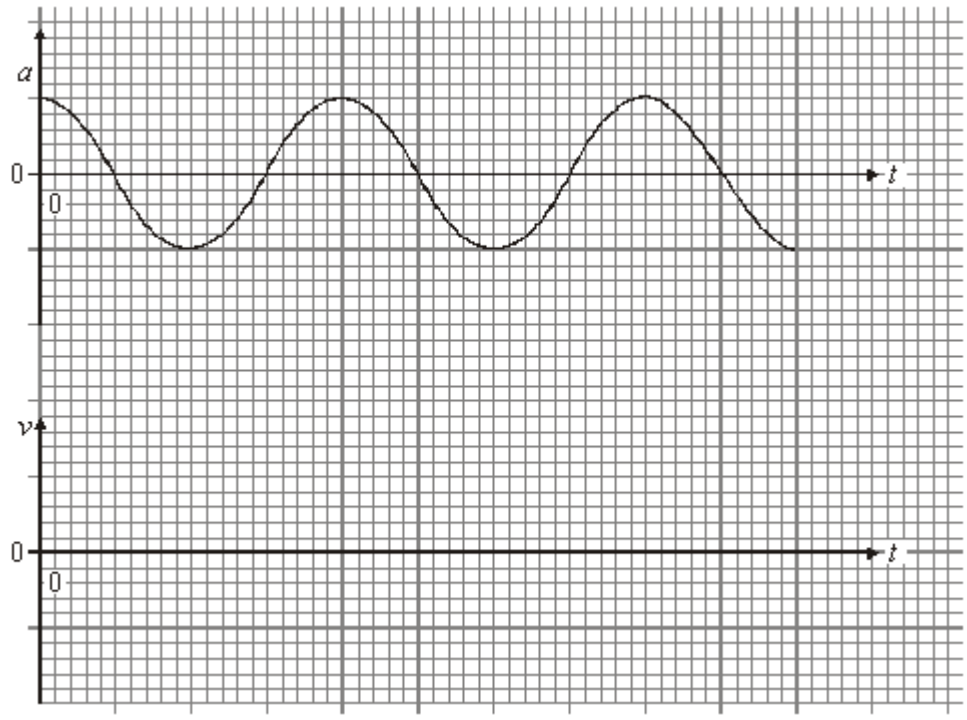
(i) Explain the significance of the minus sign in this equation.

_____

_____

(1)

(ii) In **Figure 1** sketch the corresponding *v*-*t* graph to show how the **phase** of velocity *v* relates to that of the acceleration *a*.



(1)

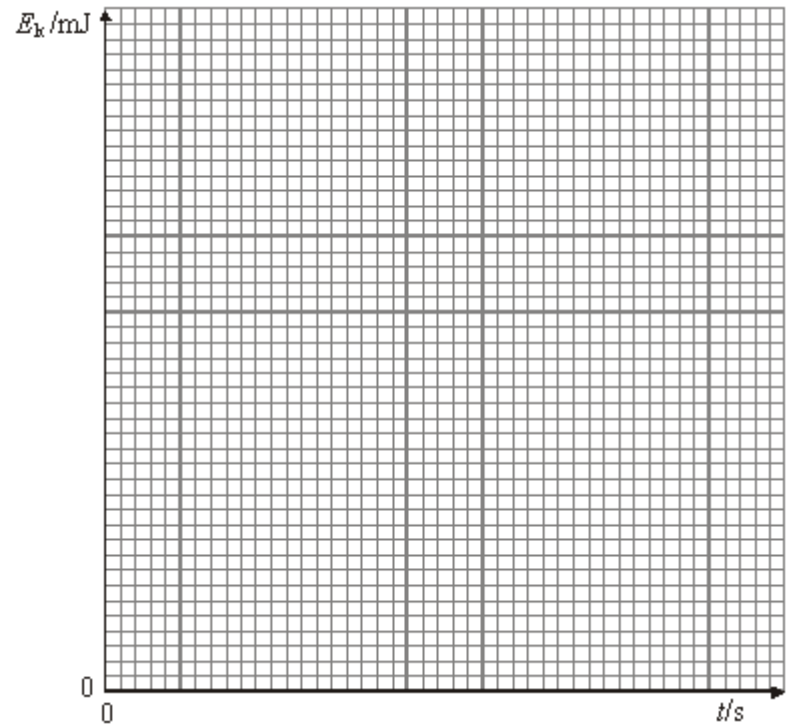
(b) (i) A mass of 24 kg is attached to the end of a spring of spring constant 60 N m^{-1}. The mass is displaced 0.035 m vertically from its equilibrium position and released. Show that the maximum kinetic energy of the mass is about 40 mJ.

(5)

(ii) When the mass on the spring is quite heavily damped its amplitude halves by the end of each complete cycle. On the grid of **Figure 2** sketch a graph to show how the kinetic energy, E_k, of the mass on the spring varies with time over a single period. Start at time, $t = 0$, with your maximum kinetic energy. You should include suitable values on each of

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your scales.



(3)
(Total 10 marks)

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