2016 Newton

3 Fig. 3.1 shows a metal plate attached to the end of a spiral spring. The end **A** of the spring is fixed to a rigid clamp. The plate is pulled down by a small amount and released. The plate performs simple harmonic motion in a vertical plane at a natural frequency of 8 Hz and the spring remains in tension at all times.

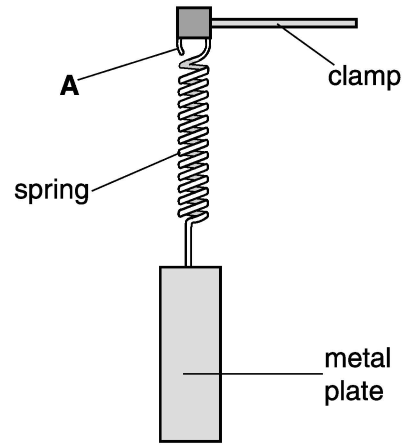


Fig. 3.1

(a) (i) On Fig. 3.2 sketch an acceleration *a* against displacement *x* graph for the motion of the metal plate. You are not required to give values on the axes.

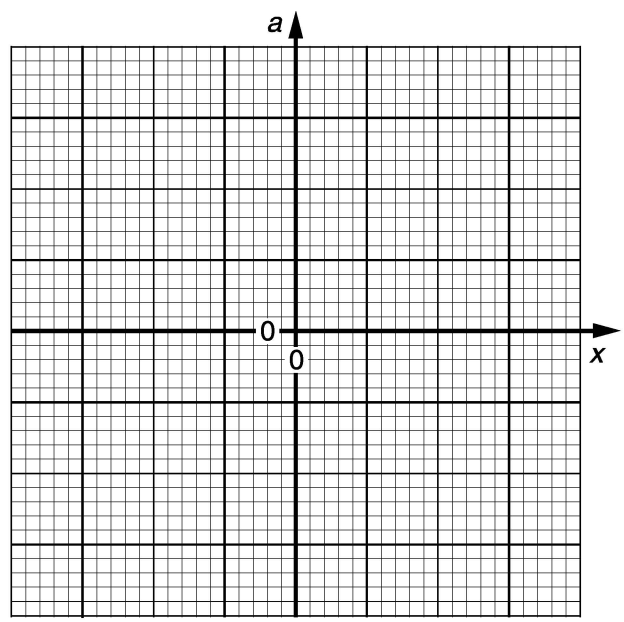


Fig. 3.2

[2]

(ii) Explain how your graph could be used to determine the frequency of oscillation of the metal plate.

....

....

.... **[2]**

(b) Fig. 3.3 shows the variation of the vertical velocity v of the plate with time t at a frequency of 8 Hz.

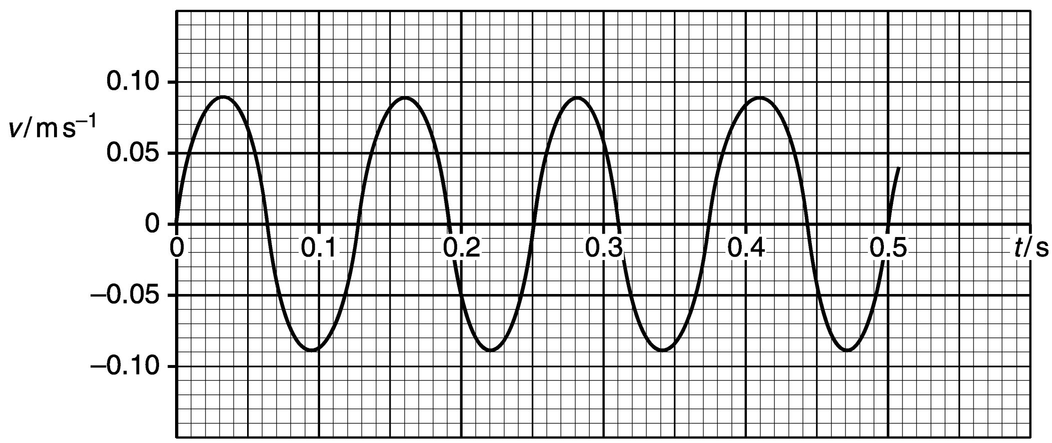


Fig. 3.3

Use the graph to determine

(i) the amplitude of the motion

amplitude = ... m **[2]**

(ii) the maximum vertical acceleration of the plate.

acceleration = ... m s^{-2} **[2]**

(c) The metal plate is now immersed in light oil which provides a constant frictional force to the plate. On Fig. 3.4 draw carefully the graph you would expect to obtain for the variation of the vertical velocity v with time t. As a guide a copy of the graph in Fig. 3.3 is drawn for you.

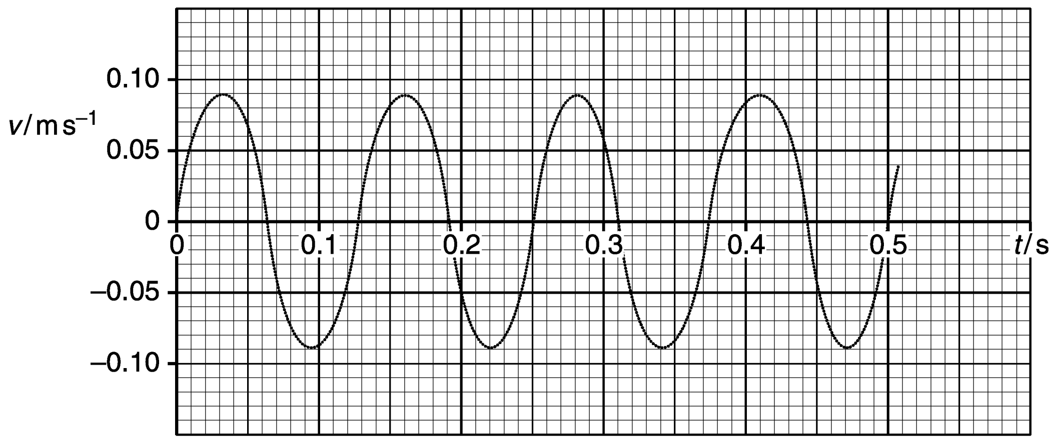


Fig. 3.4

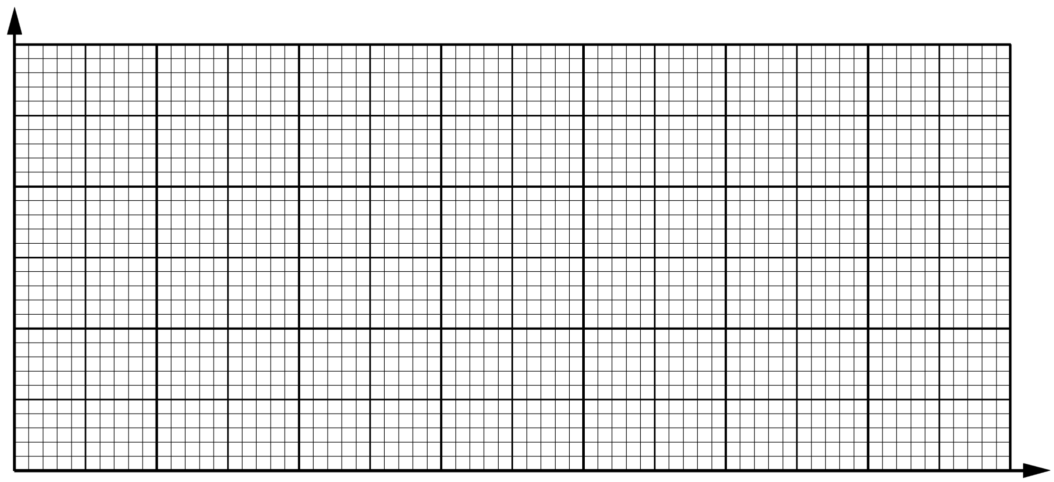
[2]

(d) The plate is now removed from the oil and the point **A** on the spring connected to an oscillator that vibrates vertically with constant amplitude. The frequency of the oscillator is increased slowly from 0 Hz to 12 Hz.

Describe and explain the motion of the metal plate during this procedure.

Sketch a labelled graph to help with your explanation.

In your answer, you should use appropriate technical terms spelled correctly.



....

....

....

....

....

....

....

.... **[3]**

CW 2015

6 A student calculates the motion of a mass of 0.25 kg suspended by a spring of force constant 50 N m^{-1}. The mass is displaced vertically from equilibrium by 0.030 m at time $t = 0$ and released.

The student uses $\Delta v = -\frac{k}{m} x \Delta t$ followed by $\Delta x = v \Delta t$ to estimate the displacement of the mass at time $t = 0.10$ s.

(a) Complete the table.

***t*/s**	***v*/m s^{-1}**	***x*/m**	**Δ*t*/s**	**Δ*v*/m s^{-1}**
0.00	0.00	0.030	0.05	
0.05		0.015	0.05	–0.15
0.10	–0.45			

[3]

(b) The student uses the relationship $x = A\cos(2\pi ft)$ to calculate the displacement of the mass at $t = 0.10$ s as +0.0047 m.

Why is this value different from that obtained from the method of **(a)**?

[1]

Processes 2014

14 This question is about the article *Simple pendulum experiment*.

(a) A student obtains the following data for a pendulum of length 30 cm.

Time for 10 oscillations / s									
10.9	10.9	11.0	11.0	10.9	11.0	11.0	11.1	10.9	11.0

(i) The student uses a stopwatch which records time to the nearest 0.01 s.

She decides to quote the data to one decimal place.

Give a reason for this choice.

[1]

(ii) State why measuring the time for 10 oscillations instead of one improves the quality of the results.

[1]

(iii) For the data above, the student correctly writes:

mean time for 10 oscillations = 11.0 ± 0.1 s.

Explain why the uncertainty in the period T is ± 0.01 s.

[1]

(iv) Show that a period $T = 1.10 \pm 0.01\,s$ leads to a value of

$$T^2 = 1.21 \pm 0.02\,s^2.$$

[2]

(b) A second student times 10 oscillations for the range of lengths given in the table. He does not repeat the timing at each length.

***L*/m**	**Time for 10 oscillations/s**	***T*/s**	**T^2/s^2**
0.10	6.0		
0.15	7.9		
0.20	9.2	0.92	0.85
0.25	10.0	1.00	1.00
0.30	11.2	1.12	1.25
0.35	11.7	1.17	1.37
0.40	12.5	1.25	1.56

(i) Complete the first two rows of the table, and use those data to complete the graph opposite. **[2]**

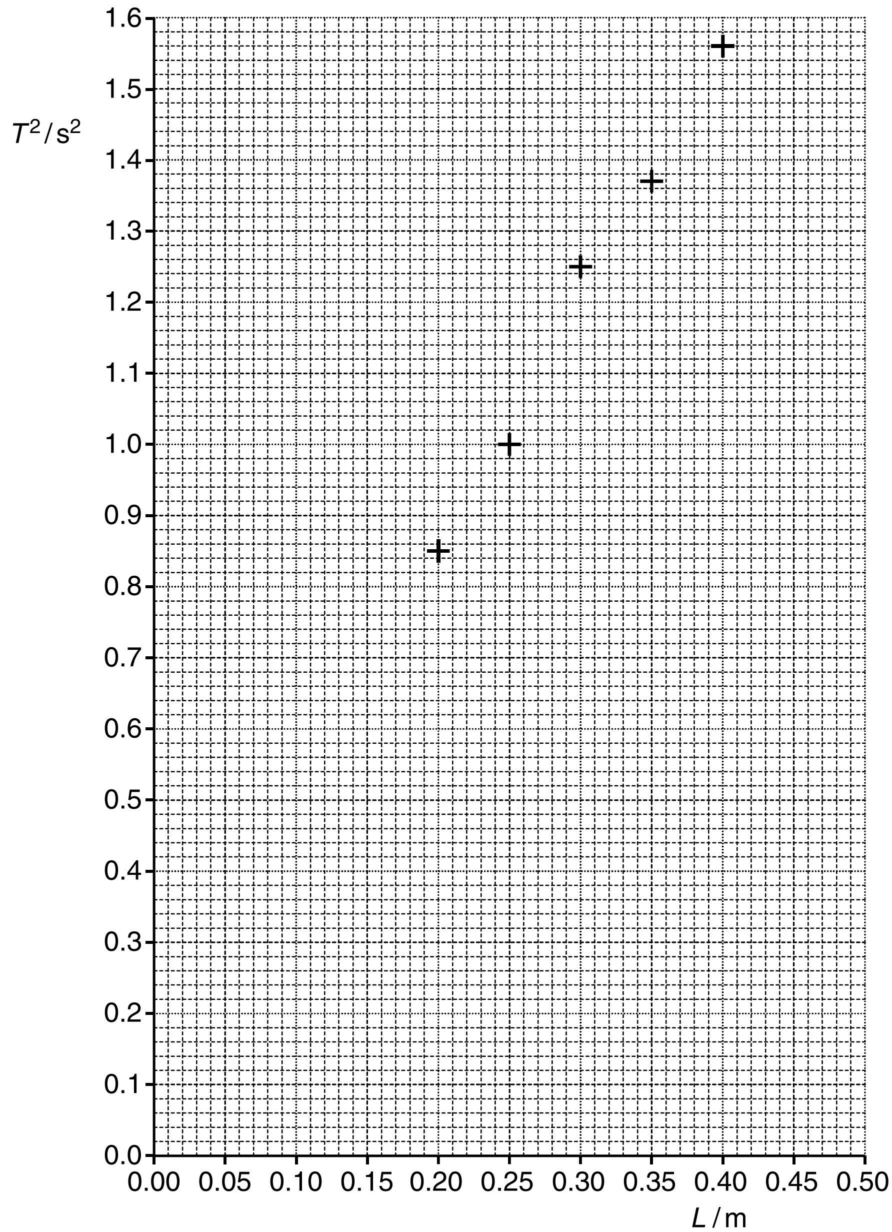
(ii) Explain why the gradient of this graph should be

$$\frac{4\pi^2}{g}$$

given that

$$T = 2\pi\sqrt{\frac{L}{g}}$$

[2]



(iii) Use the graph to determine a value for *g*. Show your working clearly.

g = ... m s^{-2} **[3]**

Question 14 continues on page 26

(c) A third student suggests that the experiment could be improved by using pendulums of lengths between 2 m and 3 m.

Discuss the advantages and disadvantages of this suggestion.

[3]

[Total: 15]

END OF QUESTION PAPER