1 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.

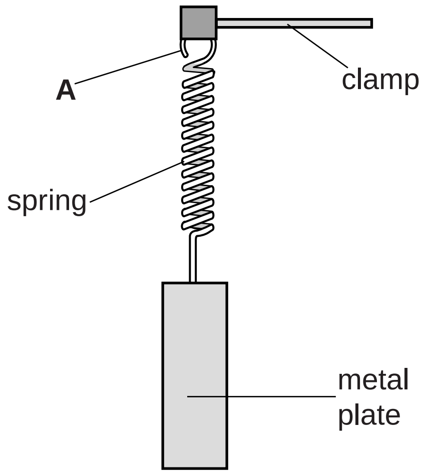


Fig. 3.1

(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.

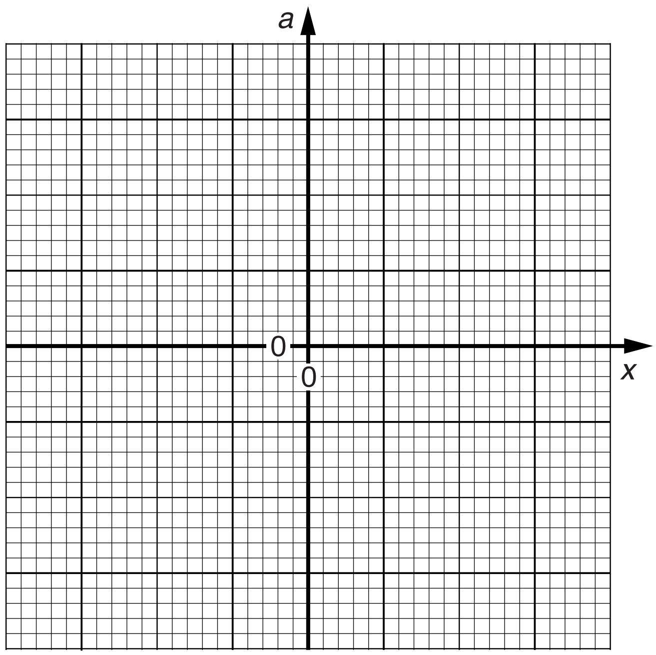


Fig. 3.2

[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.

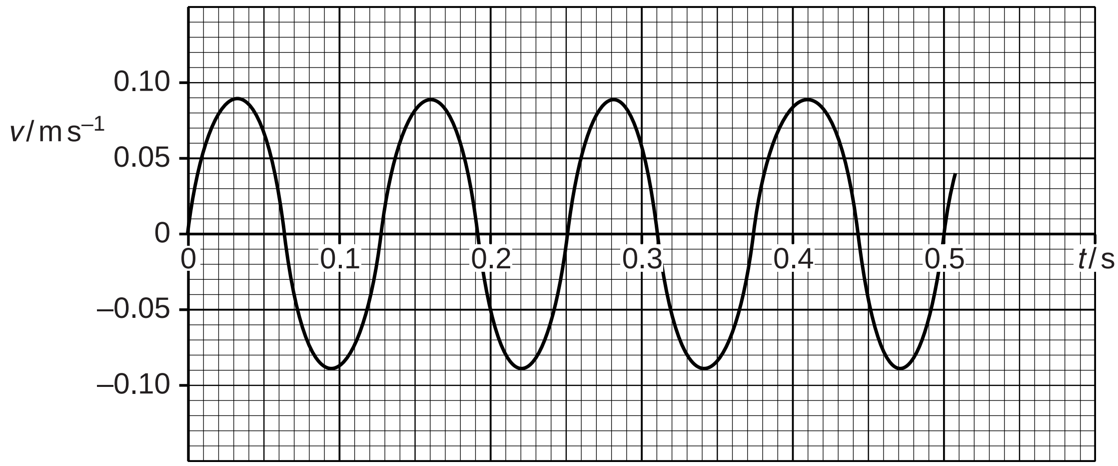


Fig. 3.3

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.

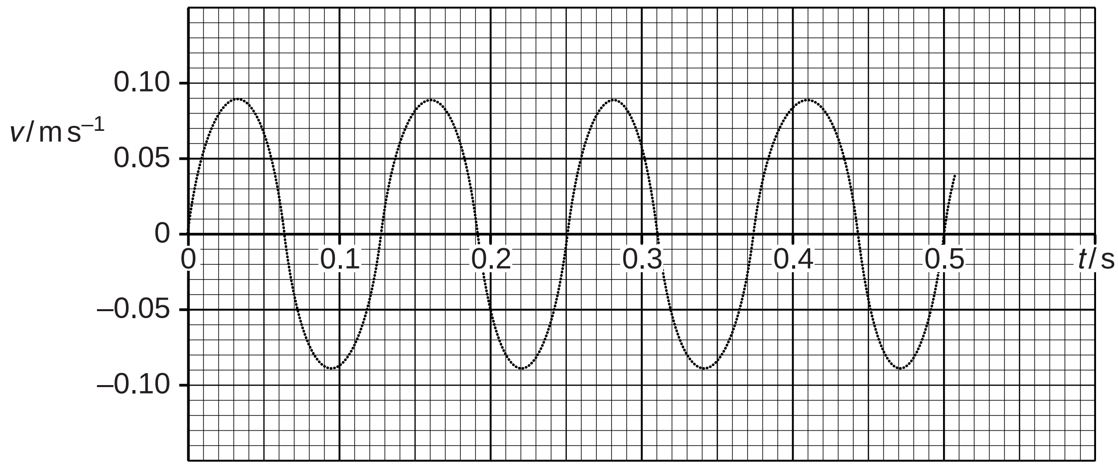


Fig. 3.4

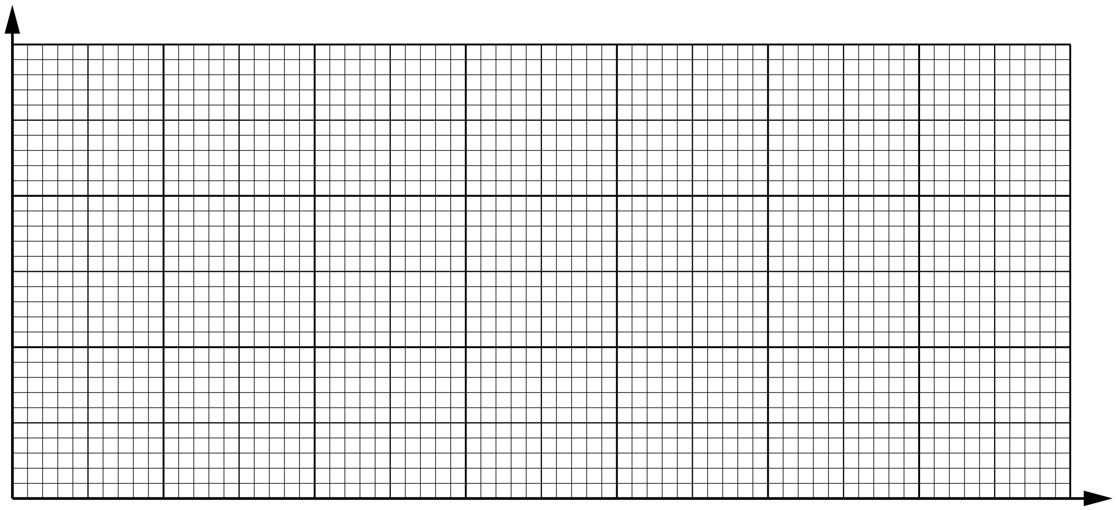
[2]

(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.



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.... **[3]**

2 **(a)** Fig. 3.1 shows a simple pendulum consisting of a steel sphere suspended by a light string from a rigid support. The sphere is displaced 50 mm from its vertical equilibrium position and released at time t = 0.

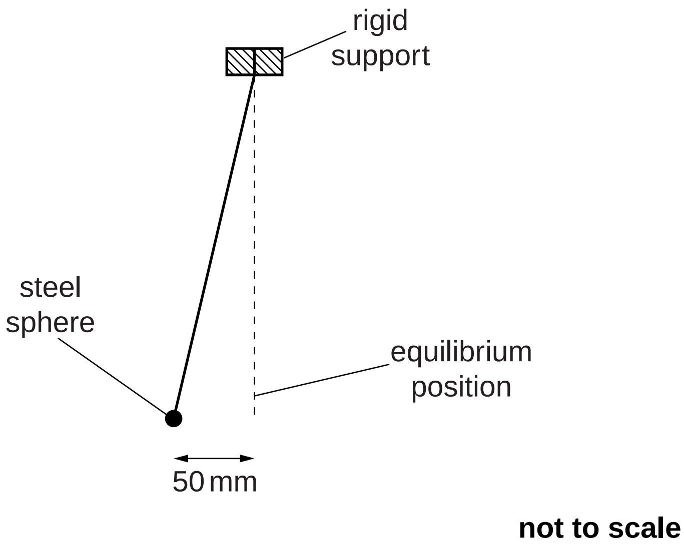

Fig. 3.1

Fig. 3.2 shows the graph of displacement x of the sphere against time t.

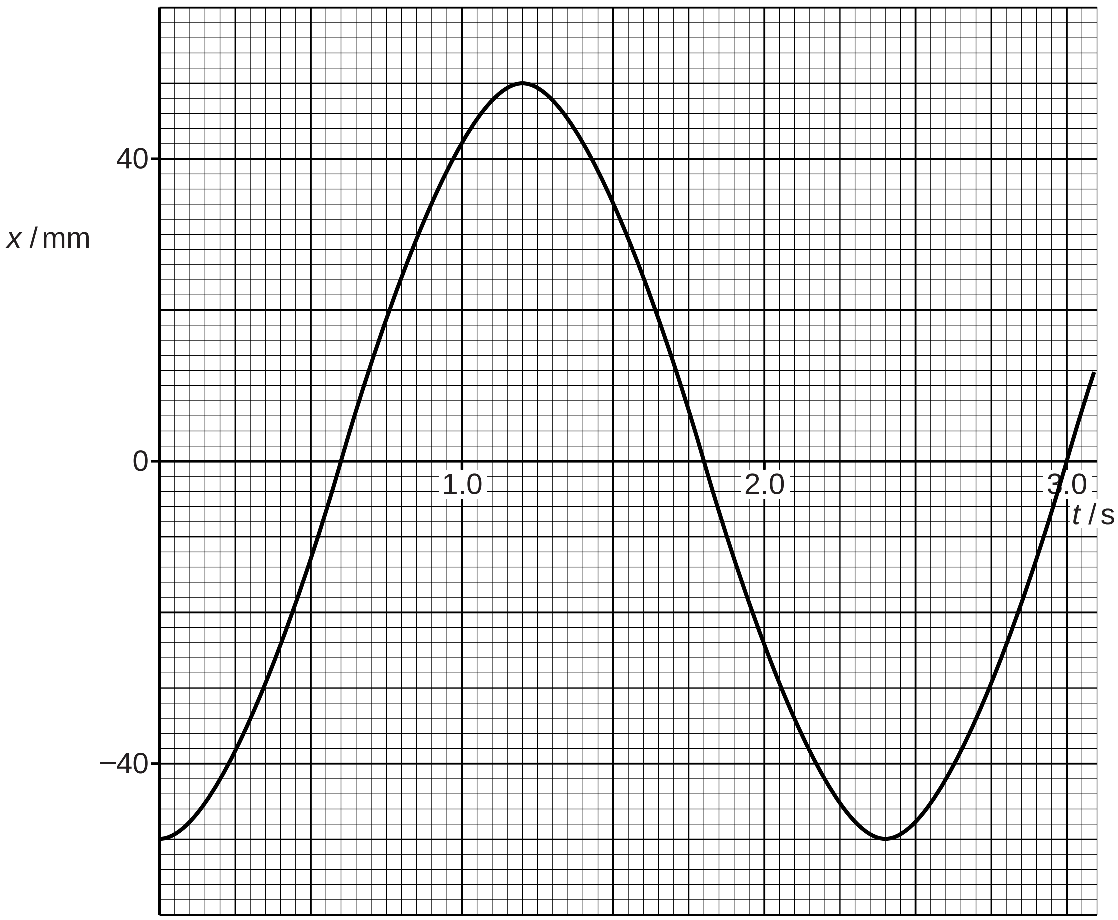

Fig. 3.2

(i) Use Fig. 3.2 to determine the frequency of oscillation of the pendulum.

frequency = ... Hz **[1]**

(ii) Use Fig. 3.2, or otherwise, to determine the maximum speed of the sphere.
Show your method clearly.

speed = ... $m s^{-1}$ **[2]**

(b) The sphere is now released from rest with a displacement x = 25 mm.
State with a reason, the change if any in

(i) the frequency of the oscillations

....

....

.... **[1]**

(ii) the maximum kinetic energy of the sphere.

....

....

....

.... **[2]**

(c) In turbulent air the wingtip of an aircraft can vibrate vertically. To investigate this effect, the acceleration and the vertical displacement of the wingtip are measured. Fig. 3.3 shows how the acceleration of the wingtip varies with displacement.

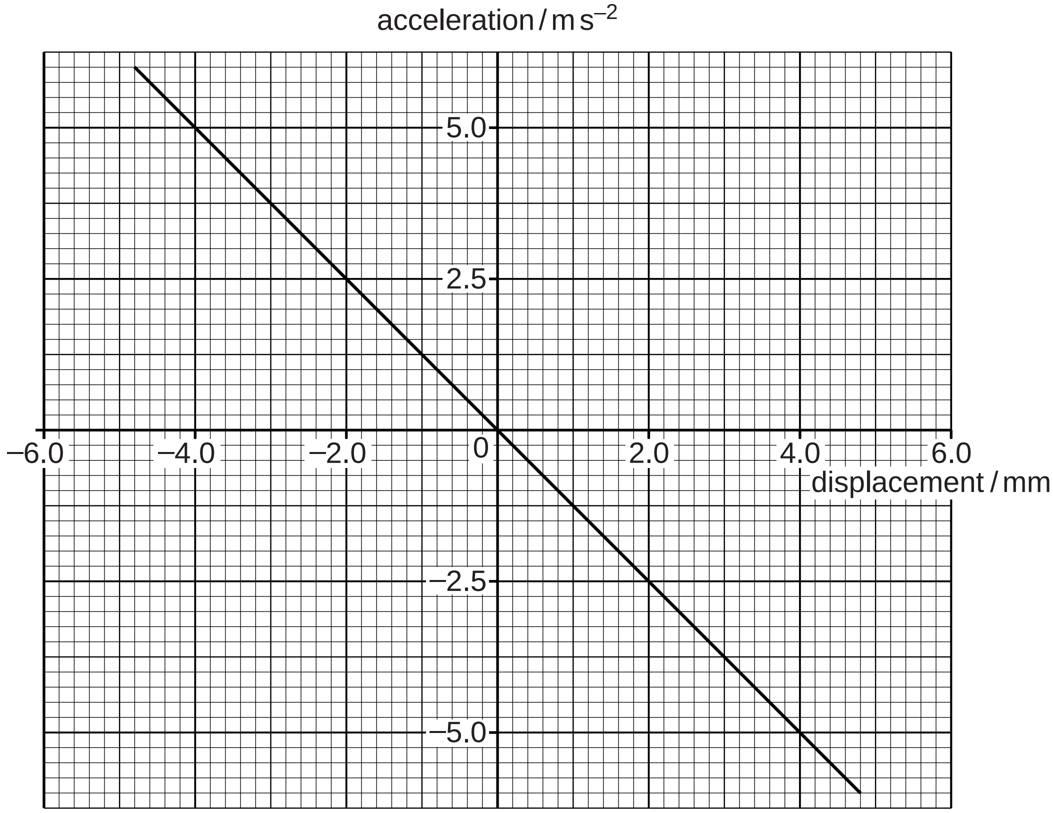

Fig. 3.3

(i) Explain how Fig. 3.3 suggests that the wingtip undergoes simple harmonic motion under the test conditions.

....

....

....

.... **[2]**

(ii) Use Fig. 3.3 to determine the frequency of the vibration.

frequency = ... Hz **[2]**

[Total: 10]

3 **(a)** An object is oscillating with simple harmonic motion. Place a tick (✓) in the box against each true statement that applies to the acceleration of the object.

The acceleration …

… is in the opposite direction to the displacement. ☐

… is directly proportional to the amplitude squared. ☐

… increases as the displacement decreases. ☐

… increases as the speed of the object decreases. ☐

[2]

(b) The graph in Fig. 3.1 shows the variation of the velocity v of the object with time t.

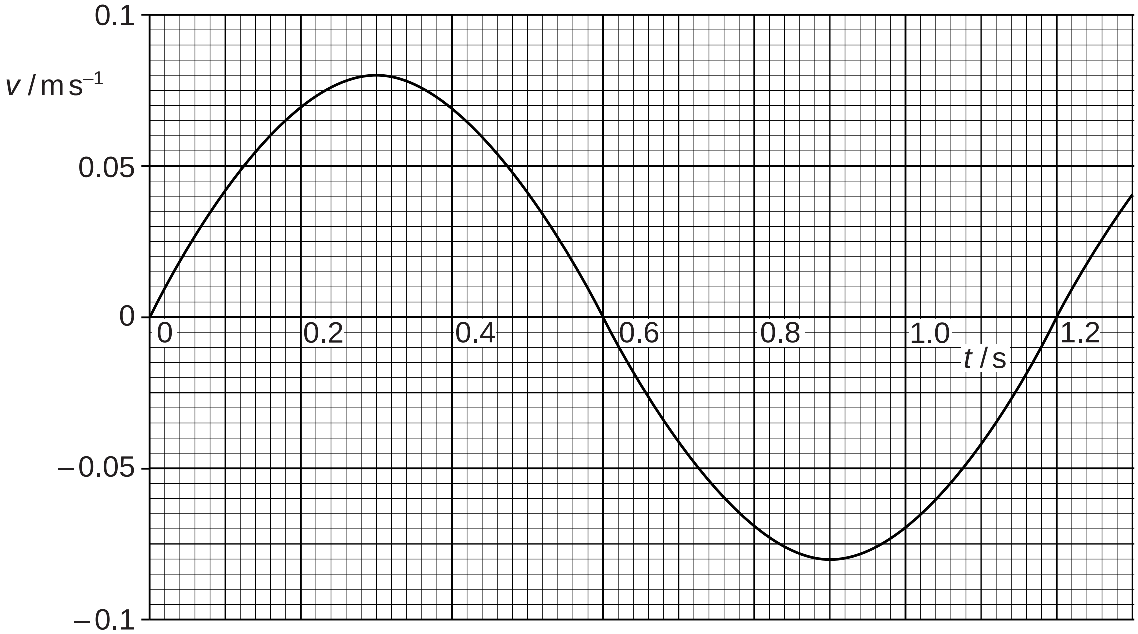

Fig. 3.1

Using the graph, determine

(i) the frequency of the motion

frequency = ... Hz **[1]**

(ii) the amplitude of the motion

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

(iii) the maximum acceleration of the object.

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

(c) **(i)** With the help of a suitably labelled graph, explain what is meant by *resonance* of a mechanical system.

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.... **[4]**

(ii) State and explain an everyday example of resonance.

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.... **[2]**

[Total: 13]

4 **(a)** A body moves with simple harmonic motion. Define, in words, *simple harmonic motion*. *In your answer, you should use appropriate technical terms, spelled correctly.*

....

....

.... **[2]**

(b) A horizontal metal plate connected to a vibration generator is oscillating vertically with simple harmonic motion of period 0.080 s and amplitude 1.2 mm. There are dry grains of sand on the plate. Fig. 2.1 shows the arrangement.

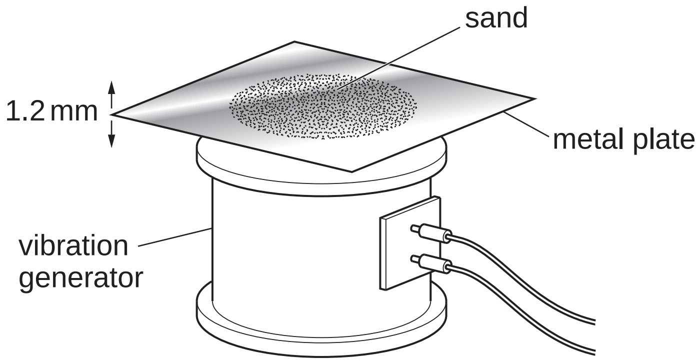

Fig. 2.1

(i) Calculate the maximum speed of the oscillating plate.

maximum speed = ... $m\,s^{-1}$ **[2]**

(ii) The frequency of the vibrating plate is kept constant and its amplitude is slowly increased from zero. The grains of sand start to lose contact with the plate when the amplitude is A_0. State and explain the necessary conditions when the grains of sand first lose contact with the plate. Hence calculate the value of A_0.

....

....

....

A_0 = ...m **[4]**

(c) The casing of a poorly designed washing machine vibrates violently when the drum rotates during the spin cycle. Fig. 2.2 shows how the amplitude of vibration of the casing varies with the frequency of rotation of the drum.

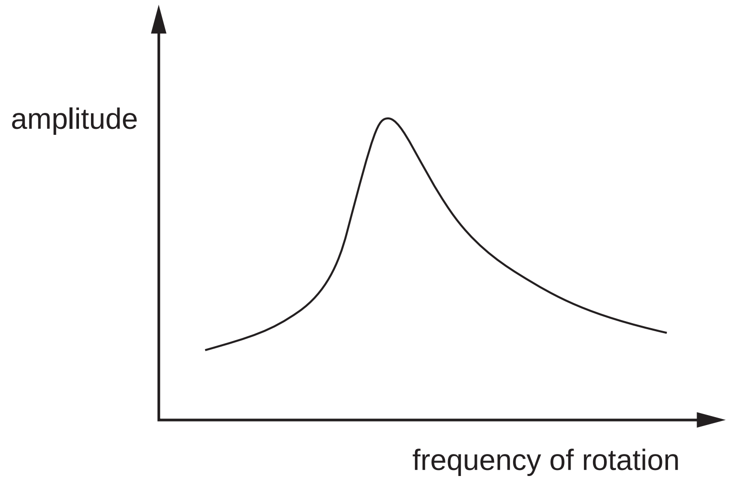

Fig. 2.2

(i) State the name of this effect and describe the conditions under which it occurs.

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....

....

.... **[2]**

(ii) The design of the washing machine is improved to reduce the effect by adding a damping mechanism to the inside of the machine. Sketch on Fig. 2.2 the new graph of amplitude against frequency of rotation expected for this improved design. **[2]**

[Total: 12]

1 **(a)** Fig. 2.1 shows a mass attached to the end of a spring. The mass is pulled down and then released. The mass performs vertical simple harmonic motion.

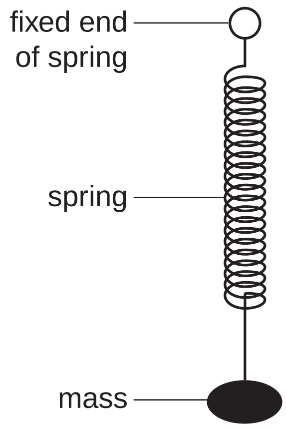

Fig. 2.1

(i) Define *simple harmonic motion*.

....

....

....

.... **[2]**

(ii) Mark the following statements about the oscillating mass-spring system as *true* or *false*. **[2]**

statement	**true/false**
The period of oscillation is constant.	
The net force on the mass is equal to its weight.	
The acceleration of the mass is a maximum at the mid-point of the oscillations.	
The velocity of the mass is proportional to the displacement.	

(b) A student wishes to investigate whether the period of oscillation of a simple pendulum is constant for all angles of swing. Describe how the student should carry out the investigation. Include the following in your description:

- a sketch of the apparatus with angle of swing labelled
- details of how the measurements would be made
- how these results would be used to form a conclusion
- the major difficulty likely to be encountered and how this might be overcome.

Sketch:

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.... **[5]**

[Total: 9]

2 **(a)** State two conditions concerning the **acceleration** of an oscillating object that must apply for simple harmonic motion.

1. ....

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2. ....

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.... **[2]**

(b) Fig. 3.1 shows how the potential energy, in mJ, of a simple harmonic oscillator varies with displacement.

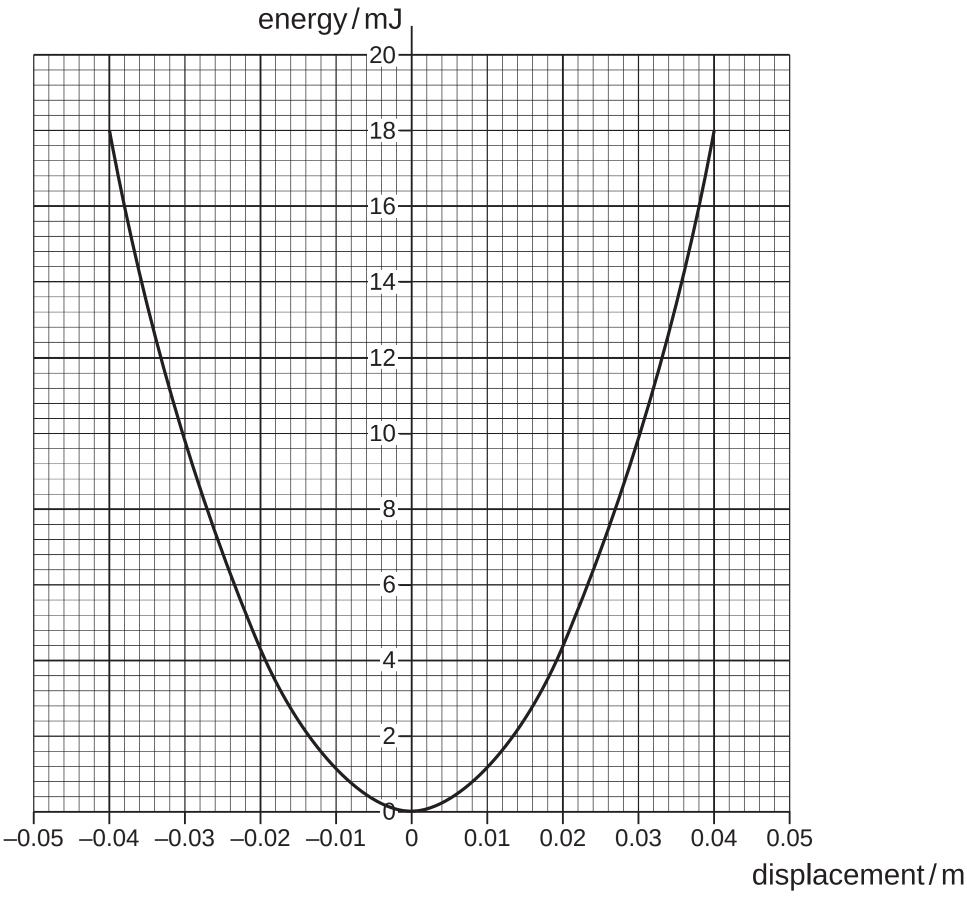

Fig. 3.1

On Fig. 3.1 sketch graphs to show the variation of

(i) kinetic energy of the oscillator with displacement – label this graph **K** **[2]**

(ii) the total energy of the oscillator with displacement – label this graph **T**. **[1]**

(c) Use Fig. 3.1 to determine

(i) the amplitude of the oscillations

amplitude = ... m **[1]**

(ii) the maximum speed of the oscillator of mass 0.12 kg

maximum speed = ... $m\,s^{-1}$ **[2]**

(iii) the frequency of the oscillations.

frequency = ... Hz **[2]**

(d) Resonance can either be useful or a problem. Describe one example where resonance has a useful application and one example where resonance is a problem or nuisance. For each example identify what is oscillating and what causes these oscillations.

(i) useful application

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.... **[2]**

(ii) problem

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.... **[2]**

[Total: 14]

3 Fig. 4.1 shows slotted masses suspended from a spring. The spring is attached to a fixed support at its upper end.

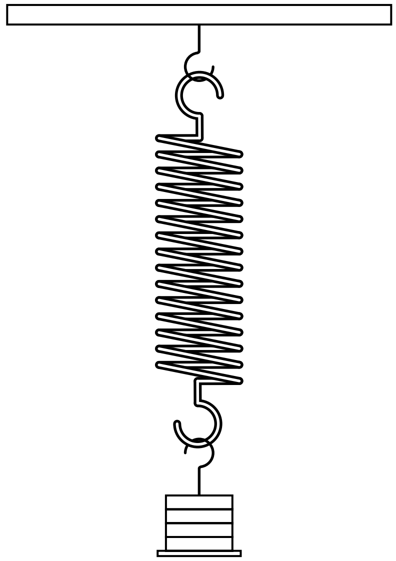

Fig. 4.1

When the masses are pulled down a short distance from the equilibrium position and released they oscillate vertically with simple harmonic motion. The frequency *f* of these oscillations depends on the mass *m* of the masses.
Two students make different predictions about the relationship between *f* and *m*.
One suggests *f* is proportional to $1/m$ and the other believes *f* is proportional to $1/\sqrt{m}$.

(a) Describe how you would test experimentally which prediction is correct.
Include in your answer:

- the measurements you would take, and
- how you would use these measurements to test each prediction.

You should also discuss ways of making the test as reliable as possible.

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.... **[4]**

(b) When the masses hanging on the spring are 400 g in total, they oscillate with an amplitude of 36 mm and a period of 1.2 s. Calculate

(i) the maximum kinetic energy of the masses

maximum kinetic energy = ... J **[3]**

(ii) the maximum acceleration of the masses.

maximum acceleration = ... $m\,s^{-2}$ **[2]**

(c) List the different types of energy involved in the oscillations of this mass-spring system. Describe the energy changes when the masses move from the lowest point of the oscillation to the highest point.
In your answer you should use appropriate technical terms spelled correctly.

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.... **[4]**

[Total: 13]

4 Fig. 2.1 shows a displacement against time graph for an oscillating mass.

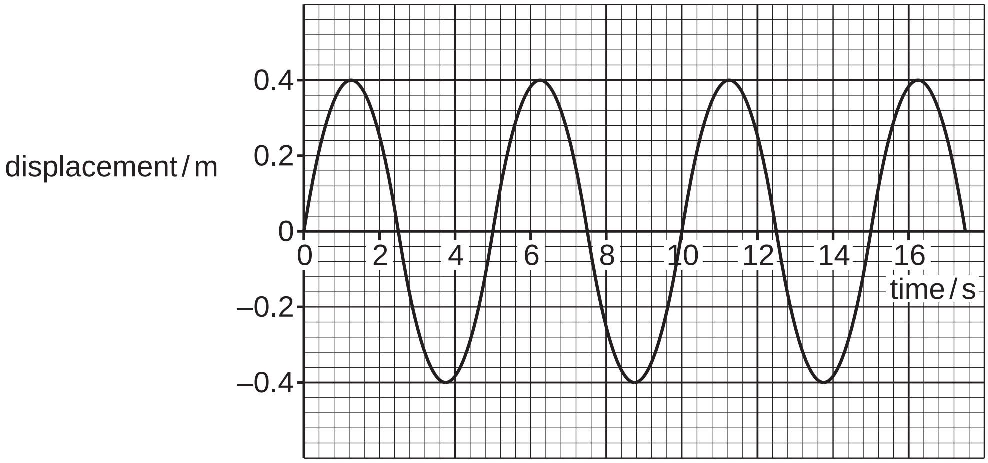

Fig. 2.1

(a) Use Fig. 2.1 to determine, for the oscillations of the mass,

(i) the amplitude and period

amplitude = ... m

period = ... s **[1]**

(ii) the angular frequency, ω.

ω = ... rad s^{-1} **[2]**

(b) Mark with a cross (**X**) on Fig. 2.1, using a different position in each case,

(i) a point where the velocity of the mass is a maximum; label it **V** **[1]**

(ii) a point where the acceleration of the mass is zero; label it **A** **[1]**

(iii) a point where the potential energy of the mass is a minimum; label it **P**. **[1]**

(c) The cone of a loudspeaker oscillates with simple harmonic motion. It vibrates with a frequency of 2.4 kHz and has an amplitude of 1.8 mm.

(i) Calculate the maximum acceleration of the cone.

acceleration = ... $m\,s^{-2}$ **[3]**

(ii) The cone experiences a mean damping force of 0.25 N. Calculate the average power needed to be supplied to the cone to keep it oscillating with a constant amplitude.

power = ...W **[3]**

[Total: 12]

Question			Answer	Marks	Guidance
1	(a)	(i)	Straight line <u>through</u> the origin Negative gradient and symmetrical about (0,0) by eye.	M1 A1	
		(ii)	Linking gradient to $[2\pi f]^2$. Frequency= $\frac{\sqrt{\text{gradient}}}{2\pi}$	C1 A1	**Allow:** use of a single data point used in a =(-)$[2\pi f]^2\ x$ **Note** frequency must be the subject of this equation
	(b)	(i)	$A = \frac{v_{\text{max}}}{2\pi f} = \frac{0.09}{2\pi \times 8.0}$ $A = 1.8 \times 10^{-3}$ (m)	C1 A1	**Allow:** values for T in range 0.125 to 0.13 s
		(ii)	$a_{\text{max}} = (2\pi f)^2 A$ $a_{\text{max}} = (2\pi \times 8.0)^2 \times 1.8 \times 10^{-3}$ $a_{\text{max}} = 4.5$ (m s^{-2})	C1 A1	Possible ecf from b(i) **Allow:** Tangent drawn on graph at any v = 0 point (C1) calculation of gradient (A1)
	(c)		Curve with same frequency /period max velocities decreasing at **three** successive **positive** peaks	B1 B1	**Allow**: ½ small square error on v = 0 points
	(d)		Axes labelled and graph showing correct bell shaped curve (amplitude increases then decreases) <u>Maximum/largest</u> amplitude or energy at f=8 Hz / natural frequency When <u>driving/oscillator's frequency</u> is equal to natural frequency / 8 Hz **resonance** occurs (AW).	B1 B1 B1	**Allow** this mark if curves are drawn asymptotically (to 8 Hz) May be scored on diagram or in text '**resonance'**/ '**resonant**' to be spelled correctly for this mark to be scored.
			Total	**13**	

Question			Answer	Marks	Guidance
2	(a)	(i)	T = 2.4 (s) f = 1/T = 1/2.4 = 0.42 (Hz)	A1	No marks for T = 3 (s) leading to f = 0.33 (Hz).
		(ii)	$v_{max} = 2\pi fA$ $v_{max} = 2\pi \times \frac{1}{2.4} \times 50 \times 10^{-3}$ $v_{max} = 0.13$ (m s^{-1})	C1 A1	**Allow:** Tangent drawn on graph at any x = 0 point (C1) calculation of gradient to give value in range 0.12 to 0.14 (m s^{-1}) (A1) Mark is for substitution. Possible ecf from a(i). Answer to 3 sf = 0.131 (m s^{-1}). Expect v_{max} = 0.10 (m s^{-1}) if answer in (i) f = 0.33 Hz (T=3).
	(b)	(i)	frequency is the same / not changed since (in SHM) it is independent of amplitude / (starting) displacement (AW)	B1	**Allow:** ...since length of pendulum is unchanged
		(ii)	(maximum velocity) is reduced because amplitude / (starting) displacement is reduced (AW) (Max) KE is reduced to one quarter / 4 times smaller	B1 B1	**Allow:** (Max) KE is smaller since amplitude/ (starting) displacement is smaller **Allow:** (Max) KE is smaller because GPE is smaller
	(c)	(i)	Straight line through origin means acceleration ∝ displacement Negative gradient means acceleration and displacement are in opposite directions / acceleration directed is towards the midpoint/equilibrium point (AW)	B1 B1	**Allow:** Straight line through origin means a ∝ x **Allow:** 1 mark for straight line through origin and negative gradient means $a \propto -x$ (hence SHM)
		(ii)	(Magnitude) Gradient = $\omega^2 = 5/0.004 = (2\pi f)^2$ $f = 5.6$ (Hz)	C1 A1	C1 mark is for substitution of gradient for ω^2 or $(2\pi f)^2$ Answer to 3 sf = 5.63 (Hz) **Allow:** 1 mark for *f* = 0.178 (Hz) not converting mm to m
			Total	10	

Question			Answer	Marks	Guidance
3	(a)		Is in the opposite direction to the displacement Increases as the speed of the object decreases	B1 B1	If more than 2 ticks are given mark all and deduct 1 mark for each error
	(b)	(i)	$f = \frac{1}{T} = \frac{1}{1.2}$ $f = 0.83 \quad (\text{Hz})$	B1	**Allow:** the fraction 5/6 only
		(ii)	$v_{max} = (2\pi f)\ A$ $0.08 = (2\pi \times 0.83)A$ $A = \frac{0.08}{(2\pi \times 0.83)} = 0.015 \quad (\text{m})$	C1 A1	Possible **ecf** from **(b)(i)** **Note:** Mark is for substitution; any subject Answer is 0.0153 (m) to 3 sf
		(iii)	$a_{max} = (2\pi f)^2 A$ $a_{max} = (2\pi \times 0.83)^2 \times 0.015$ $a_{max} = 0.42 \quad (\text{m s}^{-2})$	C1 A1	Possible **ecf** from **(b)(i)** and **(ii)** **Note:** Mark is for substitution **Ignore sign** Expect to see 0.41 if 2 sf values are used **Allow:** tangent used at v = 0 (M1) gradient of tangent calculated in range 0.37 to 0.44 (m s^{-2}) to 2sf (A1). Accept gradient of tangent =0.4 (m s^{-2})
	(c)	(i)	Graph(s) tending to single peak with axes labelled in words or appropriate symbols Peak labelled as natural / resonant frequency (of system) or f_o • Resonance occurs when the driving frequency matches natural / resonant frequency (of system) • the amplitude of vibrations / energy (transferred) is then a maximum (AW)	B1 B1 B1 B1	Can be scored even if horizontal axis is not correctly labelled
		(ii)	A valid example of resonance Explanation to include • what does the driving and what is being driven • that this occurs at specific (driver) frequency	B1 B1	**Allow:** Mirror in car, Washing machine, Child on swing, microwave (oven), radio (tuning), Structures (in wind etc) MRI **Not** musical instruments
			Total	**13**	

Question			Answer	Marks	Guidance
4	(a)		acceleration proportional to displacement (from the equilibrium position) and is always acting towards the equilibrium position / the mid-point of the motion (AW)	B1 B1	✎ **displacement** must be spelled correctly to score the mark. **Allow:** acceleration proportional to distance from equilibrium position with equilibrium spelled correctly for first B1 **Allow:** 'acceleration is in the opposite direction to displacement' for the second B1 mark **Use tick or cross on Scoris**
	(b)	(i)	$v_{max} = 2\pi f A$ f = 1/0.08 =12.5 $v_{max} = 2\pi\left(\frac{1}{0.080}\right) \times 1.2\times10^{-3} \left(= 2\pi\times12.5\times1.2\times10^{-3}\right)$ $v_{max} = 9.4\times10^{-2}$ (m s^{-1})	C1 A1	If A = 0.6 mm used $v_{max} = 2\pi\left(\frac{1}{0.080}\right)\times0.6\times10^{-3}$ (✓) $v_{max} = 4.7\times10^{-2}$ (m s^{-1}) (✓) **Note:** Answer to 3 sf is 9.42 x 10^{-2} (m s^{-1}) **Allow:** 1 mark for 94(.2) (m s^{-1}) not converting mm to m
		(ii)	This occurs at the highest point (top) of the oscillations When acceleration of plate equals/exceeds free fall acceleration /g/ 9.81 $g = (2\pi f)^2 A_0$ hence $A_0 = \frac{9.81}{\left(2\pi\times\frac{1}{0.080}\right)^2}$ A_0 = 1.6 x 10^{-3} (m)	B1 B1 C1 A1	 **Allow:** equation with any subject for this mark **Note:** Answer to 3 sf is 1.59 x 10^{-3} (m)
	(c)	(i)	Resonance Driving / drum frequency matches natural frequency (of casing) (AW)	B1 B1	
		(ii)	Graph with peak amplitude **less than** original peak amplitude Similar shape curve with peak at the **same** or **lower** frequency than given curve Curve is lower than given curve at all frequencies	M0 A1 A1	Must see this before subsequent marks can be scored.
			Total	**12**	

1	Expected Answers	Marks	Additional guidance
(a)(i)	Force/acceleration is proportional to displacement **(**from equilibrium position**)** (Resultant force) force/acceleration is (always) towards equilibrium position (WTTE, e.g. allow fixed point).	B1 B1	**Allow** force/acceleration is in opposite direction to the displacement. **Allow** acc $\propto$ *x*, provided *x* is identified as the displacement for 1st mark. 2nd mark only scored if –ve sign used and explained.
(a)(ii)	True; False False; False	B2	-1 for each error stop at zero Assume ✓ means true and X means false Do not credit blank spaces
(b)	***Measurements***: angle measured <u>with protractor</u> stated or shown on the diagram <u>stop-watch/ms timer/data-logger</u> to measure time stated or shown on the diagram ***Conclusion:*** compare periods for different angles stated/implied OR plot period against angle ***major difficulty:*** angle of swing decreases during the timing of the swing ***solution:*** e.g. measure time for ¼, ½ or 1 swing accurately (using electronic timer/datalogger) OR use data logger with motion sensor to record many swings and analyse how the period changes over time OR video the motion with onscreen timer and analyse	B1 B1 B1 M1 A1	**Allow** ruler used to measure initial and subsequent displacement/amplitude if explained. **Allow** table of results with correct column headings i.e. at least angle and period Do not allow 'time is short so measure nT and divide by n to reduce (%) error'.(WTTE)
	Total	**9**	

Question	Expected Answers	Marks	Additional guidance
2(a)	Acceleration is (directly) proportional to the displacement/distance (from the equilibrium position/central pt) Acceleration is always directed towards the equilibrium position/central point.	B1 B1	Allow "fixed point" or "point" Allow acc. is in opposite direction to displacement (WTTE) If formula is used: allow a $\propto$ -x for 1st mark and 2nd mark if x is stated as displacement.
(b)	Curve symmetrical about energy axis with maximum at 18 zero at +0.04 and – 0.04	B1 B1	Ignore points where graphs cross Give bod if not labelled **K** but correct
(b) (	Horizontal straight line passing 18	B1	Give bod if not labelled **T** but correct
(c)	0.04 m	B1	
(c) (	$\frac{1}{2}m(v_{max})^2 = 0.018$ $v_{max} = \sqrt{(2x0.018/0.12)}$ = **0.55** ms^{-1} (0.548)	C1 A1	Many will use 18 instead of 0.018. This results in 17.3 and scores 1 mark. Allow ecf for cand's value of max KE. Do not allow 0.54 for second mark.
(c) (i	correct use of $v_{max} = 2\pi fA$ f = (0.55/0.04x2π) = **2.2** (or 2.19 or 2.18)Hz	C1 A1	Allow ecf for cand's values from (c)(i) and/or (c) (ii). E.g for 17.3 f = 68.8 Hz. This scores 2 marks e.c.f. Do not allow 2.1
(d)	Award first mark for stating the **'driver'** of the oscillations and the second mark for stating what is **'driven'** i.e. oscillating useful applications: e.g. Cooking: **micro waves** cause **water molecules** to resonate Woodwind: **reed** causes **air column** to resonate Brass: **lips** cause **air column** to resonate MRI: **radio waves** (in a magnetic field) cause **nuclei/proton** to resonate Radios: **radio waves** cause **electrons/current** to resonate Person on swing: **intermittent pushes** cause **swing** to resonate problem: Bridges: **wind/walkers** causes **bridge** to resonate Vehicles: **engine vibrations** cause **panels/mirrors** to resonate Earthquakes: **ground vibrating** causes **buildings** to resonate	B1 B1 B1 B1	No marks to be awarded for a bare statement of the example e.g MRI. Please allow any other valid examples.
	Total	14	

Question			Answer	Marks	Guidance
3	(a)		Obtain a set of readings for: mass *m*, time period AND calculate frequency using $f = 1/T$. Plot graphs of *f* against 1/*m* AND *f* against 1/√*m* The graph which is a straight line through the origin provides the correct relationship Reference to one method of improving reliability eg counting more than 5 oscillations to find *T* or *f* taking repeat measurements of *T* or *f* (and average values) time oscillations from equilibrium position	B1 B1 B1 B1	**Not** number of oscillations in a set time **Allow:** product method using two or more points (B1) Select the relation which gives a constant product (B1) **Allow:** plot ln *f* against ln *m* (B1) gradient= -1 then $f \propto 1/m$ **or** gradient= -0.5 then $f \propto 1/\sqrt{m}$ (B1)
	(b)	(i)	$v_{max} = 2\pi f A = 2\pi\left(\frac{1}{1.2}\right)\times 36\times 10^{-3}$ $v_{max} = \frac{3\pi}{50}$ $(= 0.188)$ $KE_{max} = \frac{1}{2}\times 0.4\times\left(\frac{3\pi}{50}\right)^2$ $KE_{max} = 7.1\times 10^{-3}$ (J)	C1 C1 A1	**Note:** mark is for substitution
		(ii)	$a_{max} = (2\pi f)^2 A = \left[2\pi\left(\frac{1}{1.2}\right)\right]^2 \times 36\times 10^{-3}$ $a_{max} = 0.99$ (ms^{-2})	C1 A1	**Note:** mark is for correct substitution

Question			Answer	Marks	Guidance
	(c)		**Reference to** : kinetic energy (of masses and spring), gravitational potential energy (of mass and spring), elastic (potential) energy / strain energy of spring KE: zero (at lowest point), increasing to max at equilibrium point, decreasing to zero (at highest point) GPE: increases (as masses rise from lowest to highest point) (clearly worded ora)(AW) strain / elastic energy: decreases (as masses rise from lowest to highest point) (clearly worded ora) (AW)	B1 B1 B1 B1	**Note:** mark to be awarded only if **all** 3 forms are quoted ✐ **Note: potential** must be spelled correctly throughout to score this mark
			Total	**13**	

Question			Answer	Marks	Guidance
4	(a)	(i)	amplitude = 0.4(0) (m) **and** period = 5.(0) (s)	B1	**Note**: Both values are required. **Allow** 1 sf values
		(ii)	$\omega = (2\pi f) = 2\pi / \tau$ $\omega = 2\pi / 5.0 = (2\pi \times 0.2)$ $\omega = 1.3$ (rad s^{-1})	 C1 A1	Possible ecf from a(i) for period Mark is for correct substitution
	(b)	(i)	V clearly marked at any point where graph crosses time axis	B1	
		(ii)	A clearly marked at any point where graph crosses time axis	B1	
		(iii)	P clearly marked at any point where graph crosses time axis	B1	
	(c)	(i)	Selecting from data sheet $a = -(2\pi f)^2 x$ $a_{max} = (-)(2\pi \times 2.4 \times 10^3)^2 \times 1.8 \times 10^{-3}$ $a_{max} = 4.1 \times 10^5$ (m s^{-2})	C1 C1 A1	**Allow**: $a = (-)\ \omega^2 x$ **Note**: Ignore sign of a **Allow**: 2 marks for 4.1×10^n , $n \neq 5$ [POT error]
		(ii)	Work done = mean force x distance moved For ¼ oscillation distance moved = 1.8 mm, Work done = $0.25 \times 1.8 \times 10^{-3}$ (= 4.5×10^{-4} J) Time taken $\Delta t = ¼\ T = ¼\ (1/2.4 \times 10^3) = 1.04 \times 10^{-4}$ Power = work done / Δt = $0.25 \times 1.8 \times 10^{-3} / 1.04 \times 10^{-4}$ = **4.3 W** Power = 4.3 (W)	 C1 C1 A1	**Allow:** other correct values of distance moved and compatible time taken. Eg 7.2 (mm) and 4.17×10^{-4} (s) for 1 complete oscillation
			Total	**12**	