Cambridge Assessment International Education

Interactive

# Interactive Example Candidate Responses
# Paper 4 (May/June 2016), Question 4
# Cambridge International AS & A Level Physics 9702

Version 1.0

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HIGH | MIDDLE | LOW

4 A metal block hangs vertically from one end of a spring. The other end of the spring is tied to a thread that passes over a pulley and is attached to a vibrator, as shown in Fig. 4.1.

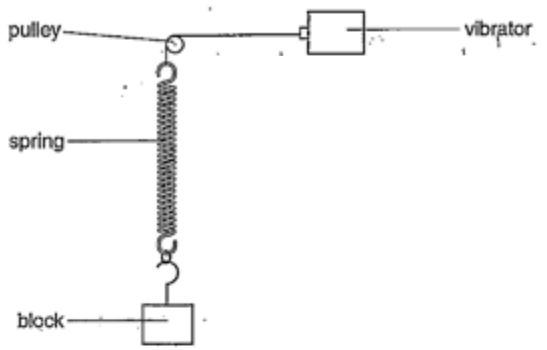


Fig. 4.1

(a) The vibrator is switched off.
The metal block of mass 120 g is displaced vertically and then released. The variation with time $t$ of the displacement $y$ of the block from its equilibrium position is shown in Fig. 4.2.

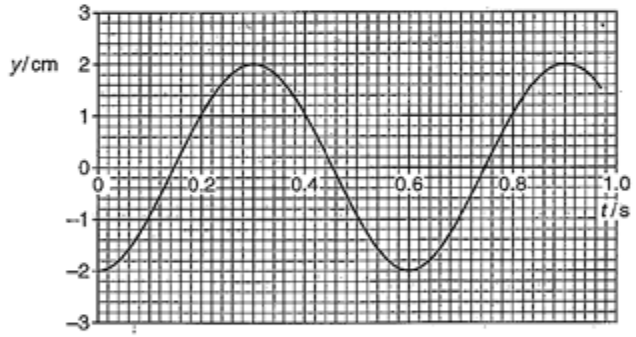


Fig. 4.2

For the vibrations of the block, calculate

(i) the angular frequency $\omega$,

$\omega = \frac{2\pi}{T} = \frac{2\pi}{0.6}$

$\omega = 10.47$

$\omega$ = 10.5 rad s$^{-1}$ [2]

Your Mark

4(a)(i)

4(a)(ii)

4(b)

4(c)

| Q4 | Mark scheme | | |
|---|---|---|---|
| (a)(i) | $T$ = 0.60 s and $\omega = 2\pi / T$ | C1 | |
| | $\omega$ = 10 (10.47) rad s$^{-1}$ | A1 | **[2]** |
| (a)(ii) | energy = $\frac{1}{2}m\omega^2x_0^2$ or $\frac{1}{2}mv^2$ and $v = \omega x_0$ | C1 | |
| | = $\frac{1}{2} \times 120 \times 10^{-3} \times (10.5)^2 \times (2.0 \times 10^{-2})^2$ | | |
| | = $2.6 \times 10^{-3}$ J | A1 | **[2]** |
| (b) | sketch: smooth curve in correct directions | B1 | |
| | peak at $f$ | M1 | |
| | amplitude never zero and line extends from 0.7$f$ to 1.3$f$ | A1 | **[3]** |
| (c) | sketch: peaked line always below a peaked line A | M1 | |
| | peak not as sharp and at (or slightly less than) frequency of peak in line A | A1 | **[2]** |
| | | | **[Total: 9]** |

EXAMINER COMMENTS

MARK SCHEME

(ii) the energy of the vibrations.

$E = \frac{1}{2}m(\omega\sqrt{x_0^2 - x^2})^2$

$= \frac{1}{2}m\omega^2 x_0^2$

$= \frac{1}{2} \times 120 \times 10^{-3} \times (10.47)^2 \times (2 \times 10^{-2})^2$

$= 2.631 \times 10^{-3}$

energy = $2.6 \times 10^{-3}$ J [2]

**(b)** The vibrator is now switched on.

The frequency of vibration is varied from $0.7f$ to $1.3f$ where $f$ is the frequency of vibration of the block in **(a)**.

For the block, complete Fig. 4.3 to show the variation with frequency of the amplitude of vibration. Label this line A. [3]

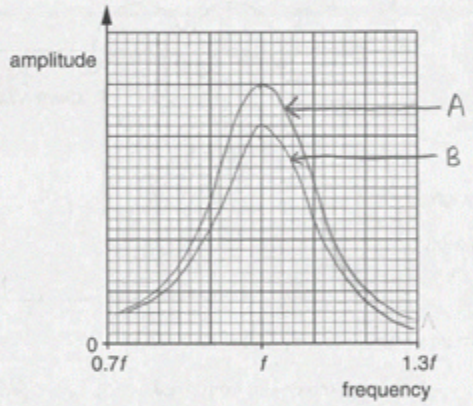


**Fig. 4.3**

**(c)** Some light feathers are now attached to the block in **(b)** to increase air resistance.

The frequency of vibration is once again varied from $0.7f$ to $1.3f$. The new amplitude of vibration is measured for each frequency.

On Fig. 4.3, draw a line to show the variation with frequency of the amplitude of vibration. Label this line B. [2]

[Total: 9]

Select page

HIGH MIDDLE LOW

Your Mark

4(a)(i)

4(a)(ii)

4(b)

4(c)

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EXAMINER COMMENTS

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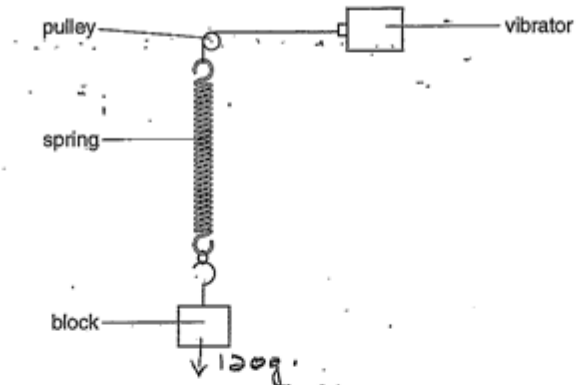


Fig. 4.1

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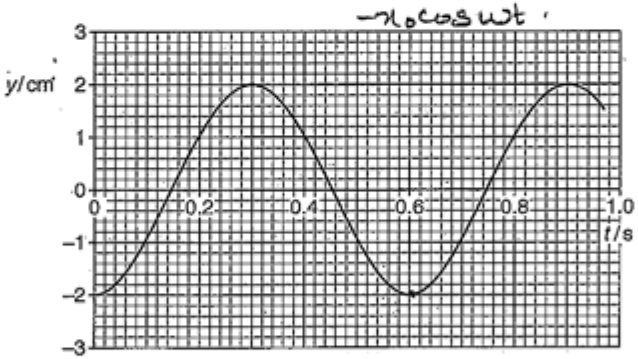


$\frac{1}{2} m x_0^2 \omega^2$

Fig. 4.2

For the vibrations of the block, calculate

**(i)** the angular frequency $\omega$.

$\omega = 2\pi f$

$= 1/0.6 = f = 1.67$ Hz.

$= 10.5$

$\omega =$ 10.5 rads$^{-1}$ [2]

Your Mark

4(a)(i) ☐

4(a)(ii) ☐

4(b) ☐

4(c) ☐

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EXAMINER COMMENTS

MARK SCHEME

(ii) the energy of the vibrations.

$T.E = \frac{1}{2} m x_0^2 \omega^2$

$= \frac{1}{2}(0.12)(2 \times 10^{-2})^2 (10.5)^2$

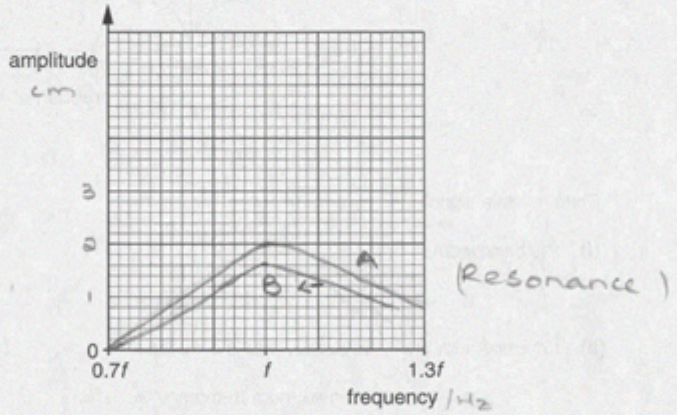
$= 0.646 \times 10^{-3}$

energy = $0.65 \times 10^{-3}$ J [2]

**(b)** The vibrator is now switched on.

The frequency of vibration is varied from 0.7*f* to 1.3*f* where *f* is the frequency of vibration of the block in **(a)**.

For the block, complete Fig. 4.3 to show the variation with frequency of the amplitude of vibration. Label this line A. [3]

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On Fig. 4.3, draw a line to show the variation with frequency of the amplitude of vibration. Label this line B. [2]

[Total: 9]



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| | = $\frac{1}{2} \times 120 \times 10^{-3} \times (10.5)^2 \times (2.0 \times 10^{-2})^2$ | | |
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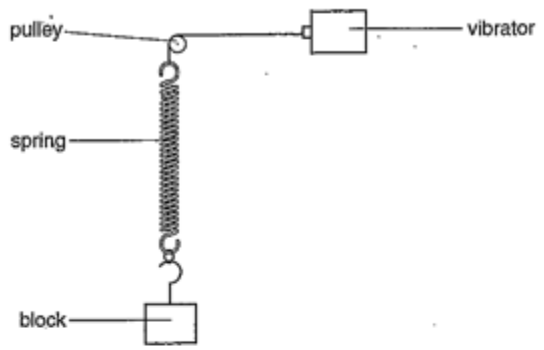


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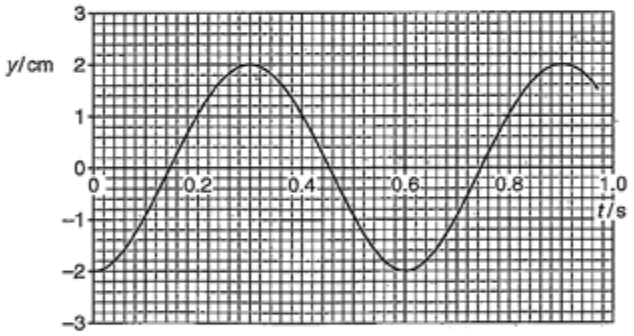


Fig. 4.2

For the vibrations of the block, calculate

**(i)** the angular frequency $\omega$,

$f = \frac{1}{T}$ $= \frac{1}{0.6} = 1.67$ $\omega = \frac{2\pi}{T} = \frac{2\pi}{0.6} =$

$\omega =$ 1.67 10.47 rads$^{-1}$ [2]

Your Mark

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EXAMINER COMMENTS

MARK SCHEME

(ii) the energy of the vibrations.

$\frac{1}{2} \times m \times \omega^2$

$= \frac{1}{2} \times 0.12 \times (10.47)^2$

$= 0.06 \times 109.6 = 6.58$

energy = 6.58 J [2]

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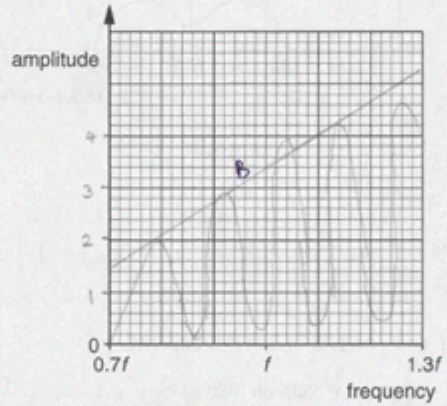


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HIGH MIDDLE LOW

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EXAMINER COMMENTS

MARK SCHEME

Cambridge Assessment International Education
The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA, United Kingdom
t: +44 1223 553554  f: +44 1223 553558
e: info@cambridgeinternational.org  www.cambridgeinternational.org