

1)

a	i	elastic potential energy and gravitational potential energy ✓	1	For elastic pe allow "pe due to tension", or "strain energy" etc.
a	ii	elastic pe → kinetic energy → gravitational pe → kinetic energy → elastic pe ✓✓ [or pe → ke → pe → ke → pe is ✓ only] [or elastic pe → kinetic energy → gravitational pe is ✓ only]	2	If kinetic energy is not mentioned, no marks. Types of potential energy must be identified for full credit.
b	i	period = 0.80 s ✓ during one oscillation there are two energy transfer cycles (or elastic pe → ke → gravitational pe → ke → elastic pe in 1 cycle) or there are two potential energy maxima per complete oscillation ✓	2	Mark sequentially.
b	ii	sinusoidal curve of period 0.80 s ✓ – cosine curve starting at $t = 0$ continuing to $t = 1.2$ s ✓	2	For 1 st mark allow ECF from T value given in 3(i)(i).
c	i	use of $T = 2\pi\sqrt{\frac{m}{k}}$ gives $0.80 = 2\pi\sqrt{\frac{0.35}{k}}$ ✓ $\therefore k\left(-\frac{4\pi^2 \times 0.35}{0.80^2}\right) = 22\text{ (21.6)} \checkmark \quad \text{N m}^{-1} \checkmark$	3	Unit mark is independent: insist on N m^{-1} . Allow ECF from wrong T value from (b)(i): use of 0.40s gives 88.4 (N m^{-1}).
c	ii	maximum ke = $(\frac{1}{2}mv_{\text{max}}^2) = 2.0 \times 10^{-2}$ gives $v_{\text{max}}^2 = \frac{2.0 \times 10^{-2}}{0.5 \times 0.35} \checkmark \quad (= 0.114 \text{ m}^2\text{s}^{-2}) \quad \text{and } v_{\text{max}} = 0.338 \text{ (m s}^{-1}\text{)} \checkmark$ $v_{\text{max}} = 2gA$ gives $A = \frac{0.338}{2 \times 9.81} \checkmark$ and $A = 4.3(0) \times 10^{-2} \text{ m} \checkmark$ i.e. about 40 mm [or maximum ke = $(\frac{1}{2}mv_{\text{max}}^2) = \frac{1}{2}m(2\pi fA)^2 \checkmark$ $\frac{1}{2} \times 0.35 \times 4\pi^2 = 1.25 \times A^2 = 2.0 \times 10^{-2} \checkmark$ $\therefore A^2 = \frac{2 \times 2.0 \times 10^{-2}}{4\pi^2 \times 0.35 \times 1.25} \checkmark \quad (= 1.85 \times 10^{-3})$ and $A = 4.3(0) \times 10^{-2} \text{ m} \checkmark$ i.e. about 40 mm] [or maximum ke = maximum pe = 2.0×10^{-2} (J) maximum pe = $\frac{1}{2}kA^2 \checkmark$ $\therefore 2.0 \times 10^{-2} = \frac{1}{2} \times 21.6 \times A^2 \checkmark$ from which $A^2 = \frac{2 \times 2.0 \times 10^{-2}}{21.6} \checkmark \quad (= 1.85 \times 10^{-3})$ and $A = 4.3(0) \times 10^{-2} \text{ m} \checkmark$ i.e. about 40 mm]	4	First two schemes include recognition that $f = 1/T$ i.e. $f = 1/0.80 = 1.25$ (Hz). Allow ECF from wrong T value from (b)(i) – 0.40s gives $A = 2.15 \times 10^{-2} \text{ m}$ but mark to max 3. Allow ECF from wrong k value from (c)(i) – 88.4 Nm^{-1} gives $A = 2.15 \times 10^{-2} \text{ m}$ but mark to max 3.

2)

a		acceleration is proportional to displacement (from equilibrium) ✓ acceleration is in opposite direction to displacement or towards a fixed point/equilibrium position ✓	2	Acceleration proportional to negative displacement is 1 st mark only. Don't accept "restoring force" for acc'n.
b	i	$f\left(-\frac{1}{2\pi\sqrt{\frac{x}{l}}}\right) = \frac{1}{2\pi\sqrt{\frac{9.81}{0.984}}} \checkmark \quad (= 0.503 \text{ (0.5025) (Hz)} \checkmark$ [or $f\left(-2\pi\sqrt{\frac{l}{x}}\right) = 2\pi\sqrt{\frac{0.984}{9.81}} \checkmark \quad (= 1.9(90) \text{ (s)} \checkmark$ $f\left(-\frac{1}{T}\right) = \frac{1}{1.990} = 0.503 \text{ (0.5025) (Hz)} \checkmark$ ✓] answer to 3-SF ✓	3	3-SF is an independent mark. When $x = 9.81$ is used, allow either 0.502 or 0.503 for 2 nd and 3 rd marks. Use of $g = 9.8$ gives 0.502 Hz; award only 1 of first 2 marks if quoted as 0.502, 0.503 0.50 or 0.5 Hz.
b	ii	$a\left(-\frac{1}{(2\pi f)^2}x\right) = (-)(2\pi \times 0.5025)^2 \times 42 \times 10^{-2} \checkmark$ $= 0.42 \text{ (0.419) (m s}^{-2}\text{)} \checkmark$	2	Allow ECF from any incorrect f from (b)(i).

Phya4 Unofficial Mark Scheme

Tao Wei



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