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<br>→ kinetic energy → elastic pe ✓✓<br>[**or** pe→ke→pe→ke→pe is ✓ only]<br>[**or** elastic pe → kinetic energy → gravitational pe is ✓ only] | 2 | If kinetic energy is not mentioned, no marks.<br>Types of potential energy must be identified for full credit. |
| b | i | period = 0.80 s ✓<br>during one oscillation there are two energy transfer cycles<br>∴ (or elastic pe→ke→gravitational pe→ke→elastic pe in 1 cycle)<br>**or** there are two potential energy maxima per complete oscillation ✓ | 2 | Mark sequentially. |
| b | ii | sinusoidal curve of period 0.80 s ✓<br>– cosine curve starting at $t = 0$ continuing to $t = 1.2$s ✓ | 2 | For 1st mark allow ECF from $T$ value given in 3(b)(i). |
| c | i | use of $T = 2\pi\sqrt{\frac{m}{k}}$ gives $0.80 = 2\pi\sqrt{\frac{0.35}{k}}$ ✓<br>$\therefore k\left(=\frac{4\pi^2 \times 0.35}{0.80^2}\right) = 22$ (21.6) ✓ N m$^{-1}$ ✓ | 3 | Unit mark is independent: insist on N m$^{-1}$.<br>Allow ECF from wrong $T$ value from (b)(i): use of 0.40s gives 86.4 (N m$^{-1}$). |
| c | ii | maximum ke = ($\frac{1}{2}$ $mv_{max}^2$) = $2.0 \times 10^{-2}$ gives<br>$v_{max}^2 = \frac{2.0\times10^{-2}}{0.5\times0.35}$ ✓ (= 0.114 m$^2$s$^{-2}$) and $v_{max}$ = 0.338 (m s$^{-1}$) ✓<br>$v_{max} = 2\pi f A$ gives $A = \frac{0.338}{2\pi\times1.25}$ ✓<br>and $A = 4.3(0) \times 10^{-2}$ m ✓ i.e. about 40 mm<br>[**or** maximum ke = ($\frac{1}{2}$ $mv_{max}^2$) = $\frac{1}{2}$ $m$ $(2\pi fA)^2$ ✓<br>$\frac{1}{2} \times 0.35 \times 4\pi^2 \times 1.25^2 \times A^2 = 2.0 \times 10^{-2}$ ✓<br>$\therefore A^2 = \frac{2\times2.0\times10^{-2}}{4\pi^2\times0.35\times1.25^2}$ ✓ (= $1.85 \times 10^{-3}$)<br>and $A = 4.3(0) \times 10^{-2}$ m ✓ i.e. about 40 mm ]<br>[**or** maximum ke = maximum pe = $2.0 \times 10^{-2}$ (J)<br>maximum pe = $\frac{1}{2}$ $k$ $A^2$ ✓<br>$\therefore 2.0 \times 10^{-2} = \frac{1}{2} \times 21.6 \times A^2$ ✓<br>from which $A^2 = \frac{2\times2.0\times10^{-2}}{21.6}$ ✓ (= $1.85 \times 10^{-3}$)<br>and $A = 4.3(0) \times 10^{-2}$ m ✓ i.e. about 40 mm ] | 4 | First two schemes include recognition that $f = 1/T$ i.e. $f = 1/0.80 = 1.25$ (Hz).<br>Allow ECF from wrong $T$ value from (b)(i) – 0.40s gives $A = 2.15 \times 10^{-2}$m but mark to max 3.<br>Allow ECF from wrong $k$ value from (c)(i) – 86.4Nm$^{-1}$ gives $A = 2.15 \times 10^{-2}$m but mark to max 3. |

2)

| | | | | |
|---|---|---|---|---|
| a | | acceleration is proportional to displacement (from equilibrium) ✓<br>acceleration is in opposite direction to displacement **or** towards a fixed point/equilibrium position ✓ | 2 | Acceleration proportional to negative displacement is 1st mark only.<br>Don't accept "restoring force" for accln. |
| b | i | $f\left(=\frac{1}{2\pi}\sqrt{\frac{g}{l}}\right) = \frac{1}{2\pi}\sqrt{\frac{9.81}{0.9984}}$ ✓ = 0.503 (0.5025) (Hz) ✓<br>[**or** $T\left(=2\pi\sqrt{\frac{l}{g}}\right) = 2\pi\sqrt{\frac{0.9984}{9.81}}$ ✓ (= 1.9(900) (s) )<br>$f\left(=\frac{1}{T}\right) = \frac{1}{1.990}$ = 0.503 (0.5025) (Hz)<br>✓ ]<br>answer to **3SF** ✓ | 3 | 3SF is an independent mark.<br>When $g$ = 9.81 is used, allow either 0.502 or 0.503 for 2nd and 3rd marks.<br>**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 | $a\left(=-(2\pi f)^2 x\right) = (-)(2\pi \times 0.5025)^2 \times 42 \times 10^{-2}$ ✓<br>= 0.42 (0.4159) (m s$^{-2}$) ✓ | 2 | Allow ECF from **any** incorrect $f$ from (b)(i). |

# Phya4 2014 Mark Scheme

Annelies Wilder-Smith

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