

15 marks · one mark for each correct letter

The reason given for each answer is for learning: it is not needed in the exam.

Q	Answer	Why
1	B	Correct. These are the two conditions for SHM: $a \propto x$, and a points back to equilibrium ($a = -\omega^2 x$).
2	D	Correct. The spring force $F = -kx$ is proportional to the displacement and directed towards equilibrium.
3	A	Correct. $T = 2\pi\sqrt{m/k}$, so $T \propto \sqrt{m/k} = \sqrt{4/2} = \sqrt{2}$.
4	C	Correct. $T = 2\pi\sqrt{l/g}$, so $l = gT^2/(4\pi^2) = 9.8 \times 2.4^2/(4\pi^2) = 1.4$ m.
5	D	Correct. $\omega^2 = a/x = 6.0/0.024 = 250 \text{ s}^{-2}$, $\omega = 15.8 \text{ rad s}^{-1}$, $T = 2\pi/\omega = 0.40$ s.
6	B	Correct. Gradient $= -4.0/0.040 = -100 \text{ s}^{-2} = -\omega^2$. $\omega = \sqrt{100} = 10 \text{ rad s}^{-1}$, $f = \omega/2\pi = 1.6$ Hz.
7	A	Correct. $F = ma = m(-\omega^2 x) = -m\omega^2 x$, so the gradient is $-m\omega^2$.
8	C	Correct. At the end the object stops for an instant ($v = 0$), and $a = -\omega^2 x$ has its largest size, directed back towards equilibrium (negative).
9	B	Correct. The velocity reaches its peaks a quarter of a period ($\pi/2$) before the displacement.
10	A	Correct. $x_0 = 6.0/2 = 3.0$ cm and $T = 0.40$ s. $v_{\max} = \omega x_0 = (2\pi/0.40) \times 0.030 = 0.47 \text{ m s}^{-1}$.
11	D	Correct. The kinetic energy is zero at each end. From one end to the other end is half a period, so $T = 2 \times 0.25 = 0.50$ s.
12	C	Correct. $E_p = \frac{1}{2}m\omega^2 x^2 \propto x^2$, so at $x_0/2$ the potential energy is $(1/2)^2 = 0.25$ of E . $E_k = E - 0.25E = 0.75E$.
13	D	Correct. $\sin \phi = -1/2$ gives $7\pi/6$ or $11\pi/6$. Moving towards equilibrium from a negative x means moving in the $+$ direction, so $v(0) = \omega x_0 \cos \phi > 0$: $\cos(11\pi/6) > 0$.
14	B	Correct. $v = \omega\sqrt{x_0^2 - x^2} = 5.0 \times \sqrt{(0.080^2 - 0.040^2)} = 0.35 \text{ m s}^{-1}$.
15	A	Correct. $T = 2\pi\sqrt{m/k}$ does not depend on g (l). The extension is largest at the lowest point (II). At the equilibrium position the spring is already stretched by $e = mg/k$, so it stores $\frac{1}{2}ke^2$, not zero (III is wrong).