Name of the Student:_____
Max. Marks : 19 Marks **Time : 19 Minutes**

Mark Schemes

Q1.

Question Number	Acceptable answers	Additional guidance	Mark
	• (Resultant) force/acceleration is proportional to the displacement from the equilibrium position (1) • (Resultant) force/acceleration is in the opposite direction to the displacement **Or** (resultant) force/acceleration is always directed towards the equilibrium position (1)		2

Q2.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following points: • (As the frequency is increased) the amplitude increases to a maximum at a frequency of 2 Hz (and then decreases) (1) • This is the natural frequency (of oscillation) of the trolley (1) • When the vibrator drives the trolley at its natural frequency there is a maximum transfer of energy (from the vibrator to the trolley) (1) • This is resonance (1)		4
(ii)	• Use of $T = 2\pi\sqrt{\frac{m}{k}}$ (1) • $k = 140\ \text{N m}^{-1}$ (1) Example of calculation $0.5\ \text{s} = 2\pi \times \sqrt{\frac{0.87\ \text{kg}}{k}}$ $\therefore k = \frac{4\pi^2 \times 0.87\ \text{kg}}{(0.5\ \text{s})^2} = 137\ \text{N m}^{-1}$		2

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Q3.

Question Number	Acceptable answers	Additional guidance	Mark
	• Use of $W = mg$ (1) • Use of $\Delta F = k\Delta x$ (1) • Use of $T = 2\pi\sqrt{\frac{m}{k}}$ (1) • Use of $f = \frac{1}{T}$ (1) • f = 1.7 (Hz), so claim is incorrect. (1)	Example of calculation: $k = \frac{65 \times 10^{-3}\text{kg} \times 9.81\ \text{N kg}^{-1}}{0.085\ \text{m}} = 7.50\ \text{N m}^{-1}$ $T = 2\pi\sqrt{\frac{65 \times 10^{-3}\ \text{kg}}{7.50\ \text{N m}^{-1}}} = 0.585\ \text{s}$ $f = \frac{1}{T} = \frac{1}{0.585\ \text{s}} = 1.71\ \text{Hz}$	5

Q4.

Question Number	Acceptable answers	Additional guidance	Mark
(i)	• Determine amplitude (1) • Use of $\omega = 2\pi f$ (1) • Use of max $a = (-)\ \omega^2 A$ (1) • Max acceleration = 0.66 m s^{-2} (1)	Example of calculation Amplitude = 0.29 m / 2 = 0.145 m $\omega = 2\pi \times 0.34$ Hz = 2.14 rad s^{-1} max a = (2.14 rad s^{-1})^2 × 0.145 m = 0.66 m s^{-2}	4
(ii)	• Use of $v = (-)\ A\omega \sin \omega t$ (1) • Speed = 0.29 m s^{-1} (ecf for ω and A from (b)(i)) (1)	Example of calculation v = 0.145× 2.14 s^{-1} sin ((2.14 s^{-1} × 3.5 s) radian) = 0.145× 2.14 s^{-1} sin ((2.14 s^{-1} × 3.5 s) × 360° / 2π) Speed = 0.29 m s^{-1}	2

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