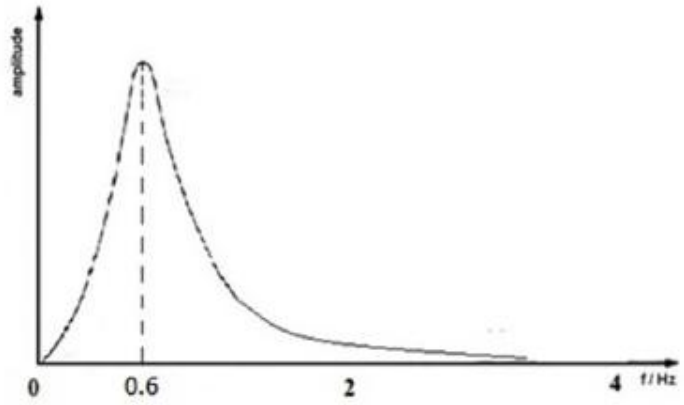
Name of the Student:_____
Max. Marks : 23 Marks **Time : 23 Minutes**

Mark Schemes

Q1.

Question Number	Answer		Mark
(a)(i)	Use of Newton's 2nd law (F = ma) with F = –kx	(1)	2
	Acceleration/force is in opposite direction to the displacement from the equilibrium position **Or** acceleration/force is (always) towards the equilibrium/undisplaced/rest position	(1)	
	Example of calculation: m a = - k x $a = -\frac{k}{m}x$		
(a)(ii)	See $a = -\omega^2 x$	(1)	3
	Compare with $a = -\frac{k}{m}x$ to give $\omega^2 = \frac{k}{m}$	(1)	
	Substitute for ω using $\omega = \frac{2\pi}{T}$	(1)	
	Example of calculation: $a = -\omega^2 x$ and $a = -\frac{k}{m}x$ $\omega^2 = \frac{k}{m}$ and $\omega = \frac{2\pi}{T}$ $\left(\frac{2\pi}{T}\right)^2 = \frac{k}{m} \quad \therefore T = 2\pi\sqrt{\frac{m}{k}}$		
(b)(i)	Use of $T = 2\pi\sqrt{\frac{m}{k}}$	(1)	3
	Use of $f = \frac{1}{T}$	(1)	
	f = 0.59 Hz	(1)	
	Example of calculation: $T = 2\pi\sqrt{\frac{3.5\times10^5\ \text{kg}}{4.8\times16^6\ \text{N m}^{-1}}} = 1.7\ \text{s}$ $f = \frac{1}{T} = \frac{1}{1.7\ \text{s}} = 0.588\ \text{Hz}$		

(b)(ii)	Correct shape Single sharp peak With the peak labelled at 0.6 Hz  	(1) (1) (1)	**3**
(b)(iii)	(Max) <u>amplitude</u> of oscillation is reduced as energy is transferred from the mass-spring system and then dissipated (in the surroundings)	(1) (1) (1)	**3**
	Total for question		**14**

Q2.

Question Number	Answer		Mark
(a)(i)	Calculation of average time period [accept average time for 10T] Use of $f = \frac{1}{T}$ $f = 1.5$ Hz Example of calculation $T = \frac{t_1 + t_2 + t_3}{30} = \frac{(6.2 + 6.6 + 6.9)\text{s}}{30} = 0.657\,\text{s}$ $f = \frac{1}{0.657\,\text{s}} = 1.52\,\text{Hz}$	(1) (1) (1)	3
(a)(ii)	Force (or acceleration): proportional to displacement from equilibrium position always acting towards the equilibrium position **Or** always in the opposite direction to the displacement [accept rest/centre point for "equilibrium position"] [both marks can be gained from an equation with terms clearly defined including a correct reference to the negative sign]	(1) (1)	2
(b)	There is (large) drag force [accept air resistance for drag] Producing a deceleration **Or** the oscillation is (heavily) damped **Or** energy is transferred/removed from the system [e.g. transferred to the surroundings.] [Do not accept "lost" for "transferred"]	(1) (1)	2
(c)	Resonance Driven at a frequency equal/near the natural frequency of the wings [accept their answer to (a) as a numerical value] [for "driven" accept "forced/made to oscillate"]	(1) (1)	2