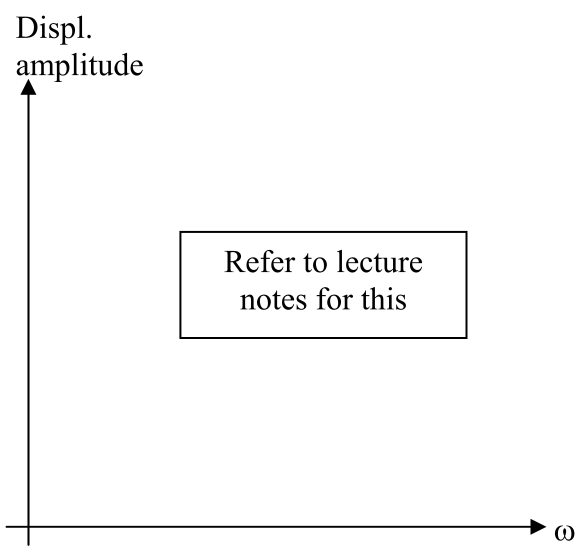
PHYSICS EXAMINATION PROBLEMS
SOLUTIONS AND HINTS FOR STUDENT SELF-STUDY

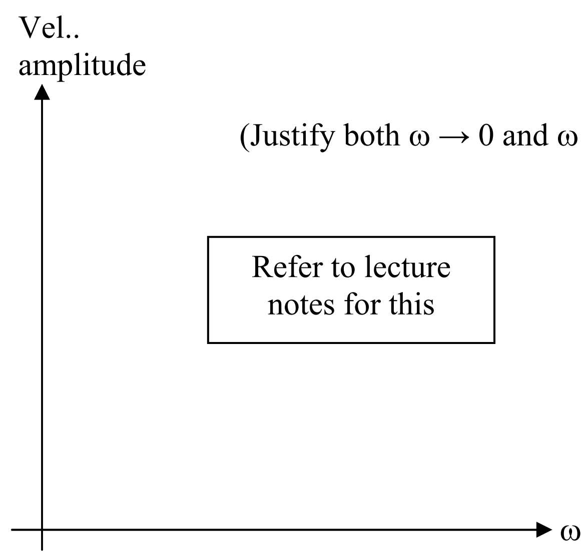
Module Code and Lecturer	PHY1106: PV
Name of module	Waves and oscillations
Date of examination	June 2004

1. Differentiate expression for displacement to produce velocity. $\dot{x} = \dfrac{F_0}{|Z_m|} e^{j(\omega t - \phi)}$

the real part comprises; $\dot{x} = \dfrac{F_0}{|Z_m|} \cos(\omega t - \phi)$

The oscillator reaches velocity resonance when $|Z_m|$ is a minimum (i.e. when $\dot{x} = \sqrt{\dfrac{k}{m}}$)





(Justify both ω → 0 and ω → ∞)

Max. velocity amp. at 4.9 rads / s or at frequency 0.78 Hz.

Use standard formula to calculate Q = 0.245.

2. Lecture note definition of phasor diagram and its use in representing phases.

Write standard V-I relations for capacitor, resistor and inductor; then use these with integration or differentiation to produce standard lecture relation for the impedance of each component (including j-term to represent phase etc.)

Add these impedance terms for series circuit situation to produce LCR circuit expression.

Use standard concepts and definitions to produce the given expression (hint: draw an argand diagram to represent the angle, and the phasors represented by each component).

Use expression $\omega = \frac{1}{\sqrt{LC}}$ to verify resonance condition.

Then use:at $I_0 = \frac{V_0}{|Z|} = \frac{V_0}{R} = \frac{100}{20} = 5A$ resonance

Similar note-work to calculate P_{av} = 250 W.

3.i. Bookwork for definitions of phase velocity, group velocity and dispersion.

Use $Vp = \frac{\omega}{k}$ and $Vp = \frac{d\omega}{dk}$ to derive expressions ($v_p = c + dk^2$ and $v_g = c + 3dk^2$)

ii. Amplitude unchanged; resonant freq. decreases by sq. root of 2; max KE and max PE unchanged.
Standard bookwork (from lectures) to prove solution works for SHM.
Start by calculating k (use F=kx) = 50 N/m. Then use resonant freq. equation to show f = 1.13 Hz.

4. $\omega = 2\pi f$ = 62.8 /s. Use $v_p = \omega/k$ to calculate k = 6.28 /m. Then $\lambda = 2\pi/k$ to calculate λ = 1m.

Use lecture notes (and common maths understanding) to draw standard curves here.

Differentiate $y = A\cos(\omega t - kx)$ and substitute into wave equation expression. The solution will then have

$$v_p = \sqrt{\frac{T}{\rho}}$$

5. Standard definition of stretched string impedance (in words and general equation).
Standard expression for impedance z in terms of T and ρ.
Use lecture notes or bookwork to derive the required relations for R and T.
The value of z_3 enables complete destructive interference since the thickness is exactly a quarter wavelength (enlarge on this slightly with appropriate diagram).