TEST QUESTIONS: FIRST INSTALLMENT

BECAUSE OUR CLASS DISCUSSIONS GO WELL OUTSIDE BOOK THE, I AM LISTING BELOW A SET OF TEST QUESTIONS TO HELP YOU PREPARE FOR THE EXAM.

WE WILL DISCUSS THE SOLUTIONS DURING THE REVIEW

IN THE INTERIM PLEASE WORK OUT YOUR ANSWERS. IN EVERY CASE WRITE OUT A NOTE TO JUSTIFY YOUR ANSWER.

QUESTIONS

1. A wave is written as

$$D = 10\,N/m^2 + 11\,N/m^2 \sin(6.28x + 12.56t)$$

where x is in meters and t in secs.

i) What kind of wave is this?

ii) Do you think that such a wave can exist?

2. FILL IN THE BLANKS IN THE EQUATION

$$\Delta = \quad \sin(x - vt)$$

and explain the physical meaning of the symbols that you write.

3. What is a travelling wave?

4. What is the difference between a longitudinal wave and a transverse wave?

5. We have shown that on a stretched string a periodic wave transports power

$$\eta = \frac{1}{2} A^2 \omega^2 \frac{F}{V}$$

where A = Amplitude, ω = Angular frequency
F = Tension in string, V = speed of wave.

How would η change if you
(a) Double ω or (b) double V or (c) double F or reduce A by a factor of 4.

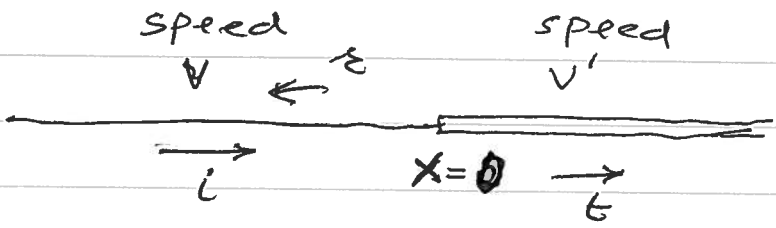
6. Two strings have the same length but one has a mass which is 9 times that of the other. If both had the same tension in them which will have a higher wave

speed and by what factor?

7. What is sound?

8. What is the speed of sound on the moon? [The moon has no atmosphere].

9. Two strings are tied together at $x=0$. An incident wave arrives at $x=0$ as



$$y_i = A_i \sin(kx - \omega t)$$

and gives rise to a reflected wave

$$y_r = A_r \sin(kx + \omega t)$$

and a transmitted wave

$$y_t = A_t \sin(k'x - \omega' t)$$

i) What is the relation between ω and ω'?

ii) What determines k'?

(iii) We are told that

$$\frac{A_r}{A_i} = \frac{v - v'}{v + v'}, \quad \frac{A_t}{A_i} = \frac{2v'}{v + v'}$$

show that if $v' = 0$, there is a phase change of π during reflection. That is a crest (trough) incident at $x=0$ is reflected as a trough (crest).

10. The speed of sound in a gas is written as

$$v_s = \sqrt{\frac{\gamma k_B T}{m}}$$

Why is there a $\gamma \left(= \frac{C_p}{C_v}\right)$ in this equation?

11. The speed of sound in air is 340m/s. Can mechanical waves of wavelengths (i) 100m, (ii) 10m, (iii) 0.1m and (iv) 0.01m be called "SOUND"?

12. Draw a periodic (Sine) sound wave as
(i) a displacement wave
(ii) a pressure wave
at $t = 0$.

13. Draw the first three <u>modes</u> of vibration of a wire fixed at both ends. If the length of the wire is 1 meter and the wave speed in it is 100m/s what are the frequencies of these <u>modes</u>?

14. The intensity of a sound wave in air is

$$I = \frac{1}{2} s_m^2 \omega^2 \rho_0 v_s = \frac{1}{2} \gamma P_0 \frac{s_m^2 \omega^2}{v_s}$$

Calculate the amplitude s_m of this wave

if $\omega = 500$ rad/s, $\rho_0 = 1.2\ kg/m^3$ and $V_s = 340\ m/s$ while $I = I_0 = 10^{-12}\ Watt/m^2$

15. How would the answer to Prob 14 change if the Intensity was 60 db?

16. The amplitude of the pressure wave of Prob 14 is

$$P_m = \gamma k S_m P_0$$

where

$\gamma = 1.4$, $P_0 = 10^5\ N/m^2$. How large is P_m for 60 db sound?

(length L)

17. When a tube is open at both ends the wavelengths of the modes in it are given by

$$\lambda_n = \frac{2L}{n} \quad n = 1, 2, 3, \ldots$$

If it is open at one end and closed at the other

$$\lambda_n = \frac{4L}{(2n-1)}, \quad n = 1, 2, 3, \ldots$$

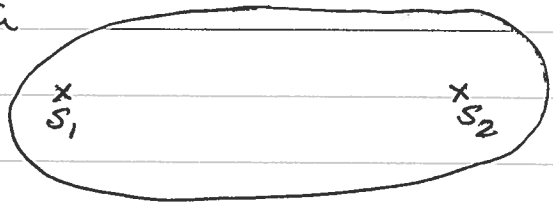
Why this difference?

18. A piano tuner finds that after some initial tuning of the "A" string she hears 4 beats with respect to a 440Hz tuning fork. (i) What are the possible frequencies of the sound

emitted by the string? (ii) If after the initial tuning she loosens the string very slightly and finds that now she hears 6 beats which of the two answers to part (i) is correct?

19. You are travelling toward a hill when you blow your horn ($f = 500$ Hz). If your speed is 30 mph and the speed of sound is 340 m/s, how many beats will you expect to discern between your horn and the sound reflected by the hill?

20. Two sources of sound having same frequency and wavelength are 10 meters apart. If the wavelength of sound is One meter and the waves leave S_1 and S_2 in phase, how many maxima will you encounter as you walk around the path shown.



21. If in Prob 20 you were to stand exactly in the middle of the line joining S_1 and S_2 and heard NOTHING. What would it tell you about the phase difference of the waves starting at the same time from S_1 and S_2.