18.11.05

204

American University of Beirut
Physics Department
Physics 204

Name: Key

I. D. No:

Multiple choice questions

1. If the tension on a guitar string is increased by a factor of 3, the fundamental frequency at which it vibrates is changed by what factor?

a. 9
b. $\sqrt{3}$
c. 1/9
d. $1/\sqrt{3}$
e. None of the above my answer is: ________________

$f = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$

$f' = \frac{1}{2L}\sqrt{\frac{3T}{\mu}}$

2. What phenomenon is created by two tuning forks, side by side, emitting frequencies which differ by only a small amount?

a. Resonance
b. Interference
c. The Doppler effect
d. Beats
e. None of the above my answer is: ________________

3. A train station bell gives off a fundamental tone of 500 Hz as the train approaches the station at a speed of 20 m/s. If the velocity of sound in air is 335 m/s, what will be the apparent frequency of the bell to an observer riding the train?

$v_o = 20$ m/s
$f = 500$ Hz
$v = 335$

$f' = f\frac{v + v_o}{v} = 500\left(1 + \frac{20}{335}\right)$

a. 532 Hz
b. 530 Hz
c. 470 Hz
d. 472 Hz
e. None of the above my answer is: OR 529.8 Hz

4. The velocity of sound in air is a function of which one of the following?

a. Wavelength
b. Frequency
c. Temperature
d. Amplitude
e. None of the above my answer is: ________________

5. Tripling the distance between sound source and a listener will change the intensity, as detected by the listener, by what factors?
a. 1/9
b. 0.33
c. 3.0
d. 9.0
e. None of the above my answer is: ______________

6. The lower A on a piano has a frequency of 27.5 Hz. If the tension in the 2-m long string is 304 N and one-half wavelength occupies the string, what is the mass of the string?

a. 100 grams
b. 25 grams
c. 37 grams
d. 50 grams
e. None of the above my answer is: 50.2 g

7. The speed of sound at 0 degree C is 331 m/s. What is the speed of sound at 25 degrees C? (0 degree C = 273 K)

a. 346 m/s
b. 356 m/s
c. 343 m/s
d. 350 m/s
e. None of the above my answer is: 345.8 m/s

8. A traveling wave passes a point (C) of observation. At this point (C) the time interval between two successive crests is 0.2 s.

a. The wavelength is 5 m.
b. The frequency is 5 Hz.
c. The velocity of propagation is 5 m/s.
d. The wavelength is 0.2 m.

9. A wave is described by the equation: $y = 8\sin\left[2\pi\left(\frac{x}{20}+\frac{t}{2}\right)\right]$, where all distances are measured in centimeters and the time is measured in s.

a. The amplitude is 4 cm.
b. The wavelength is 10/□ cm.
c. The period is 2 seconds.
d. The frequency is 2 Hz.
e. None of the above.

10. A ray of light passes from air into water, striking the surface of water with an angle of incidence of 45 degrees. Which of the following four quantities changes as light enters the water. (I) Wavelength, (II) Frequency, (III) speed of propagation, (IV) Direction of propagation.

a. (I) and (II) only.
b. (I), (III) and (IV)
c. (II), (III) and (IV)
d. (III) and (IV)
e. (I), (II), (III) and (IV)

11. A hollow pipe (such as an organ pipe open at both ends) is made to go into resonance at frequency f_{open}. One end of the pipe is now covered and the pipe is again made to go into resonance, this time at frequency f_{closed}. Both resonances are first hamonics. How do these two resonances compare.
a. They are the same.
b. $f_{open} = 2f_{closed}$
c. $f_{closed} = 2f_{open}$.
d. $f_{open} = f_{closed}$.
e. $f_{closed} = 1.5f_{open}$.

12. An instrument has two strings. Both strings have the same length. One of the strings is under twice as much tension and has twice the mass of the other. Which of the following statement is true:
a) The more massive string has a resonant frequency that equals $\sqrt{2}$ times the frequency of the other.
b) Both strings vibrate at the same frequency, but the more massive string has a longer wavelength.
c) The more massive string has a shorter wavelength and a higher vibration frequency.
d) The frequencies and wavelengths on the two strings are equal, but the velocity of the wave is less on the more massive string than on the other.
e) None of the above statements are true.

Solving Problems

I. A source of sound (1000 Hz) emits uniformly in all directions. An observer 3.00 m from the source measures a sound level of 40 dB.
a) Calculate the average power output of the source.
b) Another observer moving toward the source with a speed of 30 m/s, what is the frequency detected. (the speed of sound is 340 m/s)

a) $f = 1000\,Hz$

$R = 3\,m$

$\beta = 40\,dB$

(2) $\beta = 10 \log \frac{I}{I_0} \Rightarrow 40 = 10 \log \frac{I}{I_0} \Rightarrow$

(2) $\frac{I}{I_0} = 10^4 \Rightarrow I = 10^{-12} \times 10^4 = 10^{-8}\,W/m^2$

We know that (3) $I = \frac{P}{A} \Rightarrow P = I \times A \Rightarrow$

$P = 10^{-8} \times 4\pi r^2 = 1.13 \times 10^{-6}\,W$

OR $1.13\,\mu W$. (1)

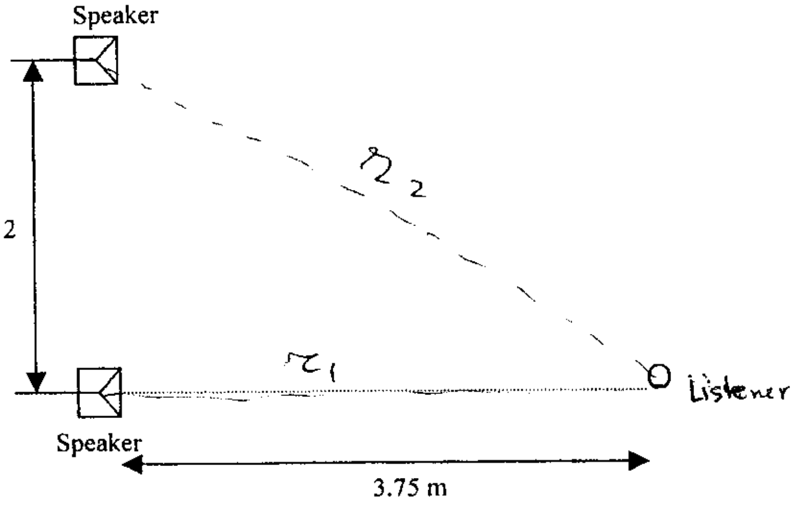
b) $v_0 = 30\,m/s$.

$v = 340\,m/s$.

(3) $f' = f\left(\frac{v + v_0}{v}\right) = 1000 \times \left(1 + \frac{30}{340}\right)$

$\Rightarrow f' = 1088.2\,Hz$ (3)

II. Two stereo loudspeakers are separated by a distance of 2.12 m. Assume the amplitude of the sound from each speaker is the same at the position of a listener, who is 3.75 m directly in front of one of the speakers; (see the figure below).
For what frequencies in the audible range (from 20 Hz up to 20,000 Hz) will there be a maximum signal. (the speed of sound is 340 m/s)



In order to hear a max Sound intensity we should have:

$$r_2 - r_1 = m\lambda$$ 4

but $\lambda = \frac{v}{f}$ 3

$$\boxed{r_2 - r_1 = m\frac{v}{f}}$$

$r_1 = 3.75\,m$ 3

$r_2 = \sqrt{(3.75)^2 + (2.12)^2} = 4.3\,m$

$$4.30 - 3.75 = m\frac{v}{f} \Rightarrow 0.55 = m\frac{v}{f} \Rightarrow$$

$$f = m\frac{340}{0.55} \approx 609\,m$$ where m is an integer.

$$20\,Hz \leq 609 \times m \leq 20000\,Hz$$

$$\frac{20}{609} \leq m \leq \frac{20000}{609} \Rightarrow 0.025 \leq m \leq 32.?$$

So $m = 1$ — — to 32 (5)

There are 32 values for which the listener hears Max int.

QUIZ II Phys 204,Fall 2002-2003 — *Dec 12, 2002*

V. A triangular glass prism with an apex angle of 60.0° has an index of refraction of 1.50.
a) Find the angle of incidence for which light will have a minimum deviation?
b) Determine the value of the minimum deviation?
c) Determine the value of the deviation for a ray with an incidence angle of 51.6°.

a) $A = 60°$

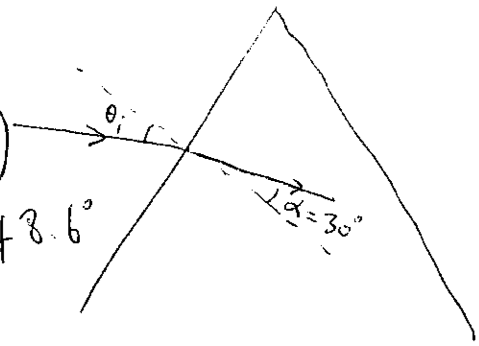
$n = 1,5$

Minimum deviation for $\alpha = \alpha' \Rightarrow \alpha = \alpha' = \frac{A}{2} = 30°$ (3)

$\sin\theta_i = n \sin 30 \Rightarrow$

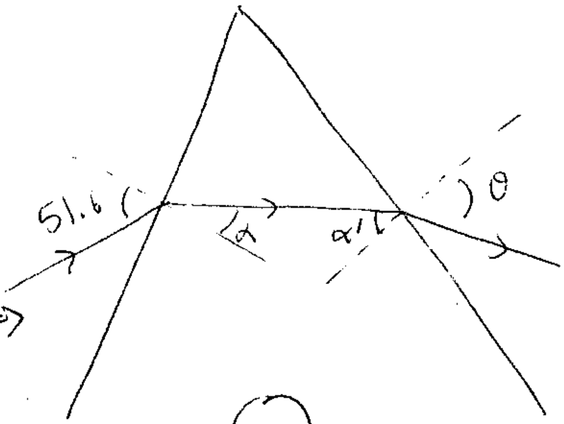
$\sin\theta_i = 1,5 \times \frac{1}{2} \Rightarrow$ (3)

$\sin\theta_i = 0,75 \Rightarrow \theta_i = 48.6°$



b) $\delta_{min} = \theta_1 + \theta_2 - A = 48.6 + 48.6 - 60 = 37,2°$ (3)

c)



$\sin 51,6 = n \sin\alpha \Rightarrow$

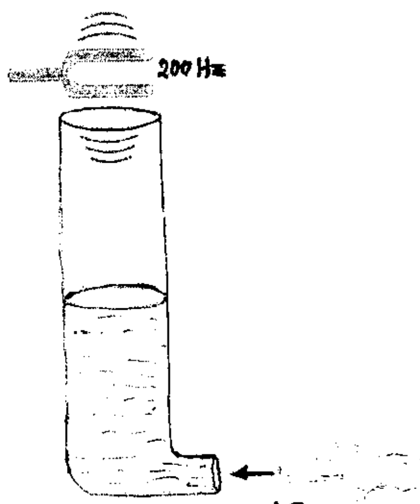
$\alpha = 31,5$ (2)

$\alpha' = A - \alpha = 60 - 31,5 = 28,5°$ (2)

$n \sin\alpha' = \sin\theta \Rightarrow \theta = 45,7°$ (2)

deviation $\delta = 51,6 + 45,7 - 60 = 37.3°$

IV. As Shown in the adjacent figure, water is pumped into a long vertical cylinder at a rate of 18.0 cm^3/s. The radius of the cylinder is 4.00 cm, and at the open top of the cylinder is a tuning fork vibrating with a frequency of 200 Hz. As the water rises, how much time elapses between successive resonances.
(Hint: flow rate = Area×speed)



The fork radiates sound at $\lambda = \frac{v}{f} = \frac{34\not{0}}{20\not{0}} = 1.7\,m$ (3)

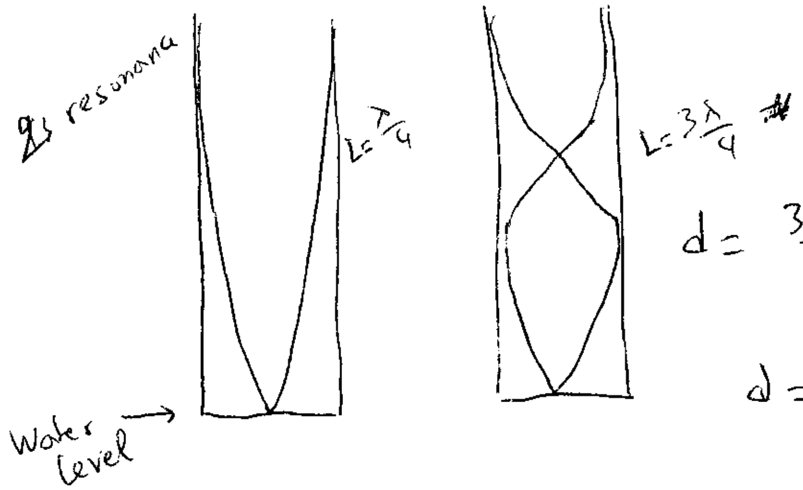
The distance between successive water levels resonance

$$d_{NN} = \frac{v}{2f} = \frac{340}{2 \times 200} = 0.85\,m \quad (4)$$

the speed is given by: flow = A × v ⇒

$$v = \frac{flow}{Area} = \frac{18 \times 10^{-6}}{3.14 \times 4^2 \times 10^{-4}} = 3.58 \times 10^{-3}\,m/s. \quad (3)$$

We Know that $d = vt \Rightarrow t = \frac{d}{v} = 237\,s$ (5)



$$d = \frac{3\lambda}{4} - \frac{\lambda}{4} = \frac{2\lambda}{4} = \frac{\lambda}{2}$$

$$d = \frac{\lambda}{2} = \frac{v}{2f}$$

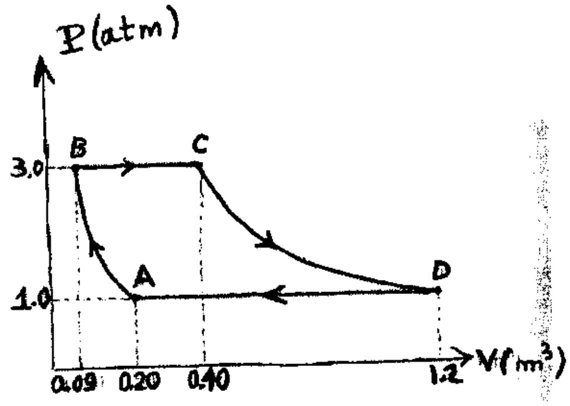


Figure P20.32

III. A sample of an ideal gas goes through the process shown in the adjacent figure. From A to B the process is adiabatic; from B to C it is isobaric, with 100 kJ of energy flowing into the system by heat. From C to D, the process is isothermal; From D to A, it is isobaric, with 150 kJ of energy flowing out of the system by heat.

a) determine the change in internal energy during the process B→C. ($E_{int,B} - E_{int,C}$=?)

b) Determine the difference in internal energy during the process B→A. ($E_{int,B} - E_{int,A}$=?)

A → B Adiabatic $Q_{AB} = 0$

BC → isobaric $Q = 100 \times 10^3$ J.

CD → isothermal $\Delta U = 0 = U_D - U_C$

D → A isobaric $Q = -150 \times 10^3$ J.

a) $\Delta U_{BC} = Q - W = 100 \times 10^3 - 3 \times 10^5 (0.4 - 0.09) \times 1.01$ (3)

$= 10^5 - 3 \times 0.31 \times 10^5 = 10^5 (1 - 0.939) =$ 6 kJ (4)

b) $U_A - U_B = ??$

$U_D - U_C = 0$ (2)

$W_{DA} = P_D (V_A - V_D) = 1 \times 1.01 \times 10^5 (0.2 - 1.2) = -101$ kJ (2)

$U_A - U_D = -150$ kJ $- (-101) = -48.7$ kJ.

$U_B - U_A = -[(U_C - U_B) + (U_D - U_C) + (U_A - U_D)]$ (4)

$U_B - U_A = -[5.79$ kJ $+ 0 - 48.7$ kJ$] = 42.9$ kJ