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PHY113

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BY KAYMATH

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WHAT YOU NEED TO KNOW ABOUT APPROXIMATIONS

Approximations are very significant in uniben physics and chemistry exams because if you approximate wrongly you will get a wrong answer but in this material I will Teach you how to approximately correctly. Note that you approximate A number only when the decimal number is in the range of **0-2** and when the decimal number is in the range of **7-9**, you don't approximate when the decimal number is in the range of **3-6** or else u get a wrong number which will be either bigger or lesser than answers in the options instead write your figures and solve like that. I will Explain what I mean in details .for instance you are solving and you Get a number like **2.1112** If you must approximate you get **2.1 or 2.11** because decimal range is **0-2**,if you get a number **3.7 or 3.79 or 3.668** you can approximate to **4,3.8 and 3.67** respectively because the decimal numbers you approximated ranges from 7-9 .but note when u have a number **2.555,2.554,2.556 or 2.443 or 2.553** you don't approximate instead solve with the figures the Way you see it in the calculator because the decimal number ranges from 3-6.This aspect is very important when solving questions else you get a number slightly different from the ones in the options please take note. More examples, if you get a number **2.2275,7.1284,6.394,2.3844,3.293,** you get **2.23,7.13,6.4,2.4,3.3,** respectively .it doesn't matter where the decimal number is as far as it follows the rules. also if u get **2.335,2.445,2.333333,2.66666,2.43434**, do not approximate solve with it the way you see it. **TAKE NOTE!!!!!!!!!!!**

(let's begin see page 19 for the theory questions and answers but let's deal with the calculation aspect first)

VIBRATIONS (CHAPTER 1)

Period of oscillation is given by $T=\frac{2\pi R}{V}$ Where r=radius, v=speed of oscillation Period is also given by $T=\frac{2\pi}{W}$,w=angular Frequency, **NOTE** period can also be given by $T=\frac{t}{n}$ **,**where t=time, n=no of oscillations. Hooke's law is given by F=KX k=force constant, x=displacement equation for simple harmonic motion is given by $\frac{d^2x}{dt^2}+w^2x=0$ angular velocity In S.H.M is given by $w=\sqrt{\frac{K}{M}}$ m=mass Amplitude is given by $A=\sqrt{B_1^2+B_2^2}$ B_1 and B_2 are equation constants other equations for S.H.M are

$x_{(t)}=B_1\cos wt+B_2\sin wt$

And $x_{(t)}=A\cos(wt+\phi)$ a=amplitude t=time, ϕ =phase angle difference, which is Given by $\Phi=\tan^{-1}\frac{B_2}{B_1}$,maximum velocity is Given by $V_{max}=WA$, maximum acceleration is given by $A_{max}=W^2A$,velocity at any point of oscilliation is given by $V=W\sqrt{A^2-X^2}$ where x=displacement, a=amplitude, w=angular velocity, period of oscillation in S.H.M is given by $T=2\pi\sqrt{\frac{l}{g}}$ l=length, g=gravity Note also this important formular $\frac{T_1}{\sqrt{L_1}}=\frac{T_2}{\sqrt{L_2}}$ & $T_1\sqrt{g_1}=T_2\sqrt{g_2}$,energy in S.H.M given by $E=\frac{1}{2}MW^2A^2$,energy per mass is given by $\frac{E}{M}=\frac{1}{2}W^2A^2$, period is also given by $T=\frac{1}{F}$

SOLUTION TO EXERCISE 1

1.1 A particle moving with simple harmonic motion has velocities 4cm/s and 3cm/s at distances of 3cm and 4cm respectively from the equilibrim position. What is the Amplitude of oscillation Velocity of the particle as it passes the equilibrium position?

SOLUTION

B_1=3cm,=4cm, A=?, from $A=\sqrt{B_1^2+B_2^2}$ $A=\sqrt{3^2+4^2}$,A=5cm. The velocity will be given by the Pythagoras theorem of the two velocities i.e $V=\sqrt{4^2+3^2}$, V=5cm/s

1.2 A punch bag of mass 0.6kg is struck so that it oscillates with SHM. The oscillation has a frequency of 2.6Hz and an amplitude of 0.45m what is (a) the maximum velocity of the bag? (b) The maximum kinetic energy of the bag? (c) what happens to the energy as the oscillation dies away

SOLUTION

m=o.6kg, f=2.6Hz, a=0.45m, from w=2πf, w=2x3.142x2.6=16.3384rad/s. in uniben exams you don't approximate anyhow that's why "w" was not approximated. See first page on hints on approximations. **(a)** from V_{max}=WA, V_{max}=16.3384x0.45=7.35m/s **(b)** The maximum kinetic energy will be given By $KE=\frac{1}{2}mv^2=\frac{1}{2}$x0.6x$7.35^2$=16.2J. **(c)** The punch bag will transfer heat to the surrounding as it stops gradually

1.3 A light spiral spring is loaded with a mass of 50g and extends by 10cm. What is the period of small vertical oscillations if the acceleration due to gravity is 10m/s

SOLUTION

L=0.1m (converted to m), g=10m/s, from $T=2\pi\sqrt{\frac{l}{g}}$, T=2X3.142$\sqrt{\frac{0.1}{10}}$= 0.63s.

1.4 How much would the time keeping of a pendulum clock be affected by taking it to the moon? Gravity on the moon is 1.6m/s^2, Compared to with 10m/s^2 on the earth.

SOLUTION

We are asked to find the ratio of the two

Period from $T_1\sqrt{g_1}$=$T_2\sqrt{g_2}$, g_1=1.6m/s^2 (gravity of moon), g_2=10m/s^2(gravity of earth), $T_1\sqrt{1.6}$=$T_2\sqrt{10}$, $\frac{T_1}{T_2}$= $\sqrt{\frac{10}{1.6}}$=2.5s, means period is 2.5 times slower in the moon

1.5 A simple pendulum has a period of 7s. When the length was shortened by 1m, the period is 6s. find the original length of the pendulum

SOLUTION

T_1=6s,T_2=7s, it was stated that the length was shortened by 1m meaning the original length-1,form $\frac{T_1}{\sqrt{L_1}}$=$\frac{T_2}{\sqrt{L_2}}$, $\frac{7}{\sqrt{L}}$=$\frac{6}{\sqrt{L-1}}$, $\frac{49}{L}$=$\frac{36}{L-1}$

49L-49=36L, 13L=49, L=3.77m

1.6 A clown is on a rocking chair in the dark His glowing red nose moves back and forth with a distance of 0.42m exactly 30 times a minute in a simple harmonic motion (a) what is the amplitude of the motion? (b) what is the period of this motion? (c) what is the frequency of this motion?

SOLUTION

(a) If the total distance back and forth is half the distance back and forth is 0.42m then amplitude is half the distance a=$\frac{0.42}{2}$=0.21m

(b) t=1x60=60secs,n=30,from T=$\frac{t}{n}$=$\frac{60}{30}$=2sec

(c) from T=$\frac{1}{F}$,F=$\frac{1}{T}$ =$\frac{1}{2}$=0.5Hz.

DAMPED OSCILLATION(CHAPTER 2)

The identity equation for a damped oscillation is given by $m\ddot{x}+b\dot{x}+kx=0$ m=mass B0damping force constant, k=force constant The three angular frequencies in damped oscillation are;

W_0= natural angular frequency
W'= damped angular frequency
W^2 or(γ)=damping force angular frequency

W' is given by $W'=\sqrt{\frac{k}{m}-\frac{b^2}{4m^2}}$,b=damping Force constant,k=force constant, m=mass. For critically damped motion $b=2\sqrt{km}$. equation For damped oscillation is given by

X=C_0=exp$-\frac{1}{2}(w^2t)\cos(w't+\phi)$ please this formula is important don't ever forget it X=damping amplitude,C_0=initial amplitude, t=time. Note that equation can be broken in two when solving --> X=C_0exp$-\frac{1}{2}(w^2t)$ This one is mainly used to solve questions but know Both of them. Note that when exp(exponenetial) crosses the '=' sign it becomes 'ln'. don't worry you will understand Better when we start solving exercises. W' is Given by $W'=\frac{b}{m}$ and $W_0=\sqrt{\frac{k}{m}}$, relaxation time is given by $T_R=\frac{2}{w^2}$, damping time is given by $T_D=\frac{1}{W^2}$, damped angular frequency is also given by $W'=\sqrt{w_0{}^2-\frac{(w^2)^2}{4}}$, nature of oscillation is positive if $w_o{}^2>\frac{(w^2)^2}{4}$, quality factor is given by Q=$\frac{w'}{w^2}$, Energy in damped oscillation is given by E=$\frac{1}{2}mw_o{}^2c_o{}^2$, period of damped oscillation is given by T=$\frac{2\pi}{W_0}$

SOLUTION TO EXERCISE 2

2.1 A simple pendulum of length 22m is set Into oscillation with amplitude 0.05m,after 5min it has fallen to 0.025m.calculate the relaxation time

SOLUTION

Pendulum was set into oscillation that means The amplitude is initial c_o=0.05m, t=5x60 t=300secs,pendulum fell to 0.025m,x=0.025m from $T_R=\frac{2}{w^2}$, we find w^2 to get relaxation time.

X=C_0=exp$-\frac{1}{2}(w^2t)$, 0.025=0.05exp$-\frac{1}{2}w^2300)$

$\frac{0.025}{0.05}$=$\frac{0.05}{0.05}$exp-$\frac{1}{2}w^2300$, 0.5=exp$-w^2300$,

Exp will cross the '=' sign and change to 'ln'

'ln' is in your calculator, $-\ln 0.5=-w^2 150$
0.693=$w^2$150, w^2=4.62x10$^{-3} rad^2/s^2$.
$t_r=\frac{2}{4.62x10^{-3}}$=432.9secs.

2.2 The equation given $3\ddot{x}+b12+39x$=0 represents (a) critically damped (b) lightly damped (c) simple harmonic motion (d) forcedly damped (e) none of the above

SOLUTION

The equation given represents an equation of **damped oscillation.answer is E.**note that equation for simple motion is

2.3 A 0.04kg mass is moving on the end of a spring with force constant k=300N/m and is acted upon by a damping force **F=−bv** (a) if b=9.00kg/s. What is the angular frequency of the mass? (b) for what value of b will the
motion be critically damped.

SOLUTION

We are asked o find the damped angular Frequency (w') because it was acted upon by a force m=0.4kg, k=300N/m, b=9kg/s

(a) From $W'=\sqrt{\frac{k}{m}-\frac{b^2}{4m^2}}$,$W'=\sqrt{\frac{300}{0.4}-\frac{9^2}{4x0.4^2}}$
$W'=\sqrt{750-126.56}$=25rad/s.

(b) for critically damped motion b=2$\sqrt{km}$
b=2$\sqrt{300x0.4}$=21.9kg/s.

2.4 The equation for motion of an oscillation is given by X=5exp$-0.25\sin(\frac{\pi}{2})t$
(a) calculate the natural angular frequency of the oscillation and it's period. (b) what is The initial energy per unit mass of the damped oscillator? (c) what is the damped time? (d) what is the nature of oscillation (e) what is the quality factor?

SOLUTION

The equation in the question conforms to X=C_0=exp$-\frac{1}{2}(w^2t)\cos w't$. I.e $(w't+\phi)$ was broken . Note also cos is sin in this question. It is same equation. Hence we find $'w^{0\prime}$ from equation $\frac{1}{2}w^2$=0.25,w^2=0.5rad^2/s^2
$w'=\frac{\pi}{2}=\frac{3.142}{2}$=1.571rad/s.from $W'=\sqrt{w_0{}^2-\frac{(w^2)^2}{4}}$
1.571=$\sqrt{w_0{}^2-\frac{(0.5)^2}{4}}$, 2.468=$w_0{}^2-\frac{0.5^2}{4}$,
$w_0{}^2$=2.5305,w^o=1.59rad/s. from T=$\frac{2x3.142}{1.59}$
T=3.95s. **(b)** from E=$\frac{1}{2}mw_o{}^2c_o{}^2$,$\frac{E}{M}=\frac{1}{2}w_o{}^2c_o{}^2$
C_0=5m, $\frac{E}{M}=\frac{1}{2}1.59^2x5^2$=31.6J/kg.**(c)** from$T_D=\frac{1}{W^2}$
$T_D=\frac{1}{0.5}$=2secs.**(d)** nature of oscillation rules are;

w'>0 or positive+ (it is lightly damped)
w'=0 (it is critically damped)
w'<0 or negative- (it is heavily damped)

thus from equation w'=1.571rad/s is greater than 0 so it is **lightly damped** **(e)** from Q=$\frac{w^{i}}{w^2}$
Q=$\frac{1.571}{0.5}$=3.142.

2.5 The equation for damped oscillation is given by X=3exp$(-0.5)t\sin\pi t$. Calculate the particle velocity (a) 2.08m/s (b) 8.43m/s (c) 1.25m/s (d) none of the above

SOLUTION

when given an equation and asked to find the particle velocity(v_p) use this shortcut;
for equation of motion ending with sin $v_p=w'xc_0$. For equation of motion ending with cos $v_p=c_0x\frac{1}{2}w^2$ take note hence
v_p=πx3=3.142x3=9.43m/s. answer is E

2.6 The equation of a damped harmonic oscillation is given by X=3exp$(-0.04)t\cos\pi t$, What is the nature of oscillation?

SOLUTION

In equation w'=π=3.142 is greater than 0 **it is lightly damped**

2.7 c_0=5 and $\frac{1}{2}w^2$=0.25 we use our shortcut here. We have cos hence from
$v_p=c_0x\frac{1}{2}w^2$=5x0.25=1.2m/s.

FORCED DAMPED OSCILLATION (CHAPTER 3)

Formulas for this topic in your textbook are very complicated but with this material you will be able to tackle any question on this topic with easy formulas. Let's begin.

The three frequencies for of forced damped oscillation are given by

W_0= natural angular frequency

W^2=damping force angular frequency

W_r=resonance angular frequency

The general equation for forced damped is given $m\ddot{x}+b\dot{x}+kx=f\cos(pt+\phi)$,m=mass, b=damping force constant, k=force constant f=driving force frequency, p=resonance frequency (related to driving force frequency) . Resonance angular frequency is given by $W_r=\sqrt{w_0{}^2-\frac{(w^2)^2}{2}}$,at steady state period $T=\frac{2\pi}{p}$,p=resonance frequency . **Note that at steady state or at resonance. Resonance angular frequency (w_r) becomes the driving force frequency.Hence at resonance w_r=p , we used 'p' as driving force frequency here because p is related to 'f' at resonance.** Mechanical impedance in forced damped oscillation is given by

$Z_m=\sqrt{R_m{}^2+\left(mp-\frac{k}{p}\right)^2}$, R_m=mechanical resistance(same as damping force constant 'b') , m=mass, p=resonance frequency $w_o=\sqrt{\frac{k}{m}}$, $w^2=\frac{b}{m}$.

SOLUTION TO EXERCISE 3

3.1 The equation of motion of a particle of mass 2kg is given by $2\ddot{x}+4\dot{x}+7x=6\sin(\pi rt)$ Determine the resonance frequency (a) 1.22rad/s (b) 4.22rad/s (b) 8.25rad/s (d) 14.32rad/s.

SOLUTION

from $m\ddot{x}+b\dot{x}+kx=f\cos(pt+\phi)$ m=2, k=7 ,b=4 from $w_o=\sqrt{\frac{k}{m}}$, $w_0{}^2=\frac{7}{2}=3.5rad^2s^2$. from $w^2=\frac{b}{m}$ $w^2=\frac{4}{2}=2rad^2s^2$ .from $W_r=\sqrt{w_0{}^2-\frac{(w^2)^2}{2}}$, $W_r=\sqrt{3.5-\frac{(2)^2}{2}}$ =1.22rad/s**. A is the answer**

3.2 The equation of motion of a particle is given as $2\ddot{x}+4\dot{x}+7x=6\sin(\pi rt)$. The maximum displacement of the periodic motion is obtained when the parameter r take the value?

SOLUTION

we are asked to find 'r' from equation p=πr. Note at maximum displacement system is at resonance that means w_r=p, b=4, m=2, k=7 from $w_0{}^2=\frac{k}{m}=\frac{7}{2}=3.5rad^2s^2$, from $w^2=\frac{b}{m}$ $w^2=\frac{4}{2}=2rad^2s^2$. $W_r=\sqrt{3.5-\frac{(2)^2}{2}}$ =1.225rad/s but p=w_r, hence p=1.225rad/s from equation p=πr, 1.225=3.142r, r=$\frac{1.225}{3.142}$=0.3898Hz.

3.3 The equation of motion of a point of mass is $3\ddot{x}+5\dot{x}+12x=5\cos(\pi rt+\phi)$. find the maximum value of r at maximum displacement of the particle.

SOLUTION

same as question 3.2. b=5, m=3, k=12 , p=w_r. $w_0{}^2=\frac{k}{m}=\frac{12}{3}=4rad^2s^2$, $w^2=\frac{b}{m}=\frac{5}{3}=1.667rad^2s^2$ $W_r=\sqrt{4-\frac{(1.667)^2}{2}}$ =1.61555rad/s. p=πr, 1.61555=3.142r , r=$\frac{1.61555}{3.142}$=0.514Hz.

3.4 The equation of motion of a point is given by $3\ddot{x}+7\dot{x}+11x=20\sin(12t+\phi)$. Find the resonance frequency.

SOLUTION

m=3, b=7, k=11. We are asked to find w_r

$w_0{}^2 = \frac{k}{m} == \frac{11}{3} = 3.66667 rad^2 s^2$, $w^2 = \frac{b}{m}$. from $w^2 = \frac{b}{m} = \frac{7}{3} = 2.33333 rad^2 s^2$, $W_r = \sqrt{w_0{}^2 - \frac{(w^2)^2}{2}}$

$W_r = \sqrt{3.66667 - \frac{(2.33333)^2}{2}}$ =0.971rad/s.

be careful about approximations.

3.5 The equation of motion of a particle is given by $\ddot{x}+6\dot{x}+27x=5\sin(wt+\phi)$. Determine the type of motion and determine the frequency at steady state.

SOLUTION

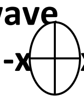
At steady state system is at resonance that is w_r=p. In this question ''p'' is ''w'' so that p=$2\pi r$, f=$\frac{p}{2\pi}$, hence **f=$\frac{w}{2\pi}$** . Note that another letter can be used to represents p e.g. a,z,c so it depends on the question.

3.6 Referring to question (3.5) above, find the angular frequency of the motion when the amplitude is maximum

SOLUTION

Note at maximum amplitude system is at resonance, so we asked to find the resonance frequency b=6, k=27, m=1. $w_0{}^2 = \frac{k}{m} = \frac{27}{1}$, $w_0{}^2$=27rad/s. $w^2 = \frac{b}{m} = \frac{6}{1}$=6rad/s. from $W_r = \sqrt{w_0{}^2 - \frac{(w^2)^2}{2}} = \sqrt{27 - \frac{(6)^2}{2}}$ =3rad/s.

WAVES (CHAPTER 4)

angular frequency is given by $W=2\pi f$. period is given by $T=\frac{1}{f}$, f=frequency . speed of propagation is given by $V=f\lambda$ λ=wavelength. **Equations of wave are given by** $y_{x,t}$=Asin wt & $y_{x,t}$=Asin$(wt \pm kx)$ t=time , a=amplitude k=wave number which is given by $k=\frac{2\pi}{\lambda}$ for the 2nd equation of wave **(+) represents a wave travelling in the negative x-axis and (-) represents wave travelling in the positive x-axis** -x  x+ **this is simply graph knowledge**.

when solving questions using the 2nd equation always use $y_{x,t}$=Asin$(wt - kx)$ .Note the ''−'' sign .phase velocity is given by $V=\frac{w}{k}$. speed of a transverse wave (wave on a string) is given by $V=\sqrt{\frac{T}{\mu}}$, T=tension given by T=mg μ=mass per unit length given by $\mu=\frac{m}{l}$ l=length, m=mass speed of longitudinal wave is given by $V=\sqrt{\frac{B}{P}}$ B= bulk modulus given by $B=\frac{1}{K}$ k=compressibility , p=density. Speed of longitudinal wave in a solid is given by $V=\sqrt{\frac{\gamma}{P}}$ γ=young modulus, p= density. The equation of wave can also be given by $y=A\sin 2\pi\left(\frac{t}{T}-\frac{x}{\lambda}\right)$ λ=wavelength, t=time, T=period. x=displacement

SOLUTION TO EXERCISE 4

4.1 The equation of a certain transverse wave is $y=4cm\sin 2\pi\left(\frac{t}{0.03}-\frac{x}{50}\right)$. Determine the wave's (a) amplitude (b) wavelength (c) frequency (d) speed of propagation

SOLUTION

(a) A=4cm. **(b)** $\frac{x}{\lambda}$ in equation is $\frac{x}{50}$,$\frac{x}{\lambda}=\frac{x}{50}$,λ=50cm to m λ=0.05m. **(c)** according to the equation T=0.03 but from $T=\frac{1}{f}$. $f=\frac{1}{T}=\frac{1}{0.03}$=33.3Hz. **(d)** from V=fλ=33.3x0.5=16.65m/s.

4.2 A wave moving along the x-axis is defined by $y_{x,t}=5\exp[-i(x+5t)]$ where x is in metres and t is in seconds . Determine (a) the direction of the wave motion (b) The speed of the wave

SOLUTION

from $y_{x,t}$=Asin$(wt - kx)$ k=1. A=5, W=5

(a) This is where we use our rule because $x+5t$ has a positive sign .It progresses to the negative direction of the x-axis .**so answer is left** **(b)** from $V=\frac{w}{k}=\frac{5}{1}$=5m/s

4.3 Transverse waves on a string have wave speed of 12m/s, amplitude of 0.05m and wavelength 0.4m. The wave travels in the positive x-direction and at t=0, the x =0 end of the string has zero displacement and is moving upward (a) find the frequency, period and wave number of these waves (b) write a wave function describing the wave (c) find the transverse displacement of a wave at x=0.25 at a time t=0.15sec

SOLUTION

V=12m/s, A=0.05m, λ=0.4m (a) from v=fλ, f=$\frac{v}{\lambda}$=$\frac{12}{0.4}$=30Hz. & period T=$\frac{1}{f}$=$\frac{1}{30}$=3.33x10^{-3}s. & wave number k=$\frac{2\pi}{\lambda}$ =$\frac{2x3.142}{0.4}$=15.7rad/s.

(b) From equation y=Asin2π$\left(ft-\frac{x}{\lambda}\right)$ note that we substituted ''f'' for $\frac{1}{T}$. Equation is

y=0.055msin2π$\left(30Hzt-\frac{x}{0.4}\right)$

4.4 Two wave sources separated by 2.0m apart vibrate in phase with frequency 200Hz and velocity 800m/s . Calculate the phase difference at a point midway between them. (a) 0 (b) 2π (c) π (d) none of the above

SOLUTION

note that the phase difference at any point midway between two wave is zero. Answer is ''0''.

4.5 The equation of a transverse wave travelling along a stretched string is given as $y_{x,t}$=$\sin(10t-4x)$, if the displacement at appoint is zero. What is the ratio of the phase velocity of the wave to the particle velocity at the same point?

SOLUTION

Here we are simply to find the ratio of v=fλ & v=WA from $y_{x,t}$=A$\sin(wt-kx)$ w= 10rad/s, from w=2πf, f=$\frac{w}{2\pi}$=$\frac{10}{2x3.142}$=1.591Hz k=4. from k=$\frac{2\pi}{\lambda}$,λ=$\frac{2\pi}{k}$=$\frac{2x3.142}{4}$=1.571m

v=fλ=1.591x1.571=2.5m/s.

A=1m.V=WA=10X1=10m/s. ratio=$\frac{2.5}{10}$=**0.25.**

4.6 A string has a total length of 5m and a total mass 0.01kg.If the string has a tension of 10N applied to it. What is the speed of a transverse wave on the spring.

SOLUTION

l=5m, m=0.01kg, T=10N from V=$\sqrt{\frac{T}{\mu}}$,μ=$\frac{m}{l}$

μ=$\frac{0.01}{5}$=0.002kg/m. V=$\sqrt{\frac{10}{0.002}}$=70.7m/s.

4.7 A string of length 10m and total mass 0.001kg is connected to a mass 'm' suppose that the string has a very high elastic limit (meaning that it takes lots of pressure on the string before it will stretch). How much mass must you place on the string in order to produce a wave speed of 200m/s.

SOLUTION

l=10m, m=0.001kg, v=200m/s from V=$\sqrt{\frac{T}{\mu}}$,μ=$\frac{m}{l}$

μ=$\frac{m}{l}$ =$\frac{0.001}{10}$=0.0001kg/m.The mass given is to find 'μ' the mass we are looking for is from T=mg hence V=$\sqrt{\frac{mg}{\mu}}$, 200=$\sqrt{\frac{mx9.8}{0.0001}}$, squaring both sides 200^2=$\frac{mx9.8}{0.0001}$,m=$\frac{200^2x0.0001}{9.8}$=0.408kg.

4.8 In a liquid with density 900kg/m^3 longitudinal waves with frequency 250Hz are found to have wavelength 8.00m. calculate the bulk modulus of the liquid.

SOLUTION

From V=$\sqrt{\frac{B}{P}}$, B=?, B=V^2P. f=250Hz, λ=8m.from v=fλ=250x8=2000m/s. p=900kg/m^3 B=2000^2X900=3.6X10^9pa.

4.9 The linear mass density of a string is 1.6x10^{-4}kg/m. A transverse wave is propagat-ed on the string and is described by the following equation $y_{x,t}$=0.021 $\sin(30t+2x)$

(a) What is the wave number? (b) What is the wave speed? (c) what is the tension on the string?

SOLUTION

(a) from equation $y_{x,t}$=Asin($wt - kx$) the wave number k=2rad/m. **(b)** from v=$\frac{w}{k}$ w=30, v=$\frac{30}{2}$=15m/s.**(c)**µ=1.6X10^{-4}kg/m from V=$\sqrt{\frac{T}{\mu}}$, T=v^2xµ ,T=15^2X1.6X10^{-4}=0.036N

4.10 A stretched string has a mass per unit length of 5g/cm and a tension of 10N. A sinusoidal wave on this string has a an amplitude of 0.12mm and frequency of 100Hz and is travelling towards the decreasing .write an equation for this wave.

SOLUTION

A=0.012cm(converted to cm) µ=0.005kg/cm (converted to kg). y=Asin2π$\left(\frac{t}{T} \pm \frac{x}{\lambda}\right)$, $\frac{1}{T}$=F , expanding we have y=Asin2π$ft \pm 2\pi\frac{x}{\lambda}$,T=10N, f=100Hz. we find λ, V=$\sqrt{\frac{T}{\mu}}$=$\sqrt{\frac{10}{0.005}}$ v=44.72m/s. from v=fλ λ=$\frac{v}{f}$=$\frac{44.72}{100}$ =0.4472m. y=0.012sin$\left(2x3.142x100t + \frac{2x3.142xX}{0.4472}\right)$ y=0.012sin$(628.4t + 14t)$. **We used (+) sign because it was stated that it was travelling in decreasing direction of X**

4.11 what is the difference between speed of longitudinal wave in air at 17^0C and their speed at 57^0C?

SOLUTION

From $\frac{V_1}{T_1}$=$\frac{V_2}{T_2}$, T_1=17+273=290K,T_2=57 +273, T_2=330K. V_2=340m/s (340 Is a constant value for speed of wave in air). V_2=?
$\frac{340}{\sqrt{290}}$=$\frac{V_2}{\sqrt{330}}$, V_2=$\frac{340x\sqrt{330}}{\sqrt{290}}$=362.69m/s. they asked for difference. V_d =362.69−340 **difference =22.7m/s.**

4.12 The elastic limit of a piece of steel wire is 2.7x10^9Pa. What is the maximum speed at which transverse wave pulses can propagate along this wire before this stress is exceeded? (The density of steel is 7.86x10^3kg/m^3).

SOLUTION

P=7.86x10^3kg/m^3, young modulus from question is γ=2.7x10^9Pa from V=$\sqrt{\frac{\gamma}{P}}$=$\sqrt{\frac{2.7x10^9}{7.86x10^3}}$ V=586m/s.

INTERFERENCE OF WAVES (CHAPTER 5)

Equation for standing wave is given by y=2Asin $kx \cos wt$, x=displacement, t=time w=angular frequency, a=amplitude. Node of a standing wave is given by n=$\frac{\lambda}{2}$, λ=wavelength. The nodes of a standing wave is a positive number e.g. (1,2,3,4,5,6 etc.). n=$\frac{\lambda}{2}$, n=$\frac{2\lambda}{2}$, n=$\frac{3\lambda}{2}$ etc. The antinode of a standing wave is given by A_n=$\frac{\lambda}{4}$. The antinodes of a standing wave is an odd number e.g. (1,3,5,7,9) A_n=$\frac{\lambda}{4}$, A_n=$\frac{3\lambda}{4}$, A_n=$\frac{5\lambda}{4}$ etc. path length difference of a wave is given by ΔL=$d_2 - d_1$ d_1= distance from 1st object, d_2= distance from 2nd object. **Path difference of constructive interference is zero and integral multiple of the wavelength** e.g. ΔL=0,1,2,3,4 etc. and ΔL=0,λ,2λ,3λ,4λ etc. but λ=$\frac{v}{f}$, hence ΔL can also be ΔL=0, $\frac{v}{f}$, $\frac{2v}{f}$, $\frac{3v}{f}$, $\frac{4v}{f}$ etc. **The path difference of a destructive interference is an odd number of half the wavelength** given by ΔL=1,3,5,7 etc. but λ=$\frac{v}{f}$, hence ΔL can also be ΔL=$\frac{v}{f}$, $\frac{3v}{f}$, $\frac{5v}{f}$, $\frac{7v}{f}$ etc. **Note that the path length difference can also be gotten using Pythagoras theorem** Formula for beats frequency is given by F_b=$F_1 - F_2$, where F_1=frequency of one (e.g. speaker), F_2=frequency of two (e.g. speaker).

beat period is given by $\boxed{T_b=\frac{1}{F_b}}$, F_b= beat frequency . Doppler effect formulas are given by **case(i) when the source is moving towards a stationery observer, frequency heard by observer is given by** $\boxed{F_0=\left(\frac{V}{V-V_S}\right)F_S}$

F_s=frequency of source , V_s=speed of source V=speed of sound. **Case (ii) when the source is moving away from the observer frequency heard by observer** is given by $\boxed{F_0=\left(\frac{V}{V+V_S}\right)F_S}$ **Case (iii) When the observer is moving towards a stationery source frequency heard by observer** is given by $\boxed{F_0=\left(\frac{V+V_0}{V}\right)F_S}$ where V_O=speed of observer. **Case (iv) when observer is moving away from a stationery source frequency heard by observer** $'F_0'$ is given by $\boxed{F_0=\left(\frac{V-V_0}{V}\right)F_S}$

SOLUTION TO EXERCISE 5

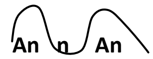
5.1 Standing waves on a wire of length 4m described by y=$(A_{sw}\sin Kx)$coswt with A_{sw}=3cm, w=628rad/s. k=1.25πrad/m and with the left end of the wire at x=0. At what distance from the left end are **(a)** The nodes of the standing wave? **(b)** The antinodes of the standing wave.

SOLUTION

K=1.25πrad/m, from k=$\frac{2\pi}{\lambda}$,1.25π=$\frac{2\pi}{\lambda}$,λ=$\frac{2}{1.25}$ λ=1.6m, n=$\frac{\lambda}{2}$=$\frac{1.6}{2}$= 0.8m**. (n=0,1,2,3,4 etc. we were simply asking to state the integers of nodes here).** (b) A_n=$\frac{\lambda}{4}$=$\frac{1.6}{4}$=0.4m (n= 1,3,5,7,9)

5.2 Adjacent antinodes of a standing wave on a string are 12cm apart. A particle at an antinodes oscillates in simple harmonic motion with amplitude 2.5cm and period 0.5s. The string lies along the πx axis and is fixed at X=0 (a) find the equation giving the displacement of a point on the string as a function of position=Find the speed of propagation of a transverse wave in the string

SOLUTION

from y=2Asinkxcoswt, adjacent antinodes are 12cm apart that means the node is between the antinode 

n=12cm, from n=$\frac{\lambda}{2}$=, λ=12x2=24cm. from k=$\frac{2\pi}{\lambda}$=$\frac{2x\pi}{24}$=$\frac{\pi}{12}$. A=2.5cm, T=0.5sec , F=$\frac{1}{T}$=$\frac{1}{0.5}$=2Hz (a) y=5sin $\frac{\pi}{12}x\cos 4\pi t$ Same as y=5cos $4\pi t\sin\frac{\pi}{12}x$. (b) from v=fλ , λ=0.24m (converted to m) ,V=2X0.24=0.48m/s.

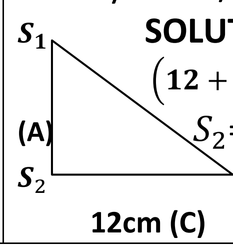
5.3 A person stands between two loudspeakers driven by an identical source . Each speaker produces a tone with a frequency of 155Hz on a day when the speed of sound is 341m/s. The person is 1.65m from one speaker and 4.95m from the other speaker. What is the path length difference produced

SOLUTION

F=155Hz ,V=341m/s, λ=$\frac{v}{f}$=$\frac{341}{155}$=2.2m. from ΔL=d_2-d_1 ,d_1=1.65m , d_2=4.95m, ΔL=$4.95-1.65$=3.3m. using and testing formulas from ΔL=$\frac{3\lambda}{2}$=$\frac{3x2.2}{2}$=3.3m. it gave us the ΔL as 3.3m. **It is a destructive interference answer is ΔL=$\frac{3(2.2)}{2}$=$\frac{3\lambda}{2}$.**

5.4 Two point loudspeaker are a certain distance apart and a person stand 12m in front of one of them on a line perpendicular to the baseline of the speakers. If the speakers emit identical 1000Hz tones, what is their minimum non-zero separation so the observer hears little or no sound? (take speed of sound as exactly 340m/s.

SOLUTION



, S_1= speaker one , S_2=speaker two . f=1000Hz. They are simply asking for the path difference given by pythagoras theorem . we find λ, from $λ=\frac{v}{f}$, v=340m/s $λ=\frac{v}{f}=\frac{340}{1000}$=0.34m. $B=\left(12+\frac{0.34}{2}\right)$=12.17m. $ΔL=\sqrt{B^2-C^2}=\sqrt{12.17^2-12^2}$ =2.03m.

5.5 What are the possible frequencies of a player's note if a first note is produced simultaneously by a first player is exactly 440Hz and 2.6 beats per second are heard.

SOLUTION

f_b=2.5Hz from $F_b=F_1-F_2$, we assume f_1=440Hz, we solve separately $2.6=440-F_2$, F_2=437.4Hz and assuming again F_2=440Hz, $2.6=F_1-440$, F_1=442.6Hz. possible frequencies will be 437.4Hz and 442.6Hz.

5.6 Two tones have frequencies of 300Hz and 298Hz. What is the beat period?.

SOLUTION

F_1=300Hz, F_2=298Hz from $F_b=F_1-F_2$ $F_b=300-298$=2Hz. From $T_b=\frac{1}{2}$=0.5secs.

5.7 The frequency of a train horn is 500Hz assume the speed in air in 340m/s. What is the frequency heard by the observer if (a) The observer is moving away from the stationary train with a speed of 30m/s?
(b) The train is approaching the stationary observer with a speed of 30m/s?

SOLUTION

(a) from $F_0=\left(\frac{V-V_0}{V}\right)F_S$ f_s=500Hz, v=340m/s, v_0=30m/s, f_0=?, $F_0=\left(\frac{340-30}{340}\right)500$=456Hz.
(b) from $F_0=\left(\frac{V}{V-V_s}\right)F_S$, v_s=30m/s, v=340m/s $F_0=\left(\frac{340}{340-30}\right)500$=548Hz.

5.8 A sound of source has a frequency of 500Hz if a listener moves at the speed of 30m/s toward the source what is the frequency heard by the listener (the speed of sound is 340m/s).

SOLUTION

from $F_0=\left(\frac{V+V_0}{V}\right)F_S$ f_s=500Hz, v_0=30m/s, v=340m/s. $F_0=\left(\frac{340+30}{340}\right)500$=544Hz.

5.9 Two loudspeakers are placed side by side and driven by the same frequency of 500Hz. If the distance from a person to one of the speakers is 5m and the person detects little or no sound, what is the possible distance from the person to the other speakers? (the speed of sound is 340m/s)

SOLUTION

possible distances are $5+\frac{λ}{2}$, $5+\frac{3λ}{2}$, $5+\frac{7λ}{2}$, $5+\frac{9λ}{2}$. but $5+\frac{9λ}{2}$ gives us best result v=340m/s, f=500Hz from v=fλ, $λ=\frac{340}{500}$=0.68m, $5+\frac{9x0.68}{2}$= 8.06m.

5.10 Two waves $Y_1=A\sin\left(\frac{2\pi x}{λ}-2\pi ft\right)$, $Y_2=A\sin\left(\frac{2\pi x}{λ}-2\pi ft\right)$. Are travelling in opposite directions. Find the amplitude of the resulting stationary wave.

SOLUTION

In the equation amplitude can be given by $A\sin\frac{2\pi x}{λ}$ for one of them . **For left and right we have two amplitude so we now have Y=2Asin $\frac{2\pi x}{λ}$**

NORMAL MODES (CHAPTER 6)

Fundamental frequency for a string and for a pipe open at both ends is given by $\boxed{F_0=\frac{V}{2L}}$ **"F_0" can also be called zero overtone** and their length is given by $\boxed{L=\frac{λ}{2}}$, λ=wavelength, l=length, v=speed. **First harmonics(zero overtone) is same as the formula for the fundamental frequency .**2nd harmonics or first overtone is=2xfundamental frequency ($\boxed{f=\frac{2xV}{2L}}$) 3rd harmonics or 2nd overtone is $\boxed{f=\frac{3xV}{2L}}$

i.e. (1st,2nd,3rd,4th,5th) and so on
shortcut; when asked to calculate frequency of any harmonics . simply find the fundamental frequency and multiply it by the number of harmonics you are asked to find e.g. 2xF_0, 3xF_0, 4xF_0, 5xF_0. Same shortcut goes for length , you find 'L' from L=$\frac{\lambda}{2}$, and multiply by the number of harmonics you are to find e.g. 2XL, 3XL, 4XL etc. you will understand better when you go through the exercises.
For a closed pipe at one end the fundamental frequency and the length is given by $F_0=\frac{V}{4L}$ and L=$\frac{\lambda}{4}$, It's harmonics is an odd number i.e. 1,3,5,7,9 etc. **Note that the first harmonics or zero overtone here is same as the formula for the fundamental frequency** same shortcut goes for this one too . find $F_0=\frac{V}{4L}$ and multiply by the harmonics you are asked to find e.g. 1xF_0, 3xF_0, 5xF_0, 7xF_0 etc. **Note that here**
1=first harmonics(zero overtone)
3=2nd harmonics (first overtone)
5= 3rd harmonics (2nd overtone) and so on.
End correction for an open pipe is given by $F_0=\frac{V}{2(L+2C)}$, F_0=fundamental frequency
l= length of pipe , c=distance from open end.
End corrections for a closed pipe is given by $F_0=\frac{V}{4(L+C)}$. Natural frequency of a taut string is given by $F_0=\frac{1}{2L}\sqrt{\frac{T}{\mu}}$,μ=mass per unit length μ=$\frac{m}{l}$, T=tension, L=length .

SOLUTON TO EXERCISE 6

6.1 A string of mass 8g and length 1m is fixed at both ends. If the string is stretched by a load of 1.92kg and then released, find the fundamental frequency of the stationary wave produced (g=10m/s^2).

SOLUTION

m=0.008kg, L=1m, m of load=1.92kg g=10m/s^2 from T=mg=1.92x10=19.2N. from μ=$\frac{m}{l}$=$\frac{0.008}{1}$ μ=0.008kg It was a string so from $F_0=\frac{1}{2L}\sqrt{\frac{T}{\mu}}$
$F_0=\frac{1}{2x1}\sqrt{\frac{19.2}{0.008}}$=24.5Hz.

6.2 Calculate the frequency of the first overtone of a stretched string of length 60cm , if the velocity of sound produced of 330m/s

SOLUTION

Frequency of first overtone is same as 2nd harmonics. Using the shortcut ,we find the fundamental frequency and multiply by it by 2 v=330m/s, l=0.6m from $F_0=\frac{V}{2L}=\frac{330}{2x0.6}$=275Hz. hence F=2X$F_0$=2X275=550Hz.

6.3 A violin string with length of 5m between fixed points has a linear mass density of 40g/m and a fundamental frequency of 20Hz (a) calculate the tension in the string (b) calculate the frequency and wavelength of the second harmonic (c) calculate the frequency and wavelength of the second overtone .

SOLUTION

F=20Hz , L=5m, μ=0.04kg/m(from g to kg)
(a) we find T from $F_0=\frac{1}{2L}\sqrt{\frac{T}{\mu}}$, 20=$\frac{1}{2x5}\sqrt{\frac{T}{0.04}}$
$20^2=\frac{1}{10^2}x\frac{T}{0.04}$, T=400X100X0.04=1600N. **(b)** frequency of 2nd harmonics is F=2X20=40Hz. from L=$\frac{\lambda}{2}$, we find λ .we multiply equation by 2 then solve for λ because it in 2nd harmonics 5=$\frac{2x\lambda}{2}$, λ=5m. (c) 2nd overtone is same as 3rd harmonics , F=3XF_0=3X20=60Hz. , from L=$\frac{\lambda}{2}$ we multiply 3 and find λ because it's a 3rd harmonics 5=$\frac{3x\lambda}{2}$, λ=$\frac{5x2}{3}$= 3.3m.

6.4 Middle C string on a guitar has a fundamental frequency of 200Hz, and the first A string above the middle C string has a frequency of 350Hz .if the strings linear mass densities are equal, but the length of the A string is only 64 percent of the length of the C string , what is the ratio of their tensions? In other words find T_A:T_C. Where T_A and T_C string is the tension in string C

SOLUTION

we are to find the ratio of $\frac{T_A}{T_C}$ from the formula $F_0=\frac{1}{2L}\sqrt{\frac{T}{\mu}}$, F_A=350Hz , F_C=200Hz , L of C=L , length of A is 64% of C , μ is constant for A and C hence length of A=$\frac{64}{100}$XL=0.64L.

$F_A=\frac{1}{2L_A}\sqrt{\frac{T_A}{\mu}}$, 350=$\frac{1}{2X0.64L}\sqrt{\frac{T_A}{\mu}}$,

T_A=122500X4X0.4096L^2μ , $F_C=\frac{1}{2L_C}\sqrt{\frac{T_C}{\mu}}$

200=$\frac{1}{2L}\sqrt{\frac{T_C}{\mu}}$, T_C=40000X4XL^2Xμ

$\frac{T_A}{T_C}=\frac{122500x4x0.4096L^2\mu}{40000x4xL^2\mu}$=1.2544.

6.5 will a standing wave be formed in a 4m length stretched string that transmits waves at a speed of 12m/s if it is driven at a frequency (a) 15Hz or (b) 20Hz? Give reasons for your answers.

SOLUTION

We find ''F_0'' to know the harmonics v=12m/s , L=4m, from f=$\frac{v}{2l}=\frac{12}{2x4}$=1.5Hz. but F=10X$F_0$=10X1.5=15Hz. **It's a harmonics 10th harmonics (b)** no matter how we multiply 1,2,3,4,5,6 etc. by .5Hz it can't give 20Hz . **it is not an harmonics**

6.6 find the first four harmonics for a string that is 2m long, and has a linear mass density of 2.5x10^{-2}kg/m, and is under tension of 40N.

SOLUTION

T=40N ,μ=2.5x10^{-2}kg/m, L=2m using the shortcut we find 'F_0' of the string using

$F_0=\frac{1}{2L}\sqrt{\frac{T}{\mu}}=\frac{1}{2x2}\sqrt{\frac{40}{2.5x10^{-3}}}$=10Hz. We multiply answer by 1,2,3,4 ,

2nd harmonics F=2X10=20Hz, 3rd harmonics F=3x10=30Hz, 4th harmonics F=4X10=40Hz.

6.7 The longest pipe found in most medium – sized pipes is 16ft long. What is the frequency of the note corresponding to the fundamental node if the pipe is open at both ends? (take speed of sound in air= 340m/s)

SOLUTION

1m—>3.28feet X —>16feet	16=3.28X X=4.878m

v=345m/s, F_0=? $F_0=\frac{V}{2L}=\frac{345}{2x4.878}$=35.36Hz.

6.8 An organ pipe has a length of 0.75m.what would be the length of a pipe closed at one end whose third harmonic is the same as the fundamental frequency of the open pipe ?

SOLUTION

its an open pipe so from $F_0=\frac{V}{2L}$, L=0.75m ''F_0'' is same for both and 2nd pipe is closed at one end in the 3rd harmonics hence from $F_0=\frac{3xV}{4L}$

$\frac{3xV}{4L}=\frac{V}{2L}$, $\frac{3xV}{4L}=\frac{V}{2x0.75}$, L=$\frac{3x2x0.75}{4}$=1.1m

6.10 A pipe of length 57cm has a fundamental frequency of 224Hz when open at both ends . If the displacement antinodes occur at a distance of 10cm from the open ends . calculate the velocity of sound.

SOLUTION

L=0.57m(converted to m), F=224Hz , C=0.1m it was an open pipe. From $F_0=\frac{V}{2(L+2C)}$,

224=$\frac{V}{2(0.57+2x0.1)}$, V=224x2x0.77=345m/s.

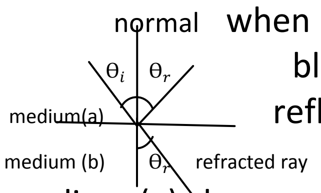
6.11 An open pipe 30cm long a closed pipe 23cm long, both of the same diameters, have the same frequencies when each of other of them is sounding it's first overtone. What is the end-correction of these pipes?

SOLUTION

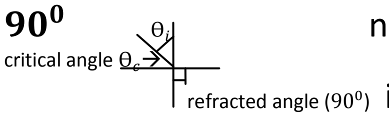
We look for the End correction of the closed and open pipes as frequency is the same ,note that both are in first overtone
open pipes —> 2^{nd} harmonics —2
closed pipes—>2^{nd} harmonics —3 . first overtone is same as 2^{nd} harmonics .we have $\frac{2xV}{2(L+2C)}=\frac{3xV}{4(L+C)}$, $\frac{2xV}{2(30+2C)}=\frac{3xV}{4(23+C)}$,
4(23+C)=3(30+2C), 92+4C=90+6C, C=1m.

OPTICS (CHAPTER 7)

I=incident ray (Θ_i) , R=reflected ray (Θ_r)
formula for refraction from Snell's law is given by $\boxed{n_a \sin\Theta_a = n_b \sin\Theta_b}$ n_a=refractive index of ''a'' medium , Θ_a=angle of ''a'' n_b=refractive index of ''b'' Θ_b=angle of ''b'' note this formula is very b important in refraction . let's do a small review on refraction



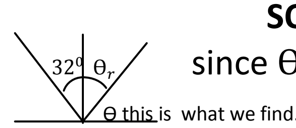
when ray of light strikes glass block at the (Θ_i) it is reflected through (Θ_r) the transmitted ray from medium (a) changes direction as it enters another medium (i.e.) medium 'b' This is called **refraction .** note that angle of incidence equals angle of refraction .
Refracted index is also given by $\boxed{n=\frac{C}{V_m}}$,
c=speed of light in that material (it's a constant given by 3x10^8m/s. note also this formula $\frac{V_1}{\lambda_1}=\frac{V_2}{\lambda_2}$, v_1=speed of medium 1 v_2=speed of medium 2 , λ_1=wavelength of 1 , λ_2=wavelength of 2, refractive index is also given by $\boxed{{}_a n_b=\frac{\sin\Theta_i}{\sin\Theta_r}}$ here Θ_r=refracted angle . **At critical angle refracted angle is $\mathbf{90^0}$**



notice that the incident angle is the critical angle we are talking about. When it is critical the refracted angle becomes 90^0 **Total internal reflection occurs when angle is critical**. Any time you think critical angle think about total internal reflection. Total internal reflection is given by $\boxed{n=\frac{1}{\sin\Theta_c}}$ where Θ_c=critical angle .

EXAMPLE 7.2: a beam of light is incidental on a plane mirror at an angle of 32^0 relative to the normal. What is the angle between the reflected rays and the surface

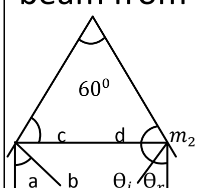
SOLUTION



since Θ_i=Θ_r then Θ_r=32^0 but Θ_r and Θ are 90^0 (it's a right angle . 32+Θ=90^0 ,Θ=58^0.

EXAMPLE 7.3: Two plane upright mirrors touch along one edge where their planes make an angle of 60^0. If a beam of light is directed onto one of the mirrors at an angle of incidence of 40^0 and is reflected onto the other mirror, what will be the angle of reflection of the beam from the second mirror.

SOLUTION



if b is the reflected ray angle of a b=40^0, but to find c, b+c=90^0 , c=50^0 . but we are to find the Θ_r(reflected ray) . 50^0+60^0+d=180^0 d=$180^0 - 110^0$=70^0, but d+Θ_i=90^0 , 70^0+Θ_i=90^0 , Θ_i=20^0 .

SOLUTION TO EXERCISE 7

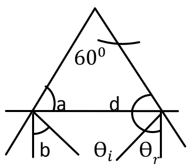
7.1 An optical fiber is made of clear plastic with index of refraction n=1.50. What is the minimum angle of incidence so that the total internal reflection can occur?

SOLUTION

n=1.5 , Θ_c=? , from n=$\frac{1}{\sin\Theta_c}$, Θ_c=$\frac{1}{\sin^{-1}1.5}$, Θ_c=41.8^0

7.2 Two plane mirror, m_1 and m_1 are placed together with edges touching each other at angle α. If the light ray is incidental on m_1 at angle 35^0 what is the angle of reflection from the second mirror m_2 (take α=60^0).

SOLUTION



from since Θ_i=Θ_r ,b=35^0 and b+c=90^0. 35^0+c=90^0, c=55^0. 55^0+60^0+d=180^0 , d=65^0 but d+Θ_i=90^0. $65^0+\Theta_i=90^0$ $\Theta_i=25^0$

7.4 What is the critical angle of light passing from a material of index of refraction 1.54 to a material of index of refraction n=1.33

SOLUTION

n_a=1.54 ,n_b=1.33 , Θ_c=?, from n=$\frac{1}{\sin\Theta_c}$, we a given two refraction hence we use $\frac{n_a}{n_b}$=$\frac{1}{\sin\Theta_c}$, $\Theta_c=\sin^{-1}\frac{n_b}{n_a}$, $\Theta_c=\sin^{-1}\frac{1.33}{1.54}$=$59.7^0$.

7.5 A glass plate of thickness 0.6cm has a refractive index of 1.55, calculate the time taken for the ray of light to pass through it.

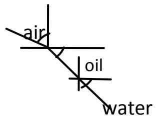
SOLUTION

n=1.55, c=3x10^8m/s (constant) from n=$\frac{C}{V_m}$ V_m=$\frac{3x10^8}{1.55}$=$1.93x10^8$m/s. from v=$\frac{distance}{time}$ distance=0.006m. time=$\frac{0.006}{1.93x10^8}$ time=$3.11x10^{-11}s$.

7.6 A layer of oil (n=1.45) float on water (n=1.33). A ray of light shines onto the oil with an incident angle of 40^0.Find the angle the ray makes in the water.

SOLUTION

we have three medium here, air, oil and water



we find the refracted angle of oil, then refracted angle of water from $n_a\sin\Theta_a$=$n_b\sin\Theta_b$, n_a=1 (note that it is constant for air) , n_b=1.45, Θ_a=40^0, Θ_b=?
$1x\sin 40^0$=$1.45\sin\Theta_b$,$\sin\Theta_b$=$\frac{1x0.6428}{1.45}$, Θ_b=26.3^0.(this is the refractive angle of oil) we now look for the refractive angle of water taking Θ_b=26.3^0 as incident angle of oil. , n_a=1.45, n_b=1.33, Θ_a=26.3^0, Θ_b=?

$1.45x\sin 26.3^0$=$1.33\sin\Theta_b$,$\sin\Theta_b$=$\frac{1.45x0.443}{1.33}$, Θ_b=28.9^0.

7.7 The speed of light in water is 75% of the speed of light in a vacuum . What is the value of it's refractive index?

SOLUTION

from n=$\frac{C}{V_m}$,V_m=$\frac{75}{100}$ $of\ c$ =$0.75c$. n=$\frac{c}{0.75c}$=1.33

7.8 What is the refractive index of a material if the critical angle of light passing from the material to air is 24.4^0.

SOLUTION

Θ_c=24.4^0 , from n=$\frac{1}{\sin\Theta_c}$ =$\frac{1}{\sin 24.4^0}$=2.42.

7.10 At what angle to the surface must a diver submerged in a lake look towards the surface to see the setting sun?

SOLUTION

for the diver to see the setting sun it has to be at critical angle . note refractive index of water is 1.33(constant) n=$\frac{1}{\sin\Theta_c}$, Θ_c=$\frac{1}{\sin^{-1}1.33}$=48.8^0.

REFLECTION AT PLANE AND CURVED SURFACES (CHAPTER 8)

CHARACTERISTICS OF MIRROR AND LENSES(THE SHORTCUT)

i. focal length (F) and radius of curvature (R) is positive for a concave mirror (+F and +R) while it is negative for a convex mirror (-F and –R)

ii. image distance (V) is positive (+V) when image is formed in front of mirror and ''+V'' means **REAL IMAGE** while V is negative (-V) when image is formed at the back of the mirror **(-V means a VIRTUAL IMAGE)**

iii. when magnification (M) is positive (+M) image is **UPRIGHT OR ERECT** but when it is negative (-M) **IMAGE IS INVERTED**

iv. when M<1, **IMAGE IS DIMINISHED OR REDUCED** but when M>1 **IMAGE IS ENLARGED OR MAGNIFIED** and when M=1 **IS A REAL IMAGE**

MIRROR FORMULAS ARE GIVEN BELOW

image distance is given by $V=\frac{UF}{U-F}$ where f=focal length , u=object distance , v=image distance . object distance is given $U=\frac{VF}{V-F}$, focal length is given by $F=\frac{UV}{U+V}$,magnification is given by $M=\frac{-V}{U}$, focal length is also given by $F=\frac{R}{2}$ where R=radius of curvature. length of image is given $\Delta V=V_B - V_A$

SOLUTION TO EXERCISE 8

8.1 Describe the image of a candle flame located 40cm from a concave spherical mirror of radius 64cm.

SOLUTION

R=64cm , by $F=\frac{R}{2}=\frac{64}{2}$=32cm. U=40cm ,we find V and M to know the description of the image from $V=\frac{UF}{U-F}=\frac{40x32}{40-32}$=160cm. V is (+) hence IMAGE IS REAL, we find M from $M=\frac{-V}{U}=\frac{-160}{40}$=-4 . m is negative hence IMAGE IS INVERTED **ANSWER IS REAL AND INVERTED**

8.2 A rod 10m long is placed along the principal axis of a convex mirror of focal length 4cm, if the side nearer the mirror is 6cm from it, find the length of the image.

SOLUTION

It was a convex mirror hence F(-) ,F=-4cm ,U_1=6cm, U_2=10cm, V=? ,we find the length from $\Delta V=V_B - V_A$ but $V_B=\frac{U_1F}{U_1-F}=\frac{6x-4}{6-(-4)}$ $V_B=-2.4$cm. we add $U_1$and U_2 and find f V_A , U=10+6=16cm. $V_B=\frac{16x-4}{16-(-4)}=-3.2$cm. $\Delta V=-2.4-(-3.2)$=0.8m.

8.3 An object 7cm high is placed 15cm from a convex spherical mirror of radius 45cm . Describe it's image and give the value for the image distance V and magnification M.

SOLUTION

R=−45cm (convex mirror) from $F=\frac{R}{2}=\frac{-45}{2}$=−22.5cm , U=15cm, from $V=\frac{UF}{U-F}$ $V=\frac{15x-22.5}{15+(-22.5)}$=−9cm. $M=\frac{-V}{U}=\frac{-(-9)}{15}$=0.6

8.4 What is the focal length of a convex spherical mirror which produces an image one−sixth the six of an object located 12cm from the mirrors

SOLUTION

$M=\frac{1}{6}$, U=12cm , we are to find the focal length from $M=\frac{-V}{U}$, $\frac{1}{6}=\frac{-V}{12}$, V=−2cm , from $F=\frac{UV}{U+V}$ $F=\frac{12x-2}{12+(-2)}$=−2.4cm.

8.5 A mirror forms an erect image 30cm from the object and twice it's height (a) where must the mirror be situated (b) what is it's radius of curvature.

SOLUTION

(a) M=2 (because twice was stated) ,let U=x , let V=X−30 , from $M=\frac{-V}{U}$,$2=\frac{x-30}{x}$, 2X=−X+30, X=10cm. (b) V will be V=10−30=−20cm. we find focal length before getting 'R' from $F=\frac{UV}{U+V}$ $F=\frac{10x-20}{10+(-20)}$=20cm, from $F=\frac{R}{2}$, R=2X20=40cm.

8.6 A convex mirror has a radius of curvature of 0.55m. calculate the position of the image of a man 10cm from the mirror.

SOLUTION

we are to find V, R=-0.55m(convex mirror) from $F=\frac{R}{2}=\frac{-0.55}{2}$=−0.275m.U=10cm from $V=\frac{UF}{U-F}$ $V=\frac{10x-0.275}{10+(-0.275)}$=−0.267m.

8.7 An object is placed 2.0cm in front of a concave mirror whose radius of curvature is 8.0cm ,find the position of the image, size and it's orientation.

SOLUTION

To find the position ,size and orientation we find V and M .U=2cm , R=8cm from $F=\frac{R}{2}=\frac{8}{2}$=4cm. (F IS (+) IT'S A CONCAVE MIRROR) from V=$\frac{UF}{U-F}$=$\frac{2x4}{2-4}$=-4cm (V IS (-) IMAGE IS VIRTUAL ,ERECT AND FORMED BEHIND(OR BACK) OF MIRROR), from M=$\frac{-V}{U}$=$\frac{-(-4)}{2}$=2cm. (M>1 ,IMAGE IS ENLARGED (OR MAGNIFIED) so **image is 4CM BEHIND THE MIRROR, VIRTUAL, ERECT & ENLARGED(MAGNIFIED)**

8.8 A child looked at a reflecting Christmas tree that has a diameter of 9.0cm and sees an image of her face that is half the real size. How far is the child's face from the ball.

SOLUTION

diameter= 9cm, radius in math is given by R=$\frac{diameter}{2}$=$\frac{9}{2}$=4.5cm. from F=$\frac{R}{2}$=$\frac{4.5}{2}$=2.23cm.

8.9 In a particular store truck mirror , there is a warning object in the mirror appear to be more closer than they appear ,what kind of mirror must that be and why?

SOLUTION

IT'S A CONVEX MIRROR.

REFRACTION THROUGH PLANE SURFACES (CHAPTER 9)

Make sure you memorize characteristics of mirror and lenses in page 14 (very important for your exam) . Refractive index ''n'' for object in a liquid (e.g. in water) is given by $n=\frac{Real\ depth(T)}{Apparent\ depth\ (A)}=\frac{T}{A}$,Apparent depth of an object is given by A=T—D , where D=displacement of an object in water ,displacement of object given by $D=T\left(1-\frac{1}{n_s}\right)$ where T=Real depth ,n_s=refractive index of object or substance .Determination of displacement of an object in three media e.g. in oil (n_1), water (n_2), and glass (n_3) is given by $D_T=d_1+d_2+d_3$ where d_1,d_2,d_3 are displacement in each medium where D_T=total displacement of (1) e.g. oil, (2) e.g. water,(3) e.g. glass. Real depth of object in three media is given by $T_t=t_1+t_2+t_3$ where t_1,t_2,t_3 are real depth in each medium where D_T=total displacement of (1) e.g. oil, (2) e.g. water,(3) e.g. glass. d_1,d_2,d_3 are given by $d_1=t_1\left(1-\frac{1}{n_1}\right)$, $d_2=t_2\left(1-\frac{1}{n_2}\right)$ and $d_3=t_3\left(1-\frac{1}{n_3}\right)$ .Refraction through prism is given by n=$\frac{\sin\left(\frac{A+D_{min}}{2}\right)}{\sin\frac{A}{2}}$, D_{min}=minimum deviation , A=refractive index angle or apex angle. Deviation of blue and red light of small angular prism are given by $d_{red}=(n_r-1)A$, $d_{blue}=(n_b-1)A$. angular deviation is given by $\Delta d=(n_b-n_r)A$

PAST QUESTION 2014/2015

Find the displacement of the bottom of a swimming pool if the apparent depth is 1.2m (n_w=1.33).

SOLUTION

from A=T—D and from n=$\frac{T}{A}$, n=1.33 , A=1.2 , T=nxA=1.33X1.2=1.596. ,Displacement=? D=T—A=1.596—1.2=0.396m.

PAST QUESTION 2014/2015

A certain glass prism has a refractive index of 1.61 for red light and 1.66 for violet light if both colours pass through symmetrically and if the apex angle is 60^0 .Find the difference between the angles of minimum deviation of the two colours.

SOLUTION

We are asked to find the change in minimum deviation from $\Delta D_m=D_{m\ violet}-D_{m\ red\ light}$ A=60^0, n_{violet}=1.66 , n_{red}=1.61 ,from n=$\frac{\sin\left(\frac{A+D_{min}}{2}\right)}{\sin\frac{A}{2}}$, for red light 1.61=$\frac{\sin\left(\frac{60+D_{min}}{2}\right)}{\sin\frac{30}{2}}$ 1.61x0.5=$\sin\frac{60+D_m}{2}$, $\sin^{-1}0.805=\frac{60+D_m}{2}$, D_m of red=47.2^0. for violet 1.66=$\frac{\sin\left(\frac{60+D_{min}}{2}\right)}{\sin\frac{30}{2}}$, 1.66x0.5=$\sin\frac{60+D_m}{2}$, $\sin^{-1}0.83=\frac{60+D_m}{2}$

D_m of violet=52.2^0 ΔD_m=$52.2^0 - 47.2^0$, ΔD_m=4.98^0=5^0.

SOLUTION TO EXERCISE 9

If the thickness and refractive index of oil ,water and glass together in a set up are respectively 4cm,6cm,5cm and 1.26,1.33,n_g. Find the value of n_g if the apparent position of an object at the bottom is 12cm.

SOLUTION

t_1=4cm , t_2=6cm, t_3=5cm, n_1=1.26, n_2=1.33 $n_3(n_g)$=? .we calculate the value of d_3 before finding n_3 from d_1=$t_1\left(1-\frac{1}{n_1}\right)$

d_1=4$\left(1-\frac{1}{1.26}\right)$=0.8254, , d_2=$t_2\left(1-\frac{1}{n_2}\right)$

d_2=6$\left(1-\frac{1}{1.33}\right)$=1.4887, from A=T−D, we find D , 12=(4+6+5)−D,D=3. From D_T=d_1+d_2+d_3 ,3=0.8254+1.4857+d_3 , d_3=3−0.8254−1.4857=0.6859. from d_3=$t_3\left(1-\frac{1}{n_3}\right)$, 0.6859=5$\left(1-\frac{1}{n_2}\right)$, 0.6859n_3=5n_3 −5 , n_3=1.16.

9.3 The difference between the refractive indices of carbon bisulfide for blue and red light is 0.48 while the critical angle for red light at carbon bisulfide air interface is 49^0. Calculate the critical angle range for carbon sulfide for blue light.

SOLUTION

Difference of two refractive index that of blue and red will be $n_b - n_r$=0.48 and the critical angle(Θ_c) of n_r=49^0,from n_r=$\frac{1}{\sin\Theta_c}$, n_r=$\frac{1}{\sin 49^0}$ n_r=1.3250 , $n_b - 1.3250$=0.48 ,n_b=1.805 . Angle which blue will be critical will be given by n_r=$\frac{1}{\sin\Theta_c}$,1.805 =$\frac{1}{\sin\Theta_c}$, Θ_c=33.64^0.

9.4 An object at the bottom of a pool 20m deep was observed to be at a 14cm position. Find the angles of incidence of the object ,if the angle of refraction of an observer vertically above is 36^0.

SOLUTION

We find the refractive index of both first, T=20m , A=14cm, from ${}_an_b$=$\frac{T}{A}$=$\frac{20}{14}$=1.42857, we we find the incident ray(Θ_i) from n=$\frac{\sin\Theta_i}{\sin\Theta_r}$, , Θ_r=36^0, 1.42857=$\frac{\sin\Theta_i}{\sin 36}$, $\sin\Theta_i$=0.588x1.42857 Θ_i=$\sin^{-1} 0.83999$=57.1^0.

Note that in this material is strictly exam focus

REFRACTION THROUGH CURVED SURFACES (LENSES) (CHAPTER 10)

Power of lens is given by P=$\frac{1}{F}$ (in metres ʼʼmʼʼ) also given by P=$\frac{100}{F}$ (in ʼʼcmʼʼ or dioptre ʼʼDʼʼ) where F=focal length . Lens maker equation is given by $\frac{1}{F}$=(n−1)$\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$, R_1=Radius of curvature of 1st lens , R_2=Radius of curvature of 2nd lens ,n=refractive index . **For concave mirror Note that R_1 is negative for ($-R_1$) and R_2 is positive ($+R_2$) but for convex mirror R_1 is positive for ($+R_1$) and R_2 is negative ($-R_2$) please take note** . Focal length of two lenses in contact is given by $\frac{1}{F}$=$\frac{1}{F_1}+\frac{1}{F_2}$, F_1=Focal length of 1st lens , F_2=Focal length of 2nd lens

PAST QUESTIONS 2012/2013(Q 26)

The near point of a certain hyperopic eye is 100cm in front of the eye .What would be the power of the lens that would permit the wearer to see clearly an object that is 25cm in front of an eye

SOLUTION

For a hyperopic eye image is formed behind the retina , hyperopic eye means longsightness problem , for an image behind ʼʼVʼʼ will be negative . **check lens laws in page**

14. V=−100cm, U=25cm, we find focal length first from F=$\frac{UV}{U+V}$=$\frac{25x-100}{25+(-100)}$=33.33. P in diopters from P=$\frac{100}{F}$=$\frac{100}{33.33}$= +3D.

PAST QUESTION 2012/2013(Q47)

Suppose the absolute values of the radii of curvature of a double convex lens are both equal to 10cm and the refractive index of the glass is 1.52 , what is the focal length of the lens

SOLUTION

From $\frac{1}{F}$=(n−1) $\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$,it was a convex lens hence R_1=+10cm & R_2=−10cm , n=1.52 $\frac{1}{F}$=(1.52−1) $\left(\frac{1}{10}-\frac{1}{(-10)}\right)$,$\frac{1}{F}$=0.104

F=$\frac{1}{0.104}$=+9.6cm.

PAST QUESTION 2016/2017 (Q 34)

Two thin lenses of focal lengths 9cm and −6cm are placed in contact . Calculate the focal length of the combination?

SOLUTION

, F_1=9cm , F_2=−6cm, From $\frac{1}{F}$=$\frac{1}{F_1}+\frac{1}{F_2}$

$\frac{1}{F}$=$\frac{1}{9}+\frac{1}{-6}$, $\frac{1}{F}$=$\frac{6-9}{54}$=$\frac{-3}{54}$, F=$\frac{54}{-3}$=−18cm.

EXERCISE 10.5

Two thin lenses of focal length of focal length +12cm and −30cm are in contact compute the focal length and power of the combination

F_1=−30cm , F_2=+12cm, From $\frac{1}{F}$=$\frac{1}{F_1}+\frac{1}{F_2}$

$\frac{1}{F}$=$\frac{1}{12}+\frac{1}{-30}$, $\frac{1}{F}$=$\frac{30-12}{360}$=$\frac{18}{360}$, F=$\frac{360}{18}$=20cm

OPTICAL INSTRUMENTS (CHAPTER 11)

i. The least distance of the eye is 25cm .

ii. A simple microscope makes use of a converging lens to further increase the apparent angular size of an object.

iii. A compound microscope consists of two converging lens.

iv. The difference between the microscope and telescope is that telescope is used to view objects of large distance while microscope is used to view small objects at close distance**.**

Length of a terrestrial telescope is given by L=F_0+4F+F_e Where F_0=focal length of objective lens, F=focal length of middle lens, F_e=focal length of eye piece

PAST QUESTION 2014/2015(Q 12)

What is the length of a terrestrial telescope made of and objective lens of focal length 0.5m , a middle lens of focal length 4cm and eye piece of focal length of 6cm?

SOLUTION

F_0=50cm(converted to cm) F=4cm,F_e=6cm

From L=F_0+4F+F_e=50+4(4) + 6=72cm.

DISPERSION AND ABBERATION (CHAPTER 12)

i. The separation of white light into it's component colours is called **DISPERSION**

ii. The spectrum of visible light is called **'ROYGBIV'** contains and stands for the red,orange,yellow,green,blue,indigo and violet

iii. 'ROYGBIV' is in the order of decreasing wavelength, decreasing speed and increasing angle of deviation (REFRACTION) .

PAST QUESTION 2012/2013(Q 22)

A Ray of white light incident upon a glass prism is dispersed into it's various colour components, which one of the following colour experiences the least refraction (a) violet (b) yellow (c) blue (d) green (e) none of the above

SOLUTION

This is a dispersion question. From 'ROYGBIV' deviation or refraction increases from red to violet but in question red wasn't given but yellow which is next was given. So yellow has the least refraction here.

ANSWER IS B → YELLOW

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THEORITICAL ASPECT OF PHY113 (INCLUDES QUESTION, ANSWERS AND EXPLANATIONS)

Some students think that the theory aspect of physics in exams are not too important but the truth is that in uniben physics exam you will be given at least 10 theory question out of 50 question , the remaining 40 will be calculations. If you are able to get up to 10 question correctly in theory and able to get 25 question out of 40 in calculations , that is an 'A' already because you need to get at least 35 correctly to get an 'A' , just make sure you take the theory aspect serious as well as the calculations if you want an easy 'A'.In this material I was able to put together **104 theory questions**, Let's begin.

1. In simple harmonic motion period depends on?

ANSWER-MASS OF OBJECT

2. The product of the period and frequency of a harmonic oscillator is always equal to?

ANSWER- 1

3. The amplitude of a simple harmonic oscillator may be defined as?

ANSWER-THE MAXIMUM DISPLACEMENT

4. The period of oscillation of a simple pendulum is independent of ?

ANSWER-MASS OF THE BOB. The mass of the pendulum doesn't affect it's period.

5. Forced oscillation is when an external force maintains vibrating system. At resonance ,the amplitude of the vibrating body ____

ANSWER-MAXIMIZES. Note that amplitude is maximum at resonance.

6. If freely suspended object is pulled to one side and released , it oscillates about the point of suspension because the ___

ANSWER- ACCELERATION IS DIRECTLY PROPORTIONAL TO THE DISPLACEMENT. Note that the acceleration and restoring force are directly proportional to the displacement.

7. Which of the following is NOT a mechanical wave? (a) Waves propagated in stretched string (b) waves in closed pipes **(c) radio waves** (d) water waves (e) sound waves

ANSWER IS C (RADIO WAVES)

note that all waves in the electromagnetic spectrum are not mechanical and radio wave is part of the spectrum (RIVUXG—Radio waves, infrared ray, visible light, ultraviolet ray, x-ray and gamma ray.)

8. Which of the following is NOT an example of longitudinal wave? (a) electromagnetic waves (b) sound waves

9. A transverse wave and a longitudinal wave travelling in the same direction in a medium differ essentially in their?

ANSWER- DIRECTION OF VIBRATION OF THE PARTICLES OF THE MEDIUM.

10. The fundamental property of a propagating wave which depends only on the source and not the medium of propagation is the ?

ANSWER- FREQUENCY. Two properties are affected by the medium of propagation of a wave: VELOCITY AND THE WAVELENGTH. The frequency of the wave depends solely on the source that generates the wave.

11. Which of the following statements about wave is/are correct ?

I. A wavefront is a line which contains all particles whose vibrations are in phase

II. The direction of propagation of a wave is the line drawn parallel to the wavefront

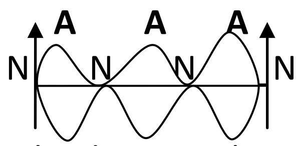
III. A wavefront is a circle which is common to all particles that are to be in the same state of disturbances

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

ANSWER- ANSWER IS E (I AND III)

A wavefront is a line or surface that joins all particles in phase or in same state of disturbance in a travelling wave .NOTE THAT WAVEFRONT DESCRIBES THE STATE OF VIBRATING PARTICLES IN PHASE NOT THEB WAVE ITSELF

12.



from the diagram above , the type of wave obtained is? . **ANSWER- STANDING WAVE. This diagram shows an incident and reflected wave that superimposed to form a standing wave . Even though the waves are transverse, The diagram illustrates a standing wave.**

13. If sound wave goes from a cold air region to a hot air region , it's wavelength will?.

ANSWER- DECREASE. Speed of sound in air increases with increase in temperature . Thus , when sound travels from cold air to hot air medium (temperature of air increased), it's speed increases accordingly while it's wavelength decreases.

14. The property that is propagated in a travelling wave is?

ANSWER- ENERGY. Travelling waves transfers energy.

15. Which of the following about a progressive mechanical wave is correct?
(a) it can be plane polarized (b) it's energy is localized at specific points of it's profile
(c) it does not require a material medium for it's propagation

ANSWER- ENERGY. Travelling waves transfers energy.

15. Which of the following about a progressive mechanical wave is correct?
(a) it can be plane polarized (b) it's energy is localized at specific points of it's profile
(c) it does not require a material medium for it's propagation **(d) it's frequency is constant as it travels between different media.**

ANSWER- D. Mechanical waves cannot be polarized .It is the electromagnetic waves that can be plane polarized . Travelling waves transfers energy. It's energy is therefore, not localized to a point. Mechanical waves require a material medium for propagation. Wave frequency depends only on source of wave thus, it's remains constant through different media. However, it's wave and velocity changes with medium.

16. Which of the following characteristics of a wave is used in measuring the depth of sea?
(a) diffusion (b) interference (c) refraction **(d) reflection**

ANSWER- D . Echoes, which can be used in determining the depth of sea , occur due to reflection of sound.

17. Which of the following properties is/are common to all waves? **I. diffraction II. refraction III. Reflection**

ANSWER- I,II,III (THE THREE ARE COMMON TO ALL WAVES).

18. A wave that travels through stretched strings is known as ?

ANSWER- MECHANICAL WAVE. It requires a material medium.

19. Ripples on water and light waves are similar because both ?

ANSWER- CAN BE REFRACTED AND DIFFRACTED.

20. Which of the following is characteristic of stationary wave? (a) the antinode is a point of minimum displacement (b) the distance between two successive nodes is one wavelength **(c) they are formed by two**

identical waves travelling in opposite direction(d) they can be transverse or longitudinal . **ANSWER- C.**

21. A wave disturbance travelling in air enters a medium in which it's velocity is less than that in air . Which of the following is true about a wave in the medium? (a) both the frequency and wavelength of the wave are decreased **(b) the frequency of the wave is unaltered while the wavelength is increased** (c) the frequency of the wave is unaltered while the wavelength is decreased (d) the frequency of the wave is decreased while the wavelength is unaltered
ANSWER- B . This wave was refracted. A decrease in velocity is accompanied by an increase in wavelength and unaltered frequency.

22. From the statements below ,the conditions for two waves to interfere are I. They should be identical II. They should originate from the same source III. They should be coherent IV. They should be monochromatic . (a) I,II and IV (b) I,II, and III only **(c) I,III and IV only** (d) II,III and IV only
ANSWER- C . For two waves to interfere constructively , they should be identical and have same frequency , However they may also have the same wavelength or be different by an integral number of wavelengths. Coherent and monochromatic describes electromagnetic waves that have the same wavelength and fixed phase relationship. Monochromatic describe lights of same colour and wavelength.

23. Which of the conditions below are necessary to produce interference fringes ? I. coherence II. Same frequency III. Same wavelength IV. same intensity
(a) I,II and III (b) I and II (c) I,II and IV (d) II and III. **ANSWER-A.**

24. Two boys communicating with each other by stretching a string passing through a hole punched at the bottom of each of two tin cans. The physical principle employed is that sound travels?
ANSWER- WITH GREATER EASE THROUGH A STRING THAN IN AIR. Speed of sound increases with density , thus sound travels faster in string than in air.

25. The difference between sound waves and light waves is that sound waves_____
ANSWER- REQUIRE A MATERIAL MEDIUM TO TRAVEL WHILE LIGHT WAVES DO NOT. Sound waves are mechanical while light waves are electromagnetic.

26. During a thunderstorm , the sound is heard over a long time. This phenomenon is referred to as____
ANSWER- REVERBERATION. Reverberation is a multiple reflection of sound waves causing it's persistence over a long time.

27. The physical properties of sound waves can be described by ____
ANSWER- REFLECTION AND DIFFRACTION. Sound waves are longitudinal ,thus they cant be polarized . polarization is exclusive to transverse waves.

28. Metal cables are used as telephones wires because ____
ANSWER- THE SPEED OF SOUND IN THEM IS VERY HIGH. Speed of sound is highest in solids.

29. Which of the following affect the velocity of sound? (a) an increase in the pitch of sound (b) an increase in the loudness of sound **(c) wind travelling in the same direction of sound** (d) a change in the atmospheric pressure at constant temperature.
ANSWER- C .

30. Which of the following factor affects speed

of sound in air?
I. temperature II. pressure III. Frequency
(a) I only (b)II only (c)I and II only (d) I and III only . **ANSWER- A.**

31. The speed of sound travelling in the media
listed below increases in the order.
(a) air, iron bar, water **(b) air, water, iron bar** (c) iron bar, water , air (d) water, air, iron bar (e) water, iron bar, air.
ANSWER- B.

32. If a source of sound is moving, a stationary listener will hear a sound of different frequency , this is called?
ANSWER- DOPPLER EFFECT. Doppler effect is an alteration in the frequency of sound heard by the listener when there is a relative motion between listener and source of sound.

33. If a sound wave goes from a cold-air region to a hot air region , it's wavelength will ____ **ANSWER- DECREASE .Going from cold-air (denser) to hot-air (less-dense) , the speed of a wave increases accompanied by a decrease in wavelength also cold-air to hot-air means an increase in temperature, which increases the speed of sound.**

34. If the load at the end of a sonometer is immersed in a bucket of water, the original fundamental frequency of the wire could be restored by ____
ANSWER- DECREASING THE LENGTH OF THE WIRE. The fundamental frequency is given by f=$\frac{1}{2L}\sqrt{\frac{T}{\mu}}$ because sonometer is like a string , immersing a load in water reduces it's weight and hence reduces the tension in string . Being that frequency is directly proportional to tension, this reduces the frequency also. However , frequency is inversely proportional to length . Thus to restore the original frequency, we decrease the length of wire or it's unit mass per unit length

35. When the bottom of a turning fork is held in contact with a wooden box , a louder sound is heard , this is phenomenon is known as ?
ANSWER- RESONANCE.

36. A note is called an octave of another if___
ANSWER- IT'S FREQUENCY IS TWICE THAT OF THE FIRST.

37. The characteristics of vibration that determines it's intensity is (a) an increase in the pitch of the sound **(b) an increase in the loudness of the sound** (c) wind travelling in the same direction of the sound (d) a change in the atmospheric pressure at constant temperature
ANSWER- B . Amplitude of the vibrating medium would have been more ideal but in the absence , loudness is the nearest.

38. The characteristics of vibration that determines it's intensity is____
ANSWER- AMPLITUDE. Intensity depends on amplitude of sound source.

39. Musical instruments playing in the same note can be distinguished from one another owing to the difference in their____
ANSWER- QUALITY . quality depends on harmonics and overtone.

40. The characteristic which differentiate a high note from a low note is_____
ANSWER- PITCH

41. The pitch of an acoustic device can be increased by _____
ANSWER- INCREASING TH FREQUENCY

<u>REFLECTION AT PLANE AND CURVED SURFACES, REFRACTION THROUGH PLANE SURFACES, REFRACTION THROUGH CURVED SURFACES (LENSES), OPTICALINSTRUEMENTS, DISPERSION AND ABBERATION</u>

42. Light is considered as a transverse wave because it travels_____
ANSWER- IN A DIRECTION PERPENDICULAR TO THE PLANE CONTAINING THE ELECTRIC AND MAGNETIC FIELD. Light is a transverse wave because it moves a direction perpendicular to the direction of the electric and magnetic field. It's doesn't have a material medium for propagation hence it is an electromagnetic wave.

43. Which of the following characteristic of light wave determines it's colour?
(a) velocity **(b) wavelength** (c) amplitude (d) intensity. **ANSWER- B . Wavelength determines colour of light. Each colour of spectrum of white light (ROYGBIV) represents one wavelength.**

44. non-luminous object can be seen because they ___
ANSWER- EMIT LIGHT. They reflect light into the eye and thus they are seen.

45. Which of the following is a non-luminous body ? (a) candle flame (b) lit bulb **(c) moon** (d) star.
ANSWER- C. The moon has no light on it's own (it's non-luminous) . it reflects the sun.

46. The sharpness of the boundary of shadow is determined by the ____
ANSWER- RAYS OF LIGHT PASSING THROUGH THE OBJECT. The sharpness of the boundary is due to rectilinear propagation light i.e. because rays travel in straight lines . It has nothing to do with the intensity of light or nature of the object. It is all because the light rays move in straight lines.

47. Which of the following phenomenon is NOT a direct consequence of rectilinear propagation of light?
ANSWER- DIFFRACTION OF LIGHT. Diffraction is due to spreading out of light rays as they pass through an aperture ,such as the pin-hole camera.

48. Shadows and eclipses result from the
ANSWER- RECTILINEAR PROPAGATION OF LIGHT. They result from rectilinear propagation of light.

49. The eclipse of the sun occurs when the ___
ANSWER- MOON IS BETWEEN THE SUN AND THE EARTH. Eclipse literally means obstruction . Eclipse of the sun means the sun is not seen from the earth , if so, then the moon lies between sun and earth blocking light from the sun from getting to the earth.

50. Which of this below is a phenomenon of total solar eclipse? I. total internal reflection of light II. conservative of light energy III. Relative motion of the earth, sun and moon IV. rectilinear propagation of light. (a) I and II only (b) II and IV only (c) I and III only (d) III and IV only . ANSWER- D. The two phenomena explain eclipse.

51. light travelling through a small pinhole usually does not make a shadow with a distinct sharp edge because of_____
ANSWER- DIFFRACTION. Diffraction is the property of light, like all waves to bend round obstacles or spread out through gaps. It is the reason behind blurred images seen in pin holes that are not small enough.

52. In daytime , it is possible to see under shady areas such as under a tree because light has undergone _____
ANSWER- DIFFRACTION.

53. A man standing between two parallel mirrors in a barber's shop will see the following number of his own image ____
ANSWER- INFINITE. Two parallel mirrors produce infinite number of images.

54. The instrument used by designers to

obtain different colour patterns is called
ANSWER- KALEIDOSCOPE.
55. Which of the following optical instruments does not depend on the use of plane mirrors?
ANSWER- SIMPLE MICROSCOPE. Simple microscope make use of a single convex lens.
56. The plane mirror in a kaleidoscope are usually placed
ANSWER- AT AN ANGLE OF 60^0.
57. Which of the following statements is/are correct about the image formed by a palne mirror?. I. The magnification produced is 1 II. The image distance is the same as object distance III. The image is real IV. the image is laterally inverted. (a) I only (b) II only (c) III only (d) I and III only
ANSWER- C. Plane mirror images are virtual images.
60. Which of the following is true for the image formed by a convex mirror?. I. The image is always virtual II. the image is always erect III. The image lies between focus and pole IV. the focal length is negative. ANSWER- THEY ARE ALL PROPERTIES OF CONVEX MIRROR IMAGES.
61. Which of the following statements is FALSE about parabolic mirrors?. (a) They are preferred in car headlamps (b) They exhibit spherical aberration (c) They focus both paraxial and marginal rays on the principal focus (d) They are improved form of concave mirrors.
ANSWER- B. Parabolic mirrors prevent spherical aberration.
63. In order to produce a parallel beam of light , a lamp is placed at a distance from the concave mirror equal to.
ANSWER- HALF THE RADIUS OF CURVATURE . A lamp is placed at the principal focus to produce parallel beam of light . It's distance is focal or half the radius of curvature.

64. An object O lies at a distance m in front of a concave mirror of focal length f. if m ▪ f, then the final image obtained will be ______
ANSWER- MAGNIFIED AND ERECT.
65. Convex mirrors are used as driving mirrors because images formed are______
ANSWER- ERECT, VIRTUAL AND DIMINISHED
66. In the microscope , the eyepiece lens merely acts as _____
ANSWER- A MAGNIFIER. While the object lens produces a magnified , the eye lens multiplies this magnification producing a highly magnified image. It's acts as a magnifier.
67. The following optical instruments make use of lenses in their modes of operation EXCEPT a (a) camera (b) microscope **(c) periscope** (d) projector (e) telescope
ANSWER- C. Periscope make use of plane mirrors in simple periscopes and right-angled triangular prisms in prismatic periscopes . They do not uses lenses.
68. The terrestrial telescope has one extra lens more than astronomical telescope. The extra lens is for
ANSWER- ERECTION OF THE IMAGE.
69. In a compound microscope , the objective and the eye piece focal length are
ANSWER- SHORT. In a compound microscope , objective and eye piece lenses are convex lenses of short focal lengths. They are not the same ;the objective's focal length is shorter than eye len's focal length
70. An astronomical telescope is said to be in normal adjustment when the**_____**
ANSWER- FINAL IMAGE IS AT INFINITY. Note that at normal adjustment
(i) the erect image coincides with the principal focus of the eye lens which produces

a final ERECT, MAGNIFIED AND VIRTUAL IMAGE AT INFINITY. (ii) the distance between the object and eye lenses and $f_0 + 4f + f_e$ where f is the focal length extra lens.

71. A telescope is said to be in normal adjustment when the _____
ANSWER- OBJECTIVE FOCAL POINT COINCIDES WITH THAT OF THE EYEPIECE . In normal adjustment the objective focal length COINCIDES with the eyepiece but both focal lengths are NOT EQUAL.

72. What optical instrument can best be constructed with converging lenses of focal lengths 50cm and 5cm?
ANSWER- ASTRONOMICAL TELESCOPE. Terrestrial telescope use 3 converging lenses . Galileo's telescope use one converging lens and one diverging lens. ASTRONIMICAL TELESCOPE use 2 converging lenses, one with a long focal length (e.g. 50cm) and the other with short focal length (e.g. 5cm). COMPOUND MICROSCOPE use 2 converging lenses both of short focal lengths.

73. In a compound microscope____
ANSWER- THE OBJECTIVE LENS HAS A SHORTER FOCAL LENGTH THAN THE EYEPIECE WHICH IS CONVEX. In a compound microscope the objective lens and eyepiece lenses are convex and the objective's focal length is shorter than the eyepiece's focal length.

74. The Galilean telescope has an advantage over all other telescope in that it_____
ANSWER- IS SHORTEST IN LENGTH.

75. A convex lens of long focal length f_0 and another convex lens of short focal length f_e was used to make an optical instrument, The distance between the lenses is_____
ANSWER- f_0+f_e .

76. A projection lantern of focal length of f, the object distance u, Is such that ____
ANSWER- $f < u < 2f$. In a projection lantern the object is placed between the center of curvature and the focus of the lens.

77. The eye controls the amount of light reaching the retina by adjusting the____
ANSWER- PUPIL. The pupil is a space by within the iris through which light rays reach the retina . The iris controls the amount of light reaching the retina by adjusting the diameter of the pupil.

78. The still pictures in films appear to have a continuity owing to ______
ANSWER-PERSISTENCE OF VISION

79. In comparing the camera to the human eye the film of the camera functions as the ___
ANSWER- RETINA.

80. Which of the following defeats of vision is as a result of the eyeball being too long___
ANSWER- SHORT SIGHT. While a short eyeball causes long-sight.

81. For a short sighted person , light rays from a point on a very distant object is focused __
ANSWER- IN FRONT OF THE RETINA.

82. For correction of the myopic defects in the human eye we require______
ANSWER- A CONCAVE LENS.

83. Presbyopia is a defect of the eye resulting from ___. **ANSWER- LOSS OF SPHERICITY OF THE LENS. Presbyopia is a loss of lens elasticity and increased sphericity due to hardening seen in old age. Presbyopia literally means ageing.**

84. ASTIGMATISM IS USED IN CORRECTING EYE DEFECTS USING CYLINDRICAL LENS

85. The angular dispersion of a prism depends on__. **ANSWER- THE INDEX OF REFRACTION ONLY. Angular dispersion in a prism depends only on the refractive index or index of refraction of the prism.**

86. A narrow beam of white light can be split up into different colours by a glass prism . The correct explanation is that___ **ANSWER- DIFFERENT COLOURS OF WHITE LIGHT TRAVELS WITH DIFFERENT SPEED IN GLASS. Dispersion results from the different speeds of the components of white light due to the different wavelengths. Keep in mind that one wavelength represents one colour of light.**

87. The angle of deviation of light of various colours passing through a triangular prism increases in the order____ (a) green —>violet—>blue (b) blue —>red—>green (c) blue—>green—>red (d) **red —>green—>blue**
ANSWER- RED —>GREEN—>BLUE. The angle of deviation increases in the order of the spectrum from ROYGBIV. Take note.

88. The spectrum of white light consists of colouring lights arranged in the following order; . **ANSWER- RED, ORANGE, GREEN, BLUE, INDIGO, VIOLET. From ROYGBIV**

89. Dispersion of white light is the ability of white to___
ANSWER- SEPARATE INTO IT'S COMPONENT. Dispersion is the separation of the components of white light after refraction through a prism.

90. The colours seen in soap bubbles are due to______
ANSWER- DISPERSION

91. Which of the following pairs of light rays shows the widest separation in the spectrum of white light?
ANSWER- BLUE AND RED.

92. When white light is dispersed by a spectrometer the components having the shortest wavelength is____
ANSWER- VIOLET. The spectrum ROYGBIV is in the order of decreasing wavelength Thus violet has the least wavelength.

93. A spectrum of light is said to be impure when__**ANSWER- THE DIFFERENT COLOURS IN IT OVERLAP.**

94. Production of pure spectrum could easily be achieved using a _____
ANSWER- TRIANGULAR PRISM WITH TWO CONVEX LENSES

95. In sunlight a blue flower looks blue because we see the flower by the light it ___
ANSWER- REFLECTS. Non-luminous objects are seen by the light they reflect.

96. What is the apparent colour of a RED SHIRT when viewed in pure green light?
ANSWER- BLACK. The red colour absorbs the green colour with nothing to reflect , the shirt appears black. Red + green—>yellow , red + blue—> magenta(purple) , blue + green —>cyan(bluish green), red + green + green —>white.

97. When light is incident on an object which is magenta in colour ,which of the following colours would be absorbed?
ANSWER- GREEN ONLY

98. The electromagnetic waves that are sensitive to temperature changes are____
ANSWER- INFRARED RAYS

99. INFRARED RAYS ARE THE LEAST ENERGETIC RAYS

100. Of the following, which is different from the others? (a) X-rays (b) gamma rays **(c) cathode rays** (d) ultraviolet rays (e) infrared rays. **ANSWER- C. Cathode rays are electrons . They are not part of the E-M spectrum.**

101. Which of the following are true about infrared radiation? I. It is invisible II. It is called heat ray III. It's frequency is higher than that of blue light IV. It travels as a transverse, (a) I,II,III, and IV **(b) I,II and IV** (c) I,III and IV only (d) II,III and IV only.
ANSWER- B . The E-M spectrum in order

of increasing frequency is RMIVUXY. Blue light is a part of visible light (white light). In the order, infrared came before visible light and same applies to blue light III is wrong.

102. Radio carrier waves are generated by causing electrons to oscillate rapidly in__

ANSWER- A TRANSMITTER. Radio waves are generated by alternating electric current within transmitters.

103. Which of the following is not part of the electromagnetic spectrum?

ANSWER- ALPHA RAYS. Alpha particles are not part of the electromagnetic spectrum

104. In which of the arrangements is the wavelength in an increasing order ?
(a) gamma rays, infrared rays , x-rays **(b) gamma rays m x-rays** , infrared rays (c) radio waves , x-rays, gamma rays , infrared waves (d) infrared rays, radio waves, x-rays , gamma rays.

ANSWER- B . **MAKE SURE YOU GET OTHER COPIES OF MATERIALS BY KAYMATH LIKE PHY111, MTH110 AND MTH112. CALL KAYMATH ON 08068552755 TO GRAB YOUR COPY. ALWAYS MAKE SURE YOU BACK UP YOUR STUDYING WITH PAST QUESTIONS. JOIN ANY OF THE FOLLOWING WHATSAPP GROUPS FOR INFORMATION AND TIPS ON STUDYING**

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THE END