Set - D

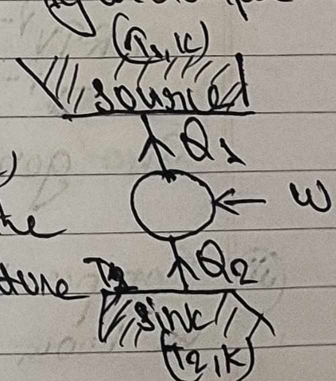
1	c	4	d	7	a	10	d
2	d	5	a	8	c	11	b
3	a	6	c	9	b		

Group B

1(a) ⇒ Heat pumps are designed to move thermal energy opposite to the direction of spontaneous heat flow by absorbing heat from cold space and releasing it to a warmer one. Due to surrounding temperature a refrigerator consume more power in summer than in winter to cool the same quantity of food by same degree. Which means that if the surrounding temperature is more then it'll more amount of work to be done by the heat pump to cool the food, Hence the refrigerator will use more energy to ~~cool~~ cool the food even if it is to the same temperature.

(b) ⇒ A refrigerator transfers heat from a body at lower temperature to a body at higher temperature by doing work on it.

If Q_2 is the heat absorbed from body at temperature ~~(Q_2)~~ ~~sink~~ T_2 (sink) and Q_1 is the heat liberated by the refrigerator to a body at temperature T_1 (source) then work done by there refrigerator,



$W = Q_1 - Q_2$

∴ The coefficient of performance $(\beta) = \frac{Q_2}{W} = \frac{Q_2}{Q_1 - Q_2}$

$= \frac{T_2}{T_1 - T_2}$

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OR (a) In a compressed (real) gas, the mutual attraction between the molecules increases as the molecules come close. Therefore potential energy is added to the internal energy. Since the potential energy is negative, the total internal energy of the gas decreases. The kinetic energy of the molecules is the same as both are at the same temperature.

(b) ⇒ Soln

We have,

The adiabatic equation is PV^{γ} = constant. — (i)

i.e $P_1V_1^{\gamma} = P_2V_2^{\gamma}$

now,

(i) temperature and volume.

we know $P = \frac{nRT}{V}$

Then from eqn (i)

$\frac{nRT}{V} \cdot V^{\gamma}$ = constant.

$nRTV^{\gamma-1}$ = constant

$TV^{\gamma-1}$ = constant

In general, $T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$

(ii) Temperature and pressure

we know $V = \frac{nRT}{P}$

from eqn (i)

$P\left(\frac{nRT}{P}\right)^{\gamma}$ = Constant

$P^{1-\gamma} T^{\gamma} (nR)^{\gamma}$ = constant

$T^{\gamma} P^{1-\gamma}$ = constant

In general, $T_1^{\gamma} P_1^{1-\gamma} = T_2^{\gamma} P_2^{1-\gamma}$

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2(a)

⇒ Progressive wave	Stationary wave
1. The disturbance travels forward with a definite velocity	1. The disturbance remains confined to the region where it is produced
2. Each particle of the medium executes SHM about its mean position with the same amplitude	2. Except nodes, all particles of the medium execute SHM with varying amplitude.
3. No particle of the medium is permanently at rest.	3. The particles of the medium at nodes are permanently at rest
4. There is no instant when all the particles are at the mean positions together	4. Twice during each cycle, all particles pass through their mean positions simultaneously
5. There is flow of energy across every plane along the direction of propagation of the wave	5. Energy of one region remains confined to that region.

2(b) ⇒ Soln

Given the eqn is $y = 0.02 \sin(30t - 4x)$

comparing this eqn with the standard wave eqn

$y = a \sin(\omega t - kx)$, where $k = \frac{2\pi}{\lambda}$, we have

$\omega = 30$

$2\pi f = 30$

$f = \frac{30}{2\pi}$

$\therefore$ frequency, $f = 4.77 \, Hz$

And, $k = 4$

or $\frac{2\pi}{\lambda} = 4$

$\lambda = \frac{2\pi}{4} = \frac{\pi}{2}$ $\therefore$ wavelength, $\lambda = 1.571 \, m$

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And for speed (v),

we have $v = f\lambda = \frac{\pi}{2} \times \frac{15}{\pi} = 7.5 ms^{-1}$

$\therefore$ frequency (f) = 4.77 Hz.

speed (v) = 7.5 ms^{-1}

wavelength (λ) = 1.571 m

3 (a) ⇒ The phenomenon of reflection of sound from a surface is called echo. Echo can't be ~~heard~~ hear in a room because in the room echo of the sound can't be reflected back. And for an echo of a sound to be heard, the minimum distance between the source of sound and the walls of the room should be 17.2 m. Obviously, in a room this gap can't be found. So, we can't hear echo in a room.

(b) ⇒ Newton's formula for the velocity of sound in air is $v = \sqrt{\frac{P}{\rho}}$ which is equals to 280 ms^{-1}

But this value is about 16% less than its experimental value which is about 332 m/sec. This large difference between the theoritical and experimental value of ~~sound~~ in air at STP cannot be due to experimental error. Laplace correction gives correction to the speed of sound in the gas. The formula for the speed of sound in the gaseous medium was estimated by Newton, he assumed that the propagation of sound waves in air or gas is under isothermal conditions.

(c)

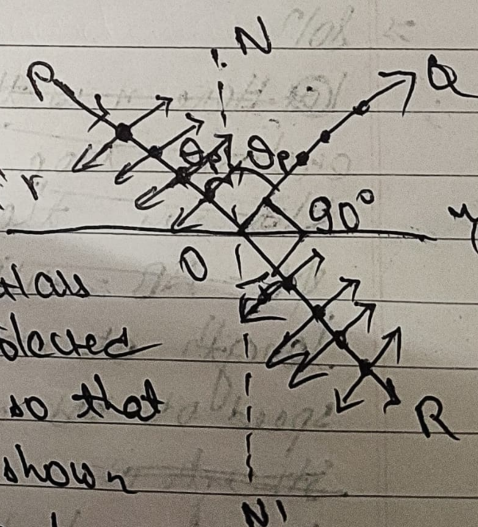
4 (a) ⇒ The polarizing angle for a medium of refractive index μ is given by

$\mu = \tan i_p$; i_p = polarizing angle.

Since, the refractive index of a medium depends upon the wavelength of the light by the Cauchy relation

$\mu = A + \frac{B}{\lambda^2} + \frac{C}{\lambda^4} + \dots$ where A and B are constant and λ be the wavelength of the light. Thus, the polarizing angle also depends upon the wavelength of light.

(b)



Let XY be the surface separating a transparent medium of refractive index μ and air. A ray PO incident Glass at the polarizing angle θ_p gets reflected along OQ and refracted along OR so that 'r' be the angle of refraction as shown in the figure. For polarizing angle (i.e. $i = \theta_p$) we get

$\angle QOR = 90°$

$\theta_p + r = 90°$

$r = 90° - \theta_p$

By using snell's law

$$\mu = \frac{\sin i}{\sin r} = \frac{\sin\theta_p}{\sin(90° - \theta_p)}$$

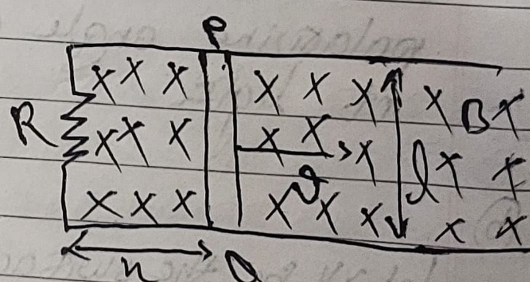
$$= \frac{\sin\theta_p}{\cos\theta_p} = \tan\theta_p$$

$$\boxed{\mu = \tan\theta_p.}$$

(c) It states that, the tangent of angle of polarization is numerically equal to the refractive index of the medium.

5 (a) ⇒ Faraday's law of electromagnetic induction states that, When the magnetic flux or the magnetic field changes with time, the electromotive force is produced.

(b)



⇒ Soln

Here x is the width of the enclosed loop. The magnetic flux is then

$\phi B = AB = xlB$

length of rod $(l) = 1.2$ m

speed of rod while sliding $(v) = 2$ m/s

Strength of

magnetic field $(B) = 2.5$ T

Resistance $(R) = 6\Omega$

Force required $(F) = ?$

we have

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$$F = \frac{B^2 l^2 v}{R} = \frac{(2.5)^2 (1.2)^2 \times 2}{6} = 3\,N$$

6(a)

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(b)

⇒ Sol^n

Current (I) = 5A

Distance of P (r) = 10 cm = 0.1 m

Earth's horizontal magnetic flux density (B_H) = 4×10^{-5} T

Now let B is the magnetic flux density at P due to conductor. Then,

$$B = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 5}{2\pi \times 0.1} = 1 \times 10^{-5} \text{ T}$$

According to Fleming's right hand rule, the direction of B is from north to south. But the direction of horizontal component of earth's magnetic field is from south to north

∴ Resultant magnetic flux density at P,

$B_T = 4 \times 10^{-5} - 1 \times 10^{-5}$ T

$= 3 \times 10^{-5}$ T. (from south to north)

(c)

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(5)

1(a) =>

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OR7 (Q7) The quanta of electromagnetic radiation are called photons.

(ii) (a)

⇒ Soln

we have $E = mc^2$

$$m = \frac{E}{c^2} = \frac{hf}{c^2}$$

$$m \propto f$$

So, different radiations have different frequencies, So, their photons have different mass

(b) ⇒ Yes the mass of a body change when it emits or absorbs photons. As a photons has energy hf and according to theory of relativity energy E is equivalent to a mass (E/c^2), so photon has a mass $\left(\frac{hf}{c^2}\right)$. So theoritically the mass of a body will decrease if it emits phons and will increase if it absorbs them.

(c)

⇒ Soln

given,

frequency (f) = 1000 kHz = 1000×10^3 Hz.

$1 eV = 1.6 \times 10^{-19}$ J

$h = 6.62 \times 10^{-34}$ Js.

now

Energy of photon (E) = hf

$= 6.62 \times 10^{-34} \times 1000 \times 10^3$ Hz.

$= 6.62 \times 10^{-28}$

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8 ⓐ

ⓑ => A gravitational wave is an invisible (yet incredibly fast) ripple in space. Gravitational waves travels at the speed of light (186000 miles per second). These waves squeeze and stretch anything in their path as they pass by.

Gravitational waves are a new way of observing the universe Astronomy traditionally uses light to explore the universe, but there are lots of things you can miss because a lot of the universe is dark, including black holes. The source of gravitational waves is two dense objects (like black holes or neutron stars) in orbit around each other

ⓒ => Some examples of events that could cause a gravitational waves are:-

i) When a star explodes asymmetrically (called a supernova
ii) When two big stars orbit each other
iii) When two black holes orbit each other and merge

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Group - C

9 (a) => Resonance is the relatively large selective respon of an object or a system that vibrates in step or phase with an externally applied oscillatory force. OR (a)

(b) => We know
In pendulum, $T = 2\pi\sqrt{\frac{l}{g}}$

i.e. $T \propto l$ (l belong to radius)

so in case of an ice pendulum the period depends on the radius of ice bobs. As the ice melts radius decreases, so period of oscillation decreases. But if the centre of mass of ice remains constant then there will be no change in the period

(c) => Any two reasons why motion of the mass is not simple harmonic are
(i) maximum displacements / accelerations are different
(ii) graph is curved / not a straight line

(d)

=> Soln

given, $R = 6380\ km = 6380 \times 10^3\ m = 6.38 \times 10^6\ m$

$g = 10\ m/s^2$

The mass will execute SHM in the tunnel

So, $T = 2\pi\sqrt{\frac{R}{g}} = 2\pi\sqrt{\frac{6.38 \times 10^6}{10}}\ s = 5018.69\ s$

$T = \frac{5018.69}{60}\ m = 83.64$ minutes

Time to reach other end, $t = \frac{T}{2} = \frac{83.64}{2} = 41.8$ minute

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OR (a) → The property of liquid by virtue of which its free surface ~~between~~ behaves like a stretched membrane under tension and tries to occupy minimum surface area is called surface tension.

For example:- Small insects such as the water strider can walk on water because their weight is not enough to penetrate the surface.
Floating a needle:- A carefully placed small needle can be made to float on the surface of water even though it is several times as dense as water.

(b) → Hot soup has less surface tension because of its high temperature than that of cold soup. Hence, the hot soup spreads over a large area of the tongue of a person. That makes hot soup more tasty than the cold one.

(c) ⇒ Sol^n

Given length of the plate (l) = 6cm = 0.06 m
Breadth of the plate (b) = 4cm = 0.04 m
Thickness of the plate (t) = 2mm = 2×10^{-3} m
Angle of contact (θ) = 0°
Surface tension of water (T) = 7×10^{-2} N/m
When the plate is placed with its largest face flat on the surface of water, then
Total length of contact (L) = 2(l+b) = 2(0.06 + 0.04)
= 0.2 m
Downward force due to surface tension (F) = T×L
= $7\times10^{-2}\times0.2$
= 1.4×10^{-2} N.

If the plate is placed vertical, then

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Total length of contact $(L) = 2(l+t) = 2(0.06+0.002)$
$= 0.124\ m$

Downward force due to surface tension $(F) = T \times L$
$= 7\times10^{-2}\times0.124$
$= 8.7\times10^{-3} N$

10 ⓐ => The impedance of LCR circuit, is the combination of resistance, capacitance and inductance present in the circuit.

The expression for it is $Z = \sqrt{R^2 + (X_L - X_C)^2}$
where Z is the impedence of the circuit

The condition for resonance is
inductive resonance should be equal to capacitive resonance i.e $X_L = X_C$
so that, $Z = R$.

ⓑ => When the value of Ac voltage is measured, it will give us the rms value of AC which is always less than its peak value. The peak value of 220 AC will be equal to $\sqrt{2} \times 220\,V$ i.e. it will be about 311 V. But if the dc voltage is mentioned as 220 V dc. it will be steady value, since the voltage in the case of AC will be more at its peak value than it is mentioned, it will be more shocking and hence can produce more ~~dangerous~~ damage than 220 V dc which makes it more dangerous than 220 V dc.

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(i) Soln

P.d across capacitor (V_c) = 170 V.
Frequency (f) = 60 Hz
Current (I) = 0.85 (A)
Capacitance (C) = ?

here,

p.d across capacitor $V_c = IX_C$

$$V_c = \frac{I}{2\pi f C}$$

$$C = \frac{I}{2\pi f V_c} = \frac{0.85}{2 \times 3.14 \times 60 \times 170}$$

$$C = 1.32 \times 10^{-5} F.$$

11(a) => Bohr's postulates of hydrogen atoms are

i) An electron moves around the nucleus in a circular orbit

ii) Electron revolve around the nucleus only in orbits in which their angular momentum is an integral multiple of $\frac{h}{2\pi}$

iii) The change in an electron's energy as it makes the quantum jump from one orbit to another is always accomplished by the emission or absorption of a photon.

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b(i) The spectral line is obtained when an electron jumps from higher energy state to lower energy state. Though there is only one electron in H-atom there are several orbits allowed for this electron. Again a sample contains large number of H-atom. Thus there are verity of possibilities of ~~transitions~~ transitions producing spectral lines.

(ii)

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