Meghalaya Board
Class XII
Physics
Sample Paper 1 – Solution

GROUP-A

1. (ii) Gain or loss of charge in terms of few electrons each carrying very small charge is unobservable at macroscopic level
2. (i) Due to charge separation, a net dipole moment is created
3. (iii) Kirchhoff's second law is applicable to closed circuits only as we form the equations using the loop and sign convention.
4. (iii) Direction of force can be obtained by applying Fleming's right hand rule
5. (iii) The magnetic induction left behind in the sample after the magnetizing field has been removed is called retentivity
6. (iv) Inductance in electric circuits plays same role as moment of inertia in mechanical circuits.
7. (ii) In a set a bulb and a capacitor are connected if we increase the frequency bulb will glow brighter as increase in frequency decreases capacitative reactance.
8. (iii) We can see the sun 2 minutes before the actual sunrise and 2 minutes after the actual sunset due to atmospheric refraction. So, the total time lengthened is 2 + 2 = 4 minutes.

GROUP-B

9. The mass of electron is small and a small increase in energy of the electron makes the electrons move with a very high speed. As a result of it, the electrons go quickly out of step with oscillating electric field.

10. Foucault currents also called Eddy currents are the induced currents when the magnetic flux linked with a conductor changes with time.

$$i = \frac{\text{induced emf}}{\text{resistance}}$$

$$i = \frac{(-d\phi / dt)}{R}$$

11. Overlapping interference pattern of different colours will form and the central bright fringe will be white.

12. When the impact parameter is minimum, the alpha particles rebound back

13. No. We cannot have resonance in RL or RC circuit as presence of L and C in the circuit is necessary for resonance.

14. Long distance radio broadcast use short wave bands as ionosphere layer of the atmosphere reflects the waves in these bands hence making the long distance broadcast feasible.

15. I_b would increase, so I_c decreases. Hence, current gain also decreases.

16. The frequency of output of half wave rectifier will be 50 Hz.

GROUP-C

17. Area vector $\vec{S}$ in y-z plane points along outward along positive x-direction.

$\vec{S}=20\hat{i}$

Hence the flux is:

$\phi_E=\vec{E}.\vec{S}=(6\hat{i}+3\hat{j}+4\hat{k}).20\hat{i}$

= 120 units.

18. If a lens has different radii of curvature, it forms an image of an object placed on its axis. If we reverse the lens the position of the image of the object will not change.
We can deduce this using the lens makers' formula which is as follows:

$$\frac{1}{f}=(\mu-1)(\frac{1}{R_1}-\frac{1}{R_2})$$

Or

The images formed by total internal reflection are brighter than those formed by mirrors or lenses because, in total internal reflection 100% of incident light is reflected back into the same medium without any loss of intensity, while in reflection from mirrors and lenses there is always some loss of intensity.

19. Let R_1 and R_2 be the resistances of the coils.

$R_1 + R_2 = 18$ (i) series connection

$R_1 R_2 / (R_1 + R_2) = 4$ (ii) parallel connection

Multiplying (i) and (ii) we have $R_1 R_2 = 18 \times 4 = 72$

Now $(R_1 - R_2)^2 = (R_1 + R_2)^2 - 4 R1 R2 = 18^2 - 4 (72) = 36$

$R_1 - R_2 = \pm 6$ (iii)

Solving equations (i) and (iii), we get

R_1=12 Ω or 6 Ω; R_2=6 Ω or 12 Ω.

20.

$$\tau = MB\sin\theta$$

$$M = \frac{\tau}{B\sin\theta}$$

$$M = \frac{0.055}{0.35 \times 0.5}$$

$$M = 0.31\,JT^{-1}$$

21.

$$T = \frac{1}{\nu} = \frac{\lambda}{c}$$

$$T = \frac{5550 \times 10^{-10}}{3 \times 10^{8}}$$

$$T = 1.85 \times 10^{-15}\ \text{seconds}$$

22. A potentiometer is sensitive if it is capable of measuring the small potential differences and it shows significant change in balancing length for a small change in the potential difference being measured.
Sensitivity of potentiometer means the smallest potential difference that can be measured by using it. This can be achieved by decreasing the potential gradient by increasing the length of the wire or reducing the current in the potentiometer using rheostat.

23. According to Einstein's photoelectric equation,
$(1/2)\ mv^2_{max} = h\ f - h\ f_0$
Where, m = mass of the electron
f = frequency of incident radiation
f_0 = threshold frequency
If the frequency of incident radiation is less than the threshold value ($f < f_0$), the K.E. of emitted electron is negative i.e. photoelectric emission will not takes place, no matter how large is the intensity of the incident radiation.

24. Ratio of electrons orbit radius to nuclear radius

= $(10^{-10} / 10^{-15}) = 10^5$ m

The radius of sun is R = 7 X 10^8 m

If we consider radius of earth orbits in same ratio the expected radius of earth orbit would be $7 \times 10^8 \times 10^5 = 7 \times 10^{13}$ m.

It means the expected radius of earth's orbit is about 500 times the actual radius which is 1.5×10^{11} m.

Or

The speed of the electromagnetic waves (whether its infra red rays or gamma rays) remains same no matter in which ever medium they travel.

Hence the ratio of the speeds of infra red rays and gamma rays in vacuum is 1:1.

GROUP-D

25. Here, $m = 3.2g = 3.2 \times 10^{-3}$ kg

$E = 10^{10}\ NC^{-1}$

Let n be the number of electrons removed from the coin. Then the charge on the coin is,

$q = +n\ e$

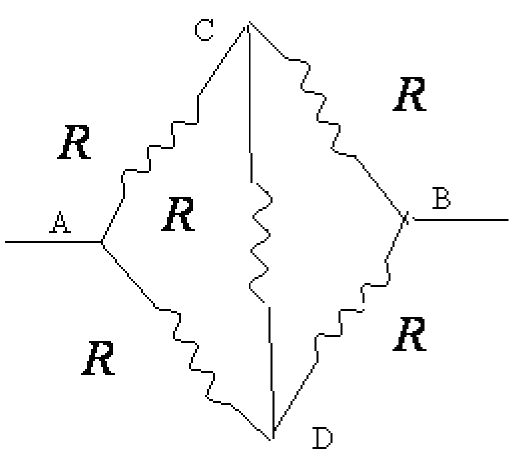
When the coin just floats,

Upward force of electric field = weight of the coin

$n\ q\ E = mg$

$$n = \frac{mg}{qE} = \frac{3.2 \times 10^{-3} \times 9.8}{1.6 \times 10^{-19} \times 10^{10}} = 1.96 \times 10^{7} \text{ electrons}$$

26. The network shown in the figure can be redrawn as shown in the figure below.



It is a balanced Wheatstone bridge. Therefore, point C and D are at the same potential. Since no current flows in the branch CD, this branch is ineffective in determining the equivalent resistance between terminal A and B and can be removed.

The branch ABC (= R+R= 2R) is in parallel with the branch ADB (= R+R= 2R)

$$R_{AB} = \frac{2R \times 2R}{2R + 2R} = R$$

27. We know when inductances are connected in parallel, then

$$\frac{1}{L_p} = \frac{1}{L_1} + \frac{1}{L_2}$$

$$\frac{1}{L_p} = \frac{1}{3} + \frac{1}{7}$$

$1 / L_p = 10 / 21$

$L_p = 2.1$ H

$L_{total} = 6 + 5 + 2.1 = 13.1$ H

Or

$\phi = (4t^2 + t + 5) \times 10^{-3}$

$e = -(d\phi / dt)$

$e = d((4t^2 + t + 5) \times 10^{-3}) / dt$

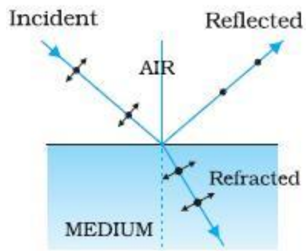
$e = (8t + 1) \times 10^{-3}$

At t = 3 s

$e = 25 \times 10^{-3}$ volts

$e = 0.025$ volts

28. In unpolarised light, the vibrations are symmetric about the direction of propagation.For an unpolarised wave the displacement will be randomly changing with time though it will always be perpendicular to the direction of propagation.



When unpolarised light is incident on the boundary between two transparent media, the reflected light is polarised with its electric vector perpendicular to the plane of incidence when the refracted and reflected rays make a right angle with each other.

Thus when reflected wave is perpendicular to the refracted wave, the reflected wave is a totally polarised wave. The angle of incidence in this case is called Brewster's angle and is denoted by i_B. We can see that i_B is related to the refractive index of the denser medium.

Since we have $i_B + r = \pi/2$, we get from Snell's law

$$\mu = \frac{\sin i_B}{\sin r} = \frac{\sin i_B}{\sin \pi/2 - i_B} = \frac{\sin i_B}{\cos i_B} = \tan i_B$$

Or

If ordinary unpolarised light of intensity I_o' is incident on first Polaroid (A,say),

intensity of light transmitted from first polaroid is $I_o = I_o'/2$

Given angle between transmission axes of two polaroids A and B is initially 90º.

According to Malus law, intensity of light transmitted from second polaroid (B, say) is

$I = I_o \cos^2 \theta = I = I_o \cos^2 90º = 0$

When one more polaroid (C say) is placed between A and B making an angle of 45º with the transmission axis of either of polaroids, then intensity of light transmitted from A is

$$I_A = \frac{I_0'}{2} = I_0$$

Intensity of light transmitted from C is

$$I_c = I_0 \cos^2 45° = \frac{I_0}{2}$$

Intensity of light transmitted from polaroid B is

$$I_B = I_c \cos^2 45° = \frac{I_0}{2} \times \frac{1}{2} = \frac{I_o}{4}$$

This mean that the intensity becomes one-fourth of intensity of light that is transmitted from first polaroid.

On further rotating the polaroid C such that if angle between their transmisson axes increases, the intensity decreases and if angle decreases, the intensity increases.

29. In a pure inductive circuit

$I = I_0 \sin\omega t$

$V = V_0 \sin(\omega t + 90^0)$

$V = V_0 \cos\omega t$

V leads by $\pi/2$

Hence,

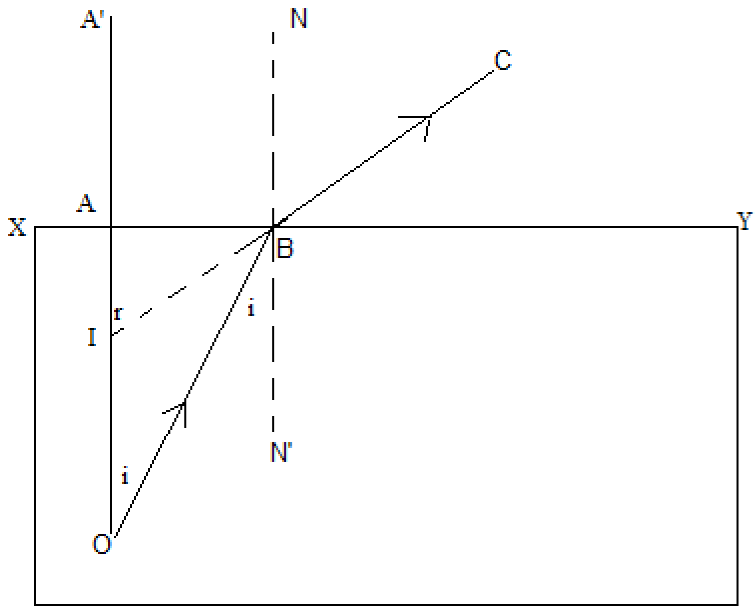
$$\text{Power}, P = \frac{1}{T}\int_0^T VIdt$$

$$P = \frac{1}{T}\int_0^T V_0 I_0 \sin\omega t \cos\omega t \, dt$$

$$P = \frac{V_0 I_0}{2T}\int_0^T \sin 2\omega t \, dt$$

P = 0

30.



In figure, OA passes straight along OAA'. Another ray of light from O incident at angle i on XY along OB deviates away from normal. It gets refracted at angle r along BC. When we produce back BC meets OA at I. Hence it's the virtual image of O. Hence AI is the apparent depth and AO is the real depth.

$\angle AOB = \angle OBN' = i$

$\angle$ AIB = $\angle$ NBC = r

In Δ OAB, sin i = AB / OB

In Δ IAB, sin r = AB / IB

Light is travelling from denser to rarer medium, so

μ_w^a = Sin r / sin i = (AB / IB) x (OB / AB) = OB / IB

μ_w^a = OA / IA = real depth / apparent depth = x / y

y = x / μ_w^a = x / 4/3 = (¾) x

Hence apparent depth is ¾ of the real depth.

31.

(a) In Young's double slit experiment, the distance of the nth fringe from the central fringe is given by;

X_n= (2n – 1) λD/2d

Where n= 1,2,3…..

For second dark fringe, n=2

X_2= (2x 2-1) (λD/2d) = 3(λD/d)

Here λ = 6000x 10^{-10}m; D = 0.800m; d=0.200x 10^{-3}m

$$X=\frac{3\times 6000\times 10^{-10}\times 0.800}{2\times 0.200\times 10^{-3}}=0.360\ \times 10^{-2}\text{m}$$

(b) The distance of nth bright fringe from the central fringe is given by;
x_n =n(λD/d)

For second bright fringe, n=2

Therefore

$$x_2=2(\lambda D/d)=\frac{2\times 6000\times 10^{-10}\times 0.800}{0.200\times 10^{-3}}=0.480\ \times 10^{-2}\text{m}$$

32. The information or message signal is called "base band signal". In general, it spreads over a range of frequencies called the signal 'bandwidth'.

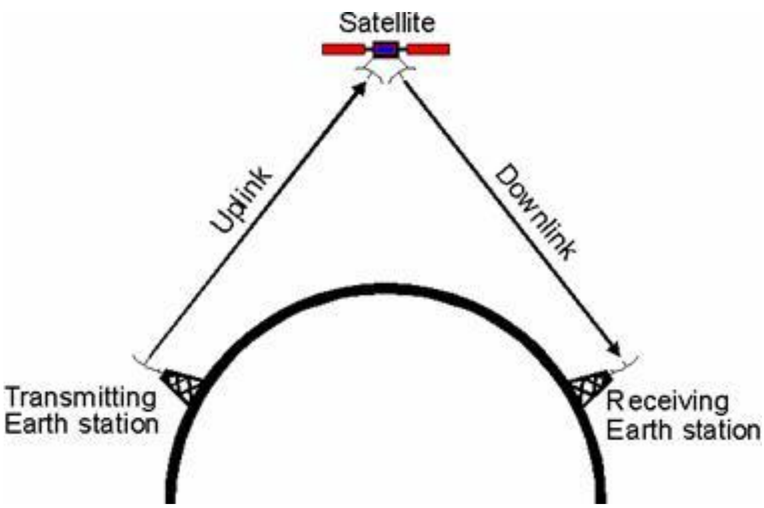
(i) The frequency range of voice of human speech is from 300 Hz to 3100Hz at the maximum end. Hence the bandwidth of 3100-300= 2800 Hz is considered adequate for speech transmission.

(ii) Different musical instruments produce high frequencies covering the entire range of audible frequencies from 20 Hz to 20 KHz. Hence, a bandwidth of about 20 KHz is required.
Video signals require about 4.2 MHz of bandwidth. As TV signals contain both video as well as voice, hence a signal band width of 4.5 MHz is required. But to avoid interference among telecast by different TV stations, a TV channel is usually allotted 6 MHz of bandwidth for transmission.

33. The communication of signal between transmitter and receiver with the help of satellite is called satellite communication.

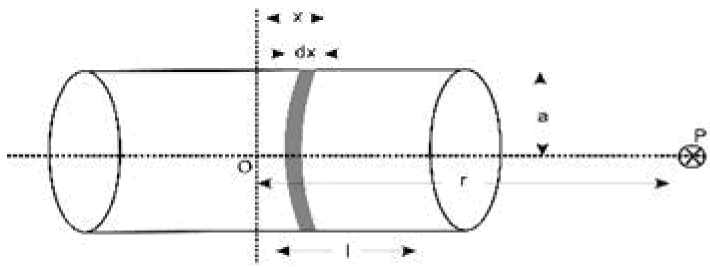
Working: A satellite receives the signals from earth (which is beamed by transmitter), processes the signals and transmits them back to earth. The signal beamed by the satellite is received back on a distant location on earth, from which the original information signal is extracted by the process called demodulation.

The frequency at which satellite receives the signal is called uplink frequency while the frequency at which satellite returns the signal towards earth is called as downlink frequency. The downlink frequency and uplink frequencies are different so that there is no interference between these two signals.



GROUP-E

34. The magnetic field lines for a bar magnet and a solenoid resembles each other. Thus a bar magnet may be considered as a large number of circulating circuits in analogy with a solenoid.
Consider the figure shown below:



The magnitude of the field at point P due to the circular element is,

$$dB = \frac{\mu_0 n dx I a^2}{2[(r-x)^2 + a^2]^{3/2}}$$

The magnitude of total field is obtained by integrating from x = - l to x = +l, thus,

$$B = \frac{\mu_0 n I a^2}{2}\int_{-l}^{+l}\frac{dx}{[(r-x)^2 + a^2]^{3/2}}$$

Considering the far axial field of solenoid i.e. r>> a and >> l, then

$$[(r-x)^2 + a^2]^{3/2} \approx r^3$$

$$\therefore B = \frac{\mu_0 n I a^2}{2r^2}\int_{-l}^{+l} dx$$

$$= \frac{\mu_0 n I a^2 2l}{2r^3}$$

Since magnetic moment of solenoid = n (2l) I (πa^2)

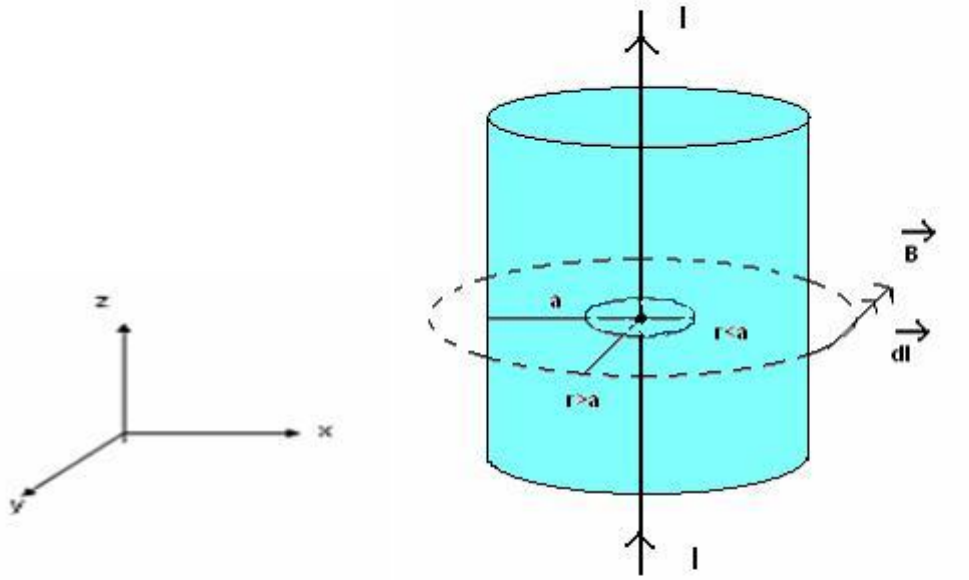
$$\therefore B = \frac{\mu_0 2m}{2\pi r^3}$$

This is also the far axial magnetic field of a bar magnet. Thus, a bar magnet and a solenoid produce similar magnetic field.

Or

Since the current distribution possesses cylindrical symmetry, therefore the magnetic field it generates also possesses cylindrical symmetry. The magnetic field circulates in the x-y plane in an anti-clockwise direction.

Let us first calculate the magnitude of magnetic field outside the wire and apply Ampere's circuital law to a circular Amperian loop in the x-y plane where the loop is centered at the centre of the wire, and is of radius r>a, where "a" is the radius of the cylindrical wire.



As the magnetic field lines form closed circle, so the magnetic field is tangential to the loop everywhere, and is in the same direction as dl taken in the counter clock wise direction. Thus, the angle between the magnetic field and dl is zero everywhere on the loop.

Also, the magnitude of magnetic field is constant. So the situation is same as that for an infinitely thin wire.

From Ampere's law,

$$\oint \vec{B}.d\vec{l} = \oint \frac{\mu_0}{2\pi r} dl = \frac{\mu_0}{2\pi r} \oint dl$$

We have, $B = \frac{\mu_0 I}{2\pi r}$ for r>a.

(Since $\oint dl = 2\pi r$, is the circumference of the circle)

That is, $B \,\alpha\, \frac{1}{r}$

Let us now apply Ampere's circuital law to a circular Amperian loop which is of radius r < a. The current I_e enclosed by the loop of radius r < a is

$$I_e = \frac{I}{\pi a^2} \pi r^2 = \frac{I r^2}{a^2}$$

From Ampere's law,

$$\oint \vec{B}.d\vec{l} = \mu_0 \mu_r I_e$$

$$2\pi r B = \mu_0 \mu_r I_e = \mu_0 \mu_r \frac{Ir^2}{a^2}$$

$$B = \frac{\mu_0 \mu_r Ir}{2\pi a^2}, \text{that is } B \alpha r$$

35. Interference is the phenomena in which the redistribution of light energy in a medium takes place due to superposition of light waves from two coherent sources.

The interference may be of two types:-

1. Constructive interference
2. Destructive interference

We are given with the values,

ΔD = - 5 x 10^{-2} m.

$\Delta \beta$ = - 3 x 10^{-5} m

d = 10^{-3}m

To find out, wavelength (λ) =?

We have the relation,

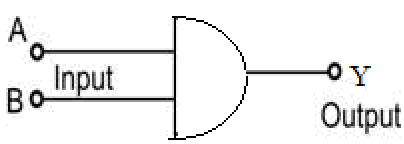
$\Delta \beta = \Delta D. \lambda / d$

Hence wavelength (λ) can be given by

λ = d. $\Delta \beta$/ ΔD = 10^{-3} x (- 3 x 10^{-5}) / (-5 x 10^{-2})

λ = 6 x 10^{-7} m.

36. The logic symbol of AND is shown in fig.

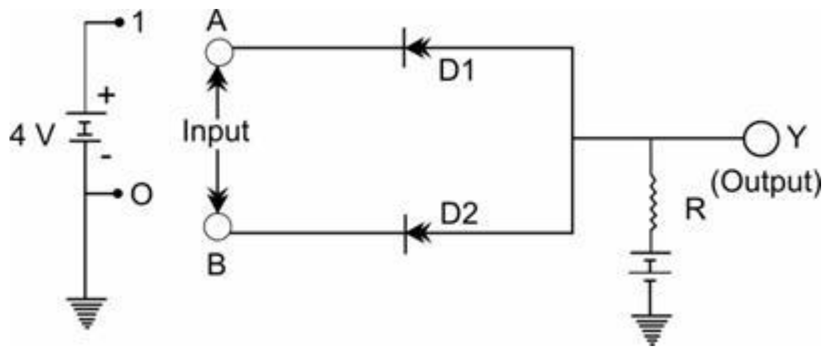


The truth table of AND gate is given below:-

A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1

Realization of an AND gate:

To realize an AND gate having two inputs A and B, we complete the electrical circuit as shown below in fig. using two diodes D_1 and D_2.



Operation:

(i) When A = 0, B = 0, both diodes conduct and offer low(almost zero) resistance. Hence, whole voltage drop is across the resistor R and the net output voltage level at Y will be zero.

(ii) When A = 1, B = 0, diode D_1 does not conduct but D_2 conducts and provides a low resistive path. As a result, output voltage level at Y is still zero.

(iii) When A = 0, B = 1, diode D_1 conducts and provides a low resistance path but D_2 does not conduct. Output voltage level at Y is even now zero.

(iv) When A = B = 1, none of the two diodes conduct and there would be no drop in voltage across resistance R. Hence, voltage of Y will be 4V i.e., Y will be at voltage level 1.

Thus, output level is 1 only when both inputs A and B are at 1 level, which is the condition of AND gate.