DELHI PUBLIC SCHOOL

CLASS XII PHYSICS ANSWER KEY

1. Phosphor bronze alloy has small restoring torque per unit twist and a high tensile strength.
2. Weber , Tesla
3. Self inductance is the phenomenon of induction of emf in a single isolated coil due to change of flux through the coil by the means of varying current through the same coil.
4. γ Rays.
5. $\sin i_c = 1 / \mu = 1 / \sqrt{2}$ or $i_c = 45^0$
6. 24.6 eV
7. Pentavalent impurity such as arsenic, antimony or phosphorous.
8. Voltage regulator.
9. It is based on discharging action of points and collecting action of hollow conductors.

   It can be used to accelerate charged particles like α , proton , deuteron etc

10. Resistivity of copper is low.

    Temperature coefficient of resistance is large.
11. During recharging the voltage Ir across the internal resistance and the emf are in the same direction and so they get added up to give terminal voltage.
12. Direction of motion of electron same as that of magnetic field ➔ Force = zero
13. $\lambda_a / \lambda_g = \nu \lambda_a / \nu \lambda_g = v_a / v_g = {}_a n_g$

    [note that frequency of light will not change]
14. Freq $_v$ >Freq $_r$ hence Violet photon is more energetic.
15. E = 66.3 e V

    $E = h \nu$

    $66.3 \text{ e V} = 6.63 \times 10^{-34} \nu$

$\nu = 66.3 \times 1.6 \times 10^{-19} / 6.63 \times 10^{-34}$

$\nu = 1.6 \times 10^{16}$ Hz

16. Whole of the positive charge of the atom is concentrated in a tiny central core in the atom.

17. The degree to which the carrier wave is modulated is called modulation index.

The modulation index determines the strength and quality of the transmitted signal. When Modulation index is high the reception will be strong and clear.

18. A transformer works on a A.C supply .Therefore during its operation, the iron core of a transformer is taken over the complete cycle of magnetization and demagnetization again and again .In taking the core over a complete cycle of magnetization, the energy spent per unit volume of the core is equal to area of the hysteresis loop. Therefore, to minimize the loss of energy, the core of the transformer is made of a material whose hysteresis loop is narrow.

19. Suppose that the charges q_1, q_2, q_3, q_4 ,............... are placed at distances r_1, r_2, r_3, r_4, …….. from the origin .Then ,potential at the origin (x=0) due to system of charges ,

$V = k [q_1/r_1 + q_2/r_2 + q_3/r_3 + q_4/r_4 \ldots]$

(a) $q_1 = q_2 = q_3 = q_4 \ldots\ldots = q$

$r_1 = 1, r_2 = 2, r_3 = 4, r_4 = 8, \ldots$

$V = k [q/1 + q/2 + q/4 + q/8 + \ldots]$

$= k q [1/1 + 1/2 + 1/4 + 1/8 + \ldots]$

$= kq S_\infty$

Where $S_\infty = [1/1 + 1/2 + 1/4 + 1/8 + \ldots]$

$S_\infty = [a / 1 - r] = [1 / (1 - ½)] = 2$

$V = 2kq$

(b) When the consecutive charges have opposite sign

$V = k [q/1 - q/2 + q/4 - q/8 + \ldots]$

$V = k [1/1 - 1/2 + 1/4 - 1/8 + \ldots\ldots]$

$= k q / [1 - (-1/2)] = q / 6 \pi \varepsilon_0$

21. Equivalent Emf = 1.45 + 1.45 V = 2.90 V

Equivalent internal resistance (r) = 0.30 ohm

Resistance of lamp (R) = 1.5 ohm

Net resistance of circuit = (r + R) = 1.80 ohm

V = I (r + R)

2.90 = I (1.80)

I = 1.61 Ampere

Current through the filament of the lamp = 1.61 ampere

22. P = 55 W

V = 110 V

➔ $P = V^2 / R$

➔ R = [110 X 110] / 55

R = 220

55 = 110 I

I = 55 / 110

I = 0.5 amp

f = 50 Hz

L = ?

When lamp is run on 220 V ac

Suppose that the choke coil of inductance L is connected in series to the lamp , so that the current of 0.5 A (equal to its current rating) flows through yhe lamp.

Now , $I_v = E_V / \sqrt{R^2 + (2 \pi f L)^2}$

$0.5 = 220 / \sqrt{220^2 + (2 \pi 50 L)^2}$

$$0.5 \text{ X } 0.5 = \frac{220 \text{ X } 220}{220^2 + (2 \pi 50 L)^2}$$

$0.5 [\sqrt{220^2 + (2 \pi 50 L)^2}] = 220$

$220^2 + (2 \pi 50 L)^2 = 440^2$

$(440 – 220)(440 + 220) = (100 \pi L)^2$

$220 \text{ X } 660 \text{ X } 7 \text{ X } 7 / 100\,00 \text{ X } 22 \text{ X } 22 = L^2$

$L = 0.7 \sqrt{3}$ Henry

23. We know that voltage $v = v_m \text{Sin } \omega t$ applied to an L C R circuit derives a current in the Circuit given by $i = i_m \text{ Sin } (\omega t + \Phi)$

where $i_m = v_m / Z$

and $\Phi = \tan^{-1} [(X_c – X_l) / R]$

therefore instantaneous power supplied by the source is

$p = v\, t = (v_m \text{ Sin } \omega t) [i_m \text{ Sin } (\omega t + \Phi)]$

$$= \frac{v_m \; i_m}{2} [\text{Cos } \Phi – \text{Cos } (2\omega t + \Phi)]$$

Average power over a cycle is given by the average of the 2 terms inR.H.S

Its average is zero (the positive half of cosine cancels the negative half)

$$P = \frac{v_m \; i_m}{2} \text{Cos } \Phi = \frac{v_m \; i_m}{\sqrt{2} \;\; \sqrt{2}} \text{Cos } \Phi$$

$P = V\, I \text{ Cos } \Phi$

This can also be written as

$P = I^2 Z \cos \Phi$

So the Average power dissipated depends not only on the voltage and current but also on the Cosine of the phase angle Φ between them. The quantity Cos Φ is called power factor.

24. f = 25 cm

Let $R_1 = y$

$R_2 = 2y$

Given μ = 1.5

We know that $\frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

$0.04 = 0.5\left[\frac{1}{y} - \frac{1}{-2y}\right]$

$0.08 = \frac{3}{2y}$

➔ $y = 3 / 0.16$

➔ $R_1 = y = 18.75$ cm

➔ $R_2 = 2y = 37.5$ cm

25. $A = 5^0$, $\delta = 3.2^0$

$\mu = \sin\left[\frac{A + \delta}{2}\right] / \sin [A / 2]$

$\mu = \sin\left[\frac{5^0 + 3.2^0}{2}\right] / \sin [5^0 / 2]$

$\mu = 4.1 / 2.5$

$\mu = 1.64$

26. Decay constant is 2.1×10^{-6} / s .

Initial decay rate is 5.6×10^{-10} / s ,

Initial decay rate = λN_0

$5.6 \times 10^{-10} = 2.1 \times 10^{-6} N_0$

$N_0 = 2.67 \times 10^{16}$

Activity at any time t is proportional to the no of atoms present at time t

Therefore $N = N_0 / 4$

Now $N_0 / 4 = N_0 e^{-\lambda t}$ or $e^{\lambda t} = 4$

$\lambda t = \log_e 4 = 2 \log_e 2 = 2 \times 0.693$

$t = 2 \times 0.693 / \lambda$

$t = 6.6 \times 10^{5}$ sec

27. Refer book for diagram of amplitude modulator.

28. Cyclotron is used for accelerating charged particles. Its length has to be very large ,if the charged particles are to be accelerated to a very high energy.

CONSTRUCTION – It consists of two D shaped hollow semiconductor metal chamber D_1 and D_2 called dees .The two dees are placed horizontally with a small gap separating them .The dees are connected to the source of high frequency electric field.The dees are enclosed in a metal box contaning a gas at low pressure of the order of 10^{-3} mm of mercury. The whole apparatus is placed between the two poles of a strong electromagnet .The magnetic field act perpendicular to the plane of the dees. The positive ions are produced in the gap between the two dees by the ionization of the gas .

THEORY : - Consider that a positive ion is produced at the centre of the gap at the time, when the dee D_1 is at positive potential and the dee D_2 is at negative potential .The positive ion will move from dee D_1 to dee D_2 .As the magnetic field acts normally to the motion of the positive ion, the positive ion experiences force .The force on the positive ion due to magnetic field provides the centripetal force to the positive ion and it is deflected along a circular path .If B is strength of magnetic field and m , v, q are the mass ,velocity and charge of the positive ion respectively then

$B\,q\,v = mv^2/r$ → I

r = radius of semi circular path along which the particle moves.After moving along the semicircular path along the dee D_2 the positive ion reaches the gap between the two dees.At this stage the polarity of the dees just reverses due to alternating electric field ie dee D_1 becomes negative and dee D_2 becomes positive .The positive ion gains energy , as it is attracted by the dee D_1.After moving along the semicircular path inside the dee D_1, the positive ion again reaches the gap and it again gains the energy.The process repeats itself time and again. The positive ion spends the same time inside a dee irrespective of its velocity or the radius of circular path .

Time to cover semicircular path = $t = \pi r/ v$

Using eq I

$t= \pi m / B q$

This time is exactly half the time period of oscillaton of Electric field

→ $T/ 2 = \pi m / B q$

$T = 2 \pi m / B q$

→ $\omega = B q / m$

Cyclotron frequency = $1 / T = Bq / 2\pi m$

LIMITATIONS

1. When a charge is accelerated its mass also starts increasing with increase in its speed. when the speed becomes comparable to yhat of light the mass of the charged particle becomes quite large as compared to its rest mass

   and as v increases t also increases and the particle takes more and more time to complete the path inside the dees.

2. Cyclotron is used to accelerate heavy charged particles and is not suitable for accelerating electrons.As due to small mass the speed of electron increases rapidly.

OR

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1 MeV = 1.6×10^{-13} J

m= 1.67×10^{-27} kg .

e = 1.6×10^{-19} C .

f = 10 MHz = 10^{7} H z

R = 60 cm = 0.60 m

$f = 1/T = Be / 2\pi m$

On substituting the values we get

$f = 0.656$ T

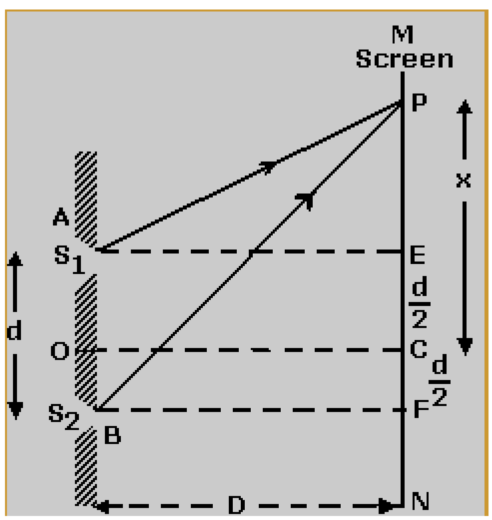
$E_{max} = B^2 e^2 R^2 / 2m$

$= 11.874 \times 10^{-13}$ J

$= 11.874 \times 10^{-13} / 1.6 \times 10^{-13}$

$= 7.421$ MeV

29. Expression for fringe width using Young's double slit method for interference of light.



Consider that two coherent sources of light S_1 and S_2 are placed at a distance d apart and a screen is placed at a distance D from the plane of the two sources .Let P be a point on the screen at a distance x from the centre of the screen .If y is the path difference between the light waves reaching point P from the source S_1 and S_2, then

$y = S_2P - S_1P$

In right angled triangle $\Delta S_2 F P$ we have

$S_2P^2 = S_2 F^2 + FP^2 = D^2 + (x + d/2)^2$

In right angled triangle $\Delta S_1 A P$ we have

$S_1P^2 = S_1 E^2 + EP^2 = D^2 + (x - d/2)^2$

$S_2P^2 - S_1P^2 = [D^2 + (x + d/2)^2][D^2 + (x - d/2)^2]$

or

$(S_2P - S_1P)(S_2P + S_1P) = (x + d/2)^2 - (x - d/2)^2$

But $S_2P - S_1P = y$

➔ $(S_2P + S_1P)\, y = 4\, x\, d / 2 = 2x\, d$

Or $y = 2xd / [S_2P + S_1P]$

$S_2P \approx S_1P \approx D$

Hence , $y = 2x\, d / 2\, D$

Or $y = x\, d / D$

Position of maxima and minima on screen

If $x\, d / D = n \lambda$ we will get bright fringe

➔ $x = n \lambda D / d$

$x_1 = \lambda D / d$

$x_2 = 2 \lambda D / d$

$x_3 = 3 \lambda D / d$

$x_n = n \lambda D / d$

If $x\, d / D = (2n + 1) \lambda / 2$ we will get dark fringe

→ $x = (2n + 1) D \lambda / 2d$

$x_{1'} = \lambda D / 2d$

$x_{2'} = 3 \lambda D / 2d$

$x_{3'} = 5 \lambda D / 2d$

$x_{n'} = (2n + 1) \lambda D / 2d$

Fringe width = The spacing between two consecutive bright fringes = $x_n - x_{n-1} = D \lambda / d$

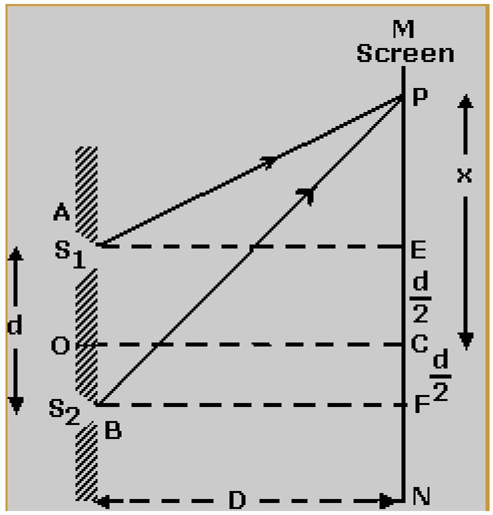
= spacing between two consecutive dark fringes = $x_{n'} - x_{n-1'} = D \lambda / d$

$\beta = D \lambda / d$

On immersing the apparatus in liquid the wavelength of light decreases [$\lambda' = \lambda / \mu$]

hence β that is fringe width will decrease.

OR



A source of monochromatic light S illuminates two narrow slits S_1 and S_2 .The two slits act as coherent sources.

$y_1 = a_1 \text{ Sin } \omega t$

$y_2 = a_2 \text{ Sin } (\omega t + \Phi)$

where Φ is the constant phase difference between the two waves. The resultant displacement will be given by the superposition principle

$y = y_1 + y_2$

$= a_1 \text{ Sin } \omega t + a_2 \text{ Sin } (\omega t + \Phi)$

$= (a_1 + a_2 \text{ Cos } \Phi) \text{Sin } \omega t + a_2 \text{ Sin } \Phi \text{ Cos } \omega t$

Let $(a_1 + a_2 \text{ Cos } \Phi) = A \text{ Cos } \theta$ and $a_2 \text{ Sin } \Phi = A \text{ Sin } \theta$

$y = A \text{ Cos } \theta \text{ Sin } \omega t + A \text{ Sin } \theta \text{ Cos } \omega t$

$= A \text{ Sin } (\omega t + \theta)$

Hence resultant displacement at point P is simple harmonic wave having amplitude A and phase difference θ with harmonic wave from source S_1

$A^2 \cos^2 \theta + A^2 \sin^2 \theta = (a_1 + a_2 \cos \Phi)^2 + a_2^2 \sin^2 \Phi$

$A^2 = a_1^2 + a_2^2 (\cos^2 \Phi + \sin^2 \Phi) + 2 a_1 a_2 \cos \Phi$

$A^2 = a_1^2 + a_2^2 + 2 a_1 a_2 \cos \Phi$

Intensity of light is proportional to square of amplitude of wave

$I = a_1^2 + a_2^2 + 2 a_1 a_2 \cos \Phi$

Constructive interference will be when Cos Φ will be + 1

$\Phi = 0 , 2\pi , 4\pi , 6\pi \ldots\ldots$

$\Phi = 2n\pi$

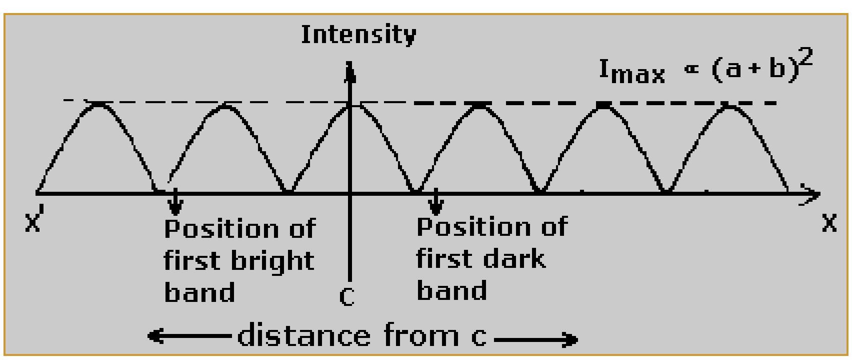
➔ Path difference = $n\lambda$

Destructive interference will be when Cos Φ will be – 1

$\Phi = \pi , 3\pi , 5\pi \ldots\ldots$

$\Phi = (2n + 1) \pi$

. ➔ Path difference = $(2n + 1) \lambda / 2$



30. For labelled circuit diagram of n-p-n transistor being used as a switch and the curve for Transfer characteristic refer text book.

OR

30. Oscillator is the circuit in which a part of output is fed as input to the same circuit.

For labelled circuit diagram of n-p-n transistor being used as an Oscillator refer textbook.