PHYSICS

BOOKS - NAVBODH PHYSICS (HINGLISH)

SOLVED PROBLEMS-II

Wave Theory Of Light

1. The refractive indices of a diamond and water are 2.4 and $4/3$, respectively. What is

the refractive index of diamond relative to water?

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2. The refractive indices of a certain liquid for red violet colours are 1.325 and 1.333, respectively. Find the difference between the speeds of the rays of these two colours in the liquid.

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3. If the wavelength of a monochromatic beam of light in air is 5000 $\mathring{A}$, what is its wave number in SI units in glass of refractive index 1.5?

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4. The wavelength of a beam of light in air is $5000\mathring{A}$. Find the number of waves of the beam in 10 cm of glass of refractive index 1.5 k

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5. The wave number of a beam of light in air is $5 \times 10^6 m^{-1}$. If the velocity of light in air is $3 \times 10^8 m/s$, find the frequency of the light.

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6. Determine the change in wavelength of light during its passage from air to glass, if the refractive index of glass with respect to air is 1.5 and the frequency of light is 3.5×10^{14} Hz.

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7. The width of a plane incident wavefront is found to be doubled on refractive in a denser medium. If it makes an anlge of $69Å$ with the normal, calculate the refractive index of the denser medium.

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8. For a glass plate (refractive inddex, 1.6) as a polarier, what is the angle of incidence at

which reflected light will be completely polarised?

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9. The wavelength of a certain light in air and in glass are 6400Å and 400Å, respectively, find the Brewster angle for the glass.

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10. The critical angle of a certain medium is $\sin^{-1}\left(\frac{3}{5}\right)$. The polarizing angle of the medium is :

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Interference And Diffraction

1. Prove that the vectors $\vec{A} = 8\hat{i} + 9\hat{j} + 7\hat{k}$ and $\vec{B} = 24\hat{i} + 27\hat{j} + 21\hat{k}$ are parallel to each other.

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2. If the amplitude ratio of two interfering choherent waves producing an interference pattern is 0.5, what is the ratio of the minimum intensity to maximum intensity?

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3. Two slits in Young's experiment have widths in the ratio $8100:7255$. What is the ratio of

the amplitude of light waves issuing out from them?

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4. At a point in an interference pattern, the two interfering coherent waves of equal intensity I_0 have phase difference 60°. What will be the resultant intensity at that point?

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5. Find the ratio of intensities at the two points X and Y on a screen in Young's double slit experiment, where waves from the two source S_1 and S_2 have path difference of zero, and $\lambda/4$ respectively.

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6. Two monochromatic light waves of equal intensities produce an interference pattern. At a point in the pattern, the phase difference

between the interfering waves is $\pi/2$ rad. Express the intensity at this point as a fraction of the maximum intensity in the pattern.

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7. At a point on the two-slit interference pattern obtained using a source of light of wavelength 6000Å, the path difference is $4.2\mu m$. Is the point bright or dark?

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8. In Young's double-slit experiment using light of wavelength 5000Å, what phase difference corresponds to the 11th dark fringe from the center of the interference pattern?

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9. In Young's experiment, the wavelength of monochromatic light used in 6000Å. The optical path difference between the rays from the two coherent sources are 0.0075 mm and $0.0015mm$ at points P and Q, respectively, on

the screen and on opposite sides of the central bright band. How many bright and dark bands are observed between points P and Q?

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10. In Young's double-slit experiment , the slits are 0.5 mm apart and interference is observed on a screen placed at 1.0 m from the slits. It is found that the 9th bright fringe is at 8.835 mm from the 2nd dark fringe on the same side

of the interference pattern. Find the wavelength of light used.

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11. In Young's double-slit experiment, the fringe pattern shifts by a distance x_0 when a mica sheet, $1.964\mu m$ thich and of refractive index 1.6, covers one of the slits. If the mica sheet is removed and the slite-to-screen distance doubled, the new fringe width is equal to x_0. Find the wavelength of light used.

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12. In a biprism experiment, the fringe width is $1.4mm$ with light of wavelength 6000Å. What will be the fringe width if light of wavelength 5400Å is used, with no other change in the experimental setup?

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13. In a biprism experiment, the fringe width is 1.5mm when the eyepiece is $1.2m$ from the

salt. What will be the fringe width if the eyepiece is moved towards the slit by 0.2m, with no other change in the experimental setup?

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14. In a briprism experiment, if the separation between the magnified images of the slit is 4.5 mm and that between the diminished images of the slit is 2mm, What is the distance between the coherent virtual sources?

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15. As observed from the top of a 100 m high light house from the sea level, the angles of depression of two ships are 30° and 45° If one ship is exactly behind the other one on the same side of the light house, find the distance between the two ships.

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16. In a biprism experiment, the distance between the first and eleventh bright fringes formed by light of wavelength λ is 1.8×10^{-3} m. If the light is replaced by one width wavelength 0.8λ, find the distance between the first and sixteenth bright fringes.

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17. In a biprism experiment, when a convex lens is placed between the biprism and eyepiece at

a distance of 30 cm from the slit, the virtual images of the slits are 7mm apart. If the distance between the slit eyepiece is 90 cm, find the linear magnification of the image.

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18. In a biprism experiment, the distance between two coherent sources is 0.5 mm and that between the slit and eyepiece is 1.2m. The slit is successively illuminated by red light of wavelength 6550Å and green light of

wavelength 5240Å. It is found that the nth red bright band coincides with the (n+1)th green bright band. Calcualte the distance of this band from the central bright band.

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19. The semi vertical angle of the cone of the rays of light incident on the objective of a microscope is 20°. If the wavelength of incident light is 6000Å, calculate the smallest

distance between two points which can be just resolved.

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20. An oil-immersion objectives of a microscope uses oil of refractive index 1.414. The wavelength of illuminating light is 4850Å and the semivertical angle is 45°. Find the limit of resolution and the resolving power of the microscope.

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21. What is the resolving power of a telescope if the diameter of the objective of the telescope is 1.22 m and the wavelength of light is 5000Å ?

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Electrostatics

1. Two metal spher4s having charge densities 5 $\mu C/m^2$ and $-2\mu C/m^2$ with radii 2 mm and 1

mm respectivly are kept in a hypothetical closed surface. Calculate total normal electric induction over the closed surface.

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2. The electric field intensity just outside a long charged metal cylinder in air is $100V/m$. What is the surface density of the cylinder?

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3. A thin metal plate of length 25 cm and breadth 4 cm in air carries a charge of $10\mu C$. Calculate the outward pull on one side of the plate.

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4. A cube of marble having each side 1 cm is kept in an electric field of intensity 300 V/m. Determine the energy contained in the cube of

dielectric constant 8.

[Given : $\varepsilon_0 = 8.85 \times 10^{-12} C^2 / Nm^2$]

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5. A parallel-plate air capacitor has rectangular plates each of size $40cm \times 10cm$, separated by 1mm, if a charge of 10^{-10} C is given to the capacitor calcualte the potential difference and electric field between the plates.

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6. A parallel-plate air capacitor has a capacitance of $4\mu F$. What will be its new capacitance if (i) the distance between the plates is redced to half the initial distance (ii) a slab of dielectric constant 5 is introduced filling the entire space between the two plates?

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7. A $2\mu F$ capacitor is connected to a 10 V battery. What is the electrostatic energy

stored in the capacitor?

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8. The electrostatic energy of 4×10^{-6} J is stored in a capacitor at 100 V. What is the charge on the capacitor?

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9. A parallel-plate air capacitor of plate separation 2mm and capacitance $1\mu F$ is

charged to 100V. A dielectric slab of relative permittivity 50 is now inserted so as to fill the space between the plates. (i)Find the polarisation charge on one of the boundaries of the dielectric slab. (ii) Find the magnitude of the polarisation of the dielectric slab. $\left(\varepsilon_0 = 8.85 \times 10^{-12} C^2 / N.m^2\right)$

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10. The equivalent capacitance of n identical capacitors in series is C_1. What will be the

equivalent capacitance of their parallel combination?

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11. Three capacitors of capacities $8\mu F, 8\mu F$ and $4\mu F$ are connected in a series and a potential difference of 120 volt is maintained across the combination. Calculate the charge on capacitor of capacity $4\mu F$.

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12. Six capacitors of capacities $10\mu F, 10\mu F, 10\mu F, 10\mu F, 20\mu F$ and $X\mu F$ are connected in a network as shown below. If the network is balanced, find X and the resultant capacitance between A and C.

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Current Electricity

1. What is the length of a wire of radius 0.2 mm and resitance 25Ω? The restivity of the

material of the wire is $2\pi \times 10^{-8}\Omega . m.$

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2. A cell of emf 2V and internal resistance 4Ω is connected across a parallel combination of two resistors of resistance 10Ω and 20Ω. Find the current through each resistor using Kirchhoff's laws.

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3. Four resistances 5Ω, 5Ω, 8Ω and 10Ω form a Wheatstone network. Find the resistance whch connected across the 10Ω resistance will balance the network.

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4. Two diametrically opposite points of a metal ring are connected to two terminals of the left gap of a metre bridge. A resistance of 22Ω is connected in the right gap. If the null point is

obtained at 45 cm from the left end, find the resistance of the metal ring.

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5. A uniform wire is cut into two pieces such that one piece is twice as long as the other. The two pieces are connected in parallel in the left gap of a metre bridge. When a resistance of 20Ω is connected in the right gap, the null pooint is obtained at 60 cm from the right end

of the bridge wire. Find the resistance of the wire before it was cut into two pieces.

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6. With an unknown resistance X in the left gap and a resistance R in the right gap of a meter bridge, the neutral point is obtained at a distance of 75cm from the left end. The shift of null point if the unknown resistance is shunted by an equal resistance X and keeping same resistance in right gap is

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7. A voltmeter has a resistance of 1000Ω. What will be its reading when it is connected across a cell of emf 2V and internal resistance 10Ω ?

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8. A potentiometer wire, 4 m long and resistance 10Ω, is connected in series with a resistance of 1988 Ω and a cell of emf 2V and

internal resistance 2Ω. What is the potential gradient along the wire?

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9. A potentiometer wire has resistance of per unit length of $0.1\Omega/m$. A cell of e.m.f. $1.5V$ balances against $300cm$ length of the wire. Find the current in the potentiometer wire.

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10. A potentiometer wire, 4 m long and resistance 10Ω, is connected in series with a resistance of 1988 Ω and a cell of emf 2V and internal resistance 2Ω. What is the potential gradient along the wire?

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11. The resistance of a 10 m long potentiometer wire is 10Ω. If the current through it is 0.4 A, what are the balancing

lenghts when two cells of emfs $1.3V$ and $1.1V$ are connected so as to (i) assist (ii) oppose each other?

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Magnetic Effect Of Electric Current

1. The magnetic induction at 0.1 m from a very long straight wire carrying a current of 5A is $10^{-6}Wb/m^2$. What will be the magnetic

induction at 0.2 m from the wire if the current through it is increased to 20 A?

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2. The strength of the magnetic field in a long solenoid having 5000 turns per meter is $3.14X10^{-2}T$. The current flowing through the solenoid is

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3. A solenoid $3 \cdot 142$ m long and $5 \cdot 0$ cm in diameter has two layers of windings of 500 turns each and carries a current of 5A. Calculate the magnetic induction at its centre along the axis.

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4. A circular coil of 300 turns and average area $5 \times 10^{-3} m^2$ carries a current of 15 A.

Calculater the magnitude of magnetic moment associated with coil.

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5. The rectangular coil is moving-coil galvanometer has 100 turns, each of length 5 cm and breadth 3 cm, and is suspended in a radial magnetic field of intuction $0.05 Wb/m^2$. The twist constant of the suspension fibre is 2×10^{-9} N.m/degree. Calculate the deflecting

torque and the current through the coil which will deflect it through 30°.

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6. A rectangular coil of a moving coil galvanometer contains 100 turns, each having area $15cm^2$. It is suspended in the radial magnetic field 0.03 T. The twist constant of suspension fibre is 15×10^{-10} N-m/degree. Calculate the sensitivity of the moving coil galvanometer.

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7. The combined resistance of a galvanometer of resistance 500Ω and its shunt is 21Ω Calculated the value of shunt.

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8. Draw a schematic diagram of circuit consisting of a battery of 3 cells of 2V each, combination of three resistors $10ohm$, $20ohm$ and $30ohm$ connected in parallel, a plug key

and an ammeter,all connected in series. Use this circuit to find the following

(i) Current through each resistor.

(ii) Total current in circuit

(iii)Total Effective resistance of circuit

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9. Two moving-coil galvanometer, P and Q, are alike in all respects except that P's coil has 10 turns of resistance 2Ω and Q's coil has 100

turns of resistance 30Ω. Compare their (i) current sensitivities (ii) Voltage sensitivities.

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10. A galvanometer of resistance 16Ωshows a full scale deflection for a curent of 20 mA. The only shunt resistance that is available is 0.06Ω but it is not sufficient into an ammeter having a range of 8A. How much resistance should be connected in series with the galavanometer to get the ammeter of the desired range?

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11. A moving-coil galvanometer of resistance 200 ohms gives full scale deflection of 100 divisons for a current of 50 milliamperes. How will you convert it into an ammeter to read 2 amperes for 20 divisons?

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12. Calculate the value of the of resistance needed to convert a moving-coil galvanometer

of 60Ω which gives a full scale deflection for a current of 50 mA into a voltmeter of range $0 - 50$V.

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13. In a cyclotron, a magnetic filed of $3.5Wb/m^2$ is used to accelerate protons. What should be the time interval in which the electric field between the dees should be reversed? [Mass of the proton

$= 1.67 \times 10^{-27} kg$, charge on the proton $= 1.6 \times 10^{-19}$C]

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Magnetism

1. The magnetic flux near the axis inside a current-carrying air-core solenoid is $\frac{\pi}{3} \times 10^{-6}$ Wb. What is its magnetic moment if the length of the solenoid is 60 cm? [Assume

the length to be large compared with the cross section of the solenoid]

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2. A current-carrying coil of magnetic moment $\vec{M}$ is placed in a uniform magnetic field of induction $\vec{B}$ such that the angle between $\vec{M}$ and $\vec{B}$ is 30°. If $M = 5A.m^2$ and $B = 0.2Wb/m^2$, what is the torque acting on the coil?

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3. The electron in a hydrogen atom revolves in an orbit of radius 0.5Å, constituting a conventional current of 1.1 mA. Calculate the magnetic induction at an axial point 100 Å from the nucleus of the atom.

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4. The revolution of the electron in the first Bohr orbit of a hydrogen atom constitutes a current loop of area $8.8 \times 10^{-21} m^2$. If the

frequency of revolution is 6.6×10^{15} Hz, calculate the equivalent magnetic moment and the orbital angular momentum. $\left[y_0 = 8.975 \times 10^{10} C / kg\right]$

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5. A protonperforms UCM of radius 50 cm. If the speed fo the proton is 2×10^6 m/s, find the corresponding orbital magnetic moment.

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6. The charge to mass of an electron is 1.76×10^{11} C/Kg what is the gyromagnetic ratio of an orbital electron

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7. A bar magnetic made of steel has a magnetic moment of $2 \cdot 5Am^2$ and a mass of $6 \cdot 6g$. If density of stell is $7 \cdot 9 \times 10^{-3} kg/m^3$, what is the intensity of magnetisation?

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8. The susceptibility of annealed iron at saturation is 5500. Find the permeability of annealed iron at saturation.

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9. The magnetic field B and the magnetic intensity H in a material are found to be $1.6T$ and $1000Am^{-1}$ respectively. Calculate the relative permeability μ, and the susceptibility χ of the material.

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10. An ideal solenoid has a core of relative permeability 500 and its winding has 1000 turns per metre. If a steady current of 1.5 A is passed through its winding, find (i) the magnetization M_z (ii) the magnetic induction B within the solenoid. Assume that M_z is directly proportional to H and single valued.

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11. A toroid of mean radius 16 cm has 1000 turns of wire closely wound on a ferromagnetic core of relative permeability 400. What is the magnetic induction B within the core for a magnetizing current of 1A?

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12. Find the percent increase in the magnetic field B when the space within a current-

carrying toroid is filled with aluminium. The susceptibility of aluminium is 2.1×10^{-5}.

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Electromagnetic Induction

1. A coil of effective area $0.45m^2$ is placed in a field-free region. Subsequently, a uniform magnetic field that increases uniformly from zero to 1.25 T in 015 s is applied perpendicular

to the plane of the coil. What is the magnitude of the emf inducted in the coil?

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2. The magnetic flux through a loop is varying according to relation $\phi = 6t^2 + 7t + 1$ where ϕ is in milliweber and t is in second. What is the e.m.f. induced in the loop at t = 2 second ?

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3. A straight copper wire of length $0.45m$ is perpendicular to a uniform magnetic field of induction 0.7 T. It is moved at right angles to its length at a speed of 2m/s. (i) Find the induced emf between the ends of the wire. (ii) If the ends of are joined by completing a circuit through a 4-ohm resistor, at what rate must be work be done to keep the wire moving at the constant speed of 2m/s ?

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4. The wing span of an aeroplane is 40m. The plane is flying horizontally due north at 360 km/h. What is the potential difference developed between the wing-tips if the horizontla component of the Earth's magnetic field $B_h = 3.2 \times 10^{-5}$T and the angle of dip at the place is 60° ?

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5. A cycle wheel with 10 spoken, each of the length 0.5m, is moved at a speed of

$18km/hour$, in a plane normal to the earth's magnetic induction of $3.6 \times 10^{-5}T$. What is the emf induced between the axle and the rim of the cycle wheel?

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6. The current through a coil of inductance 5 mH is reversed from 5A to $-5A$ in 0.01 s. What is the maximum self-induced emf in the coil?

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7. A current of 0.5 A in the primary coil of a transfomer is reduced to zero at a uniform rate in 0.1 second. If the coefficient of mutual inductance is 3H, what is the emf induced in the secondary coil and charge in the magnetic flux per turn in the secondary coil if it has 50 turns?

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8. if the threshold wavelength for the given metal is 4×10^{-7}m ,What is the photoelectric

work function for a metal ?

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9. A coil of 150 turns, each of area $50cm^2$, is rotating in a magnetic field of 0.15 T with a constant frequency of 20 rotations per second about an axis in the plane of the coil and normal to the field. Calculate the peak emf, rms emf and the instantaneous emf induced in the coil.

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10. A 25 W lamp is connected to an ac source of peak emf 100 V. Compute the rms current in the lamp.

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11. When 100 V dc is applied across a coil, a current of 1A flows through it and when 100 V ac of 50 Hz is applied to the same coil, only 0.5 flows

The resistance is

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12. An an circuit consists of an inductor of inductance 10 mH connected in parallel with a capacitor of capacity 50 pF. Determine the resonant frequency.

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13. A coil of resistance 5Ω and self-inductance 4H is connected in series with a variable

capacitor across a 10 $V_{\mathrm{rms}}, 50$ Hz supply. At what capactiance will resonance occur? Find the corresponding current.

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Electrons And Photons

1. What is the energy of a photon (quantum of radiation) of frequency 6×10^{14} Hz?

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2. If the total energy of radiation of frequency $10^{14}Hz$ is $6.63J$, calculate the number of photons in the radiation.

(Planck's constant $= 6.63 \times 10^{-34} J - s$).

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3. If in a photoelectric experiment, the stopping potential is 1.5 volts, what is the maximum kinetic energy of a photoelectrons?

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4. What is the photoelectric work function for a metal if the threshold wavelength for the metal is 3.315×10^{-7}m ?

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5. The threshold wavelenght of silver is 3800Å . Calculate the maximum kinetic energy in eV of photoelelctrons emitted, when ultraviolet light of wavelegth 2600Å falls on it. (Planck's

constant, $h = 6 \cdot 63 \times 10^{-34} \mathrm{Js}$, . Velocity of light in air, $c = 3 \times 10^{8} m / s$)

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6. The work functions for potassium and caesium are 2.25 eV and 2.14eV respectively. Will the photoelectric effect occur for either of these elements with incident light of wavelength $5650 Å$?

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7. The work function of tungsten is $4.50eV$. Calculate the speed of the fastest electron ejected from tungsten surface when electromagnetic radiation of energy 6 eV is incident on the surface.

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8. Light of wavelength 3000 Å falls on a metal surface having work function 2.3 eV. Calculate the maximum velocity of ejected electrons.

(Planck's constant , $h = 6.63 \times 10^{-34}$ J.s. ,

velocity of light $c = 3 \times 10^8 m/s$, mass of an electron = 9.1×10^{-31} kg)

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9. Find the wave number of a photon having an energy of 2.072 eV.

Given :

Charge on electron $= 1.6 \times 10^{-19} C$

Velocity of light air $= 3 \times 10^8 \ \mathrm{m/s}$

Planck's constant $= 6.63 \times 10^{-34}$ J-s.

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10. The photoelctric effect work function for a metal is 4.2 eV. If the stopping potential is 3V, find the threshold wavelength and the maximum kinetic energy of emitted electrons.

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11. Find the momentum and frequency of a photon of energy $2.4eV$.

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12. When a surface is irradiated with light of wavelength 4950Å, a photocurrent appears which vanishes if a retarding potential greater than 0.6 volt is applied across the phototube. When a second source of light is used, it is found that the critical potential is changed to 1.1 volt.

The work- function of the emitting surface is i

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1. What is the angulr momentum of the electron in the fourth Bohr orbit in the hydrogen atom?

$$\left[\frac{h}{2\pi} = 1.055 \times 10^{-34} kg.\, m^2 / s\right]$$

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2. Calculate the radius of the first Bohr orbit in the hydrogen atom. Hence calculate the radius of the second orbit.

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3. Calculate the frequency of revolution of the electron in this second Bohr orbit of the hydrogen atom. The radius of the orbit is 2.14Å and the speed of the electron in the orbit is $1.09 \times 10^6 m/s$.

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4. Determine the frequency of revolution of an electron in the second Bohr orbit in hydrogen atom.

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5. Calculate the energy of the electron in the ground state of the hydrogen atom.

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6. An electron is orbitting in the fourth Bohr orbit. Calculate the ionisation energy for this atom, if the ground state energy is -13.6 eV.

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7. The potential energy of the electron in the first Bohr orbit in the hydrogen atom is -27.2 eV. What is its kinetic energy in the same orbit?

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8. Find the value of Rydberg's constant if the energy of electron in the second orbit in hydrogen atom is -3.4 eV.

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9. The wavelength of H_α line is Balmer series is 6563 Å. Compute the wavelength of H_β line of Balmer series.

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10. Find the ratio of longest wavelength in Paschen series to shortest wavelength in Balmer series.

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11. Given the atomic mass of ^{56}Fe is $55.93u$, find its nuclear density. $\left[1u = 1.66 \times 10^{-27}kg, R_0 = 1.2fm\right]$

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12. Find the rest mass energy of a proton in MeV. $\left[m_p = 1.673 \times 10^{-27}kg\right]$

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13. The decay constant of a radioactive material is 5×10^{-4} per year.find its half-life period.

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14. Protactinium $_{91}^{233}Pa$ decays to $\frac{1}{5}$th of its initial quantitiy in 62.7 days. Calculate its decay constant and half-life.

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15. The half-life of a radiactive material is 4 days. Find the time required for $1/4$ th of the initial number of radioactive nuclei of the element to remain undisintegrated.

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16. A radioactive sample with half-life 2 days has initial activity $32\mu Ci$. What will be its activity after 8 days?

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17. $._{90}Th^{232} \rightarrow ._{82}Pb^{208}$. The number of α and $\beta-$ particles emitted during the above reaction is

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18. After a series of alpha and beta decays, $._{94}Pu^{239}$ becomes $._{82}Pb^{207}$. How many alpha and beta particles are emitted in the complete decay process?

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19. Find the de Broglie wavelength associated with a proton accelerated from rest through a potential difference of 5000 V. $\left[m_p = 1.673 \times 10^{-27} kg\right]$

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20. Calculate the de Broglie wavelength associated with an electron moving with a

speed 0.1% of the speed of light in free space.

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21. A praticle of mass M at rest decays into two particle of masses m_1 and m_2, having non-zero velocities. The ratio of the de Broglie wavelength of the particles $\frac{\lambda_1}{\lambda_2}$ is

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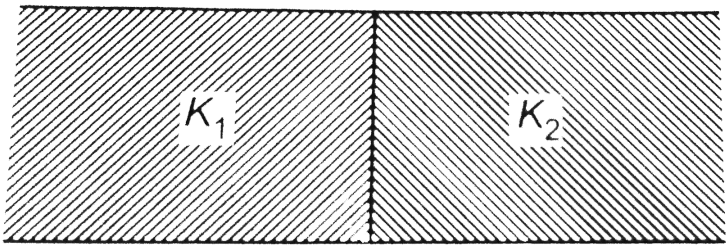
Assignments

1. Two material having the dielectric constans K_1 and K_2 are filled between two parallel plates of a capacitor.

where area of each plate is A and the distance between the plates is d.

The capacitor of the capacitor is:



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2. In a cylotron, for the same values of B and R, what is the ratio of the maximum kinetic energies of alpha particles and deutrons?

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3. The equation of a plane progressive wave is $y = 50 \sin 2\pi(4t - 5x)$. Where y and x are in an and t in seconds. Calculate the amplitude, frequency, wavelength and velocity of the wave.

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4. Find the energy of the electrons in eV in the third Bohr orbit of the hydrogen atom.

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5. if the threshold wavelength for the given metal is 8×10^{-6}m ,then What is the photoelectric work function for a metal ?

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