PHYSICS

BOOKS - NAVBODH PHYSICS (HINGLISH)

DERIVATIONS-I

Wave Theory Of Light

1. When light passes from a denser medium to a rarer medium

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Interference And Diffraction

1. Monochromatic light waves of constant phase difference ϕ and amplitues A_1 and A_2 produce an interference pattern. State an expression for the resultant amplitude at a point in the pattern. Hence deduce the conditions for (i) constructive interference with maximum intensity (ii) destructive interference with minimum intensity. Also

show that the ratio of the maximum and minimum intensities

$$\frac{I_{\max}}{I_{\min}} = \left(\frac{A_1 + A_2}{A_1 - A_2}\right)^2.$$

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2. Monochromatic light waves of intensities I_1 and I_2, and a constant phase difference ϕ produce an interference pattern. State an expression for the resultant intensity at a point in the pattern. Hence deduce the expressions for the resultant intensity,

maximum intensity and minimum intensity if $I_1 = I_2 = I_0$.

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3. Obtain an expression for path difference and frinage width of interfereance pattern in Young's double slit experiment. Show that the fring width is same for consecutive bright and dark bands.

The refractive indices of glass and water w.r.t.

air are $\frac{3}{2}$ and $\frac{4}{3}$ respectively. Determine the refractive index of glass w.r.t. water.

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4. The angular width of the central maximum of the diffraction patternn in a single slit (of width a) experiment, with λ as the wavelenth of light, is

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Electrostatics

1. State and prove Gauss's law in electrostatics.

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2. Derive an expression for the electric field intensity at a point outside a charged conducting sphere.

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3. Derive an expression for the electric field intensity at a point outside an infinitely long charged cylindrical conductor.

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4. The mechanical force acting on a unit area of a charged conductor is

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5. Which of the following factors does not affect the mechanical force per unit area of charged conductor ?

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6. Derive an expression for the capacitance of a parallel-plate capacitor filled with a dielectric.

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7. A dielectric of relative permittivity (dielectric constant) k completely fills the space between the plates of a parallel-plate capacitor with a surface charge density σ. Show that (i) the induced density of surface charge on the dielectric is $\sigma_p = \sigma\left(1 - \frac{1}{k}\right)$ (ii) the capacitance of the capacitor is increased by a factor equal to the ratio of the electric field without the dielectric to that with the dielectric.

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8. What is the effect of presence of a dielectric medium on

(i) capacitance of a parallel plate capacitor

(ii) electrostatic force between two charges ?

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9. Show that the enerty of a charged capacitor is $\frac{1}{2}CV^2$. Also express this in other forms.

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10. Write different expression for the energy stored in a capacitor.

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11. Derive an expression for the effective capacitance of three capacitors connected in series.

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12. Derive an expression for the effective capacitance of three capacitors connected in series.

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Current Electricity

1. Describe Wheatstone's network with a neat circuit diagram. Obtain the expression for its balance condition.

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2. Using Ampere's circuital law, obtain an expression for the magnetic induction at a point near an infinitely long straight conductor carrying an electric current.

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3. Using Ampere's circuital law, obtain an expression for the magnetic induction at a

point near an infinitely long straight conductor carrying an electric current.

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4. Explain sensitivity of moving coil galvanometer. Show with the help of a circuit diagram that how a moving coil galvanometer can be converted into an ammeter of given range. Write necessary mathematical relation. What is the resistance of ideal ammeter?

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5. What is a voltmeter? How can a galvanometer be converted into a voltmeter? Explain.

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6. For given positive ions in a cyclotron, obtain an expression for the cyclotron frequency.

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Magnetism

1. Show that the orbital magnetic dipole moment of a revolving electron is $evr/2$.

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Electromagnetic Induction

1. prove that the charge induced does not depend on the rate of change of magnetic flux.

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2. Prove theoretically $E = -\frac{d\Phi}{dt}$.

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3. Derive the expression for motional emf induced in a conductor moving in a uniform magnetic field.

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4. What is meant by self-inductance of a coil? Obtain an expression for the self-inductance of a long solenoid.

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5. What is a capacitor ? Define its capacitance. Explain the units of capacitance.

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6. The average power in LCR series circuit is

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Atoms Molecules And Nuclei

1. The radii of Bohr's orbit are directly proportional to

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2. The expression for Bohr radius of nth orbit of an atoms is

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3. Angular speed of an electron in a Bohr's orbit is given by

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4. Frequency of revolution of electron in the n^{th} Bohr's orbit of hydrogen is given by

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5. Total energy of electron in nth stationary orbit of hydrogen atom is

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6. The energy of an electron in the nth Bohr orbit of hydrogen atom is

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7. On the basis of the de Broglie hypothesis, obtain the expression for the de Broglie wavelength associated with an electron accelerated from rest through a p.d. V.

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Semiconductors

1. The relation between α and β of a transistor is

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Circular Motion

1. In $U.C.M.$ (Uniform Circular Motion), prove the relation $\overrightarrow{v} = \overrightarrow{\omega} \times \overrightarrow{r}$, where symbols have their usual meanings.

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2. In a uniforme circular motion, the linear velocity of a particle

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3. The relation between linear speed v, angular speed ω and angular acceleration α in circular motion is

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4. The acceleration of a particle performing S.H.M. at mean position is

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5. Assertion:- A particle is moving in a circle with constant tangential acceleration such that its speed v is increasing. Angle made by resultant acceleration of the particle with tangential acceleration increases with time.

Reason:- Tangential acceleration $= \left| \frac{d\vec{v}}{dt} \right|$ and centripetal acceleration $= \frac{v^2}{R}$

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6. The safety speed of a vehicle on a curve horizontal road is

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7. The maximum speed with which a vehicle can be safely driven along curved road of radius r, banked at angle θ is

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8. The maximum speed with which a vehicle can be safely driven along curved road of radius r, banked at angle θ is

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9. What is a simple pendulum? Find an expression for the time period and frequency of a simple pendulum.

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10. The work done by the tension in the strings of a simple pendulum in one complete oscillation is equal to

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11. Derive an expression for the difference in tensions at the highest and lowest points for a particle performing vertical circular motion.

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Gravitation

1. Obtain an expression for the critical velocity of a satellite orbiting around the Earth.

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2. Prove that the critical orbital speed of a satellite in a near-Earth is $2R\sqrt{\pi_p G/3}$, where p and R are the average density and radius of the Earth and G is the universal gravitional constant.

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3. The time period of a pendulum is directly proportional to _____

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4. Show that period of a satellite revolving around the Earth depends upon mass of the Earth.

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5. Derive an expression for the escape speed of a body from the surface of the Earth. Express it in terms of the mean density of the Earth.

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6. Prove that $g_h = g\left(1 - \frac{2h}{R}\right)$, where g_h is the acceleration due to gravity at altitude h and $h < < R$ (R is the radikus of the Earth).

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7. Draw graphs showing the variation of accleeration due to gravity with (a) height above the Earth's surface, (b) depth below the Earth's surface.

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Rotational Motion

1. For a body rotating with constant angular velcoity, its kinetic energy is directly proportional to the square of its

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2. Torque acting on a rotating body

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3. State and prove theorem of parallel axes.

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4. State and prove theorem of perpendicular axes.

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5. The moment of inertia of a thin uniform rod about an axis passing through its centre and

perpendicular to its length is I_0. What is the moment of inertia of the rod about an axis passing through one end and perpendicular to the rod ?

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6. Moment of inertia of a disc about its own axis is I. Its moment of inertia about a tangential axis in its plane is

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7. State the expression for the moment of inertia of a thin uniform disc about an axis perpendicular to its plane and through its centre. Hence deduce the expression for its moment of inertia about a tangential axis perpendicular to its plane.

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8. A solid sphere rolls on horizontal surface without slipping. What is the ratio of its rotational to translation kinetic energy.

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9. Obtain an expression for total kinetic energy of a rolling body in the form $\frac{1}{2}MV^2\left[1+\frac{K^2}{R^2}\right]$.

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10. If a rigid bady of radius 'R' starts from rest and rolls down an inclined plane of inclination

θ then linear acceleration of body rolling down the plane is _____

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11. A hollow cylinder and a solid cylinder are rolling without slipping down an inclined plane, then which of these reaches earlier ?

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12. Establish a relation between angular momentum and moment of inertia of a rigid body.

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13. Obtain an expression for torque acting on a rotating body with constant angular acceleration. Hence state the dimensions and SI unit of torque.

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Oscillations

1. Assuming the general expression for the displacement of a particle performing SHM, obtain the expressions for its velocity and acceleration as functions of the displacement.

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2. Obtain an expression for the kinetic energy of a particle performing linear SHM. State how

it depends upon the amplitude, frequency and period of SHM.

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3. Discuss analytically the composition of two linear SHMs of the same period and along the sameline. Find the resultant amplitude when the phase difference is (1)zero (2) $\frac{\pi}{3}$ (3) $\frac{\pi}{2}$rad (4) π rad

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4. If the two particles performs S.H.M. of same initial phase angle but different amplitudes of individuals, then the resultant motion initial phase angle depends on

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5. Define practical simple pendulum. Show that motion of bob of pendulum with small amplitude is linear S.H.M. Hence obtain an expression for its period. What are the factors on which its period depends ?

The total free surface energy of a liquid drop is $\pi\sqrt{2}$ times the surface tensin of the liquid. Calculate the diameter of the drop in S.I unit.

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Elasticity

1. Derive an expression for strain energy and show that the strain energy per unit volume of a stretched wire is proportional to the square of the strain.

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2. The stored energy per unit volume of a stretched wire is

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Surface Tension

1. The relation between surface tension and surface energy is

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2. Surface tension of a liquid is numerically equal to

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3. The excess pressure inside a soap bubble is

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4. Derive Laplace's law for a spherical membrane.

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Wave Motion

1. The equation of a simple harmonic progressive wave along the negative direction of X-axis is

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2. What are beats ?

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Stationary Waves

1. Explain the formation of stationary waves by analytical method. Shwo that nodes and antinodes are equally spaced in sationary waves.

The radius gyration of a body about an axis, at

a distance of 0.4 m from its centre of mass is $0.5m$. Find its radius of gyrtion about a parallel axis passing through its centre of mass.

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2. A sonometer wire of density ρ and radius r is held between two bridges at a distance L apart . Tension in the wire is T. then the fundamental frequency of the wire will be

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3. A sonometer wire is stretched by a hanging metal bob. Its fundamental frequency is n_1. When the bob is completely immersed in water, the frequency becomes n_2 . The relative density of the metal is

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4. How does the frequency of a vibrating wire change when the attached load is immersed in water.

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5. The p^{th} overtone of an organ pipe open at both ends has a frequency n_1 . What one end of the pipe is closed , its q^{th} overtone has a frequency n_2. What is the value of $\frac{n_1}{n_2}$?

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Kinetic Theory Of Gases And Radiation

1. If P is the pressure of gas, then the kinetic energy per unit volume of the gas is .

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2. Kinetic energy per unit volume of a gas is

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3. State Boyle's law.

Derive it on the basis of the kinetic theory of

an ideal gas.

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4. State and prove law of equipartition of energy.

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5. State Stefan's law of radiation. Derive an expression for the rate of loss of radiant

energy per unit area by a perfect blackbody in a cooler surroundings.

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Assignments

1. Describe biprism exper4iment to calcularte the wavelength of a monocharomatic light. Draw the necessary ray diagram.

If the critical angle of a medium is $\sin^{-1}\left(\frac{3}{5}\right)$, find the po0larising angle.

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2. Derive an expression for the electric field intensity at a point outside a charged conducting sphere.

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3. A dipole of electric dipole moment p is placed in a uniform electric field of strength E. If θ is the angle between positive direction of

p and E, then the potential energy of the electric dipole is largest when θ is

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4. An inductor and a resistor are connected in series with an ac source. In this circuit.

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5. In series resonant circuit, at resonance,

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6. When an electron is excited to n^{th} energy state in hydrogen, the possible number of spectral lines emitted are

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7. State the low of radioactive decay. Hence derive the relation N= $\mathrm{Noe}^{-\lambda t}$. Represent it graphically.

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8. The relation between half life period and decay constant is

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9. State de-Broglie hypothesis.

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10. In circular motion, assuming $\bar{v} = \overline{w} \times \bar{r}$, obtain an expressio for the resultantj acceleration of a particle in terms of tangential and radial component.

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11. Determine the binding energy of satellite of mass $1000kg$ revolving in a circular orbit around the Earth when it is close to the surface of Earth. Hence find kinetic energy and

potential energy of the satellite.

[Mass of Earth $= 6 \times 10^{24} kg$, radius of Earth $= 6400 km$, gravitational constant $G = 6.67 \times 10^{-11} Nm^2 / kg^2$]

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12. State the expression for the MI of a thin ring about a transverse axis through its centre. Hence, derive the expression for the MI of the ring about its tangent perpendicular to the plane.

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13. Obtain an expression for moment of inertia of a uniform circular disc about a diameter of the disc.

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14. Assuming he expression for the moment of inertia of a thin disc about its diameter, show that the moment of inertia of the disc about a tangent in its plane is $\frac{5}{4}MR^2$

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15. Assuming the expression for the MI of a unifrom solid sphere about its diameter, obtain the expression for its moment of inertia about a tangent.

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16. The radius of gyration of a solid sphere of radius R about its tangential is

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17. Obtain an expression for the rise of a liquid in a capillary tube.

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18. Derive an expression for pressure exterted by an ideal gas?

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