PHYSICS

BOOKS - NN GHOSH PHYSICS (HINGLISH)

INTRODUCTION TO MODERN PHYSICS

Examples

1. Calculate the velocity with which electrons in a cathode ray tube strike the anode when 30,

000 V is operating between the cathode and anode of the tube. (mass of electron $= 9 \times 10^{-31} kg$, charge of electron $= 1.6 \times 10^{-19} C$).

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2. An electron entering a magnetic field of $0.01T$ with a velocity of $10^7 ms^{-1}$ describes a circle of radius 0.6 cm. Calculate e/m (specific charge) of the electron.

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3. An electron is accelerated in between two plates maintained at $1000V$. What is the energy in eV acquired by the electrons? $\left(e = 1.6 \times 10^{-19} C\right)$

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4. A proton of mass $m = 1.67 \times 10^{-27} kg$ moves uniformly in a space where there are uniform, mutually perpendicular electric and magnetic fields with $E_z = 5kV/m$ and

$B_x = 40mT$ at an angle $\phi = 60^\circ$ with the x-axis in the xy-plane. Find the pitch of the trajectory after the electric field is switched off.

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Exercise

1. An electron falls through a potential differsence of $1000V$ and gives up

$1.6 \times 10^{-16} J$ of energy. What is the charge on the electron?

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2. The forces of cathode ray particles due to electric and magnetic fields which are at right angles to each other balance each other. If the magnetic field has an intensity $0.1T$, what is the intensity of the electric field? The velocity of cathode ray particles is $10^6 ms^{-1}$. What p.d. is required to produce this velocity?

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3. An electron falls through a potential difference of $50,000V$. What is the energy acquired by it?

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4. An electron of energy 150 eV describes a circle in a magnetic field of 0.1 tesla. Calculate the radius of the curcle.

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5. An electron is moving with a velocity of $10^7 ms^{-1}$. Find its energy in electron volts. (Mass of electron $= 9.1 \times 10^{-31} kg$ and charge of electron $= 1.6 \times 10^{-19} C$)

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6. A horizontal stream of charged particles is accelerated to velocity $3 \times 10^7 ms^{-1}$ immediately before being allowed into an

electric field between teo horizontal plates separated by 2 cm and maintained at a p.d. of 100 V. The stream is deflected by 5 mm. Calculate e/m of the charged particles of the stream. (Length of plates =10 cm).

[Hint: Electric field between plates = rate of change of potential]

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7. Electrons move at right angles to a magnetic field of 1.5×10^{-2} Tesla with a

speed of $6 \times 10^7 m/s$. If the specific charge of the electron is $1.7 \times 10^{11} C/kg$. The radius of the circular path will be

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8. In a cathode ray tube, electric and magnesity of the magnetic fields are simultaneously applied at right angles to each other and the intensity of the magnetic field is so adjusted that the beam remains undeflected. Show that the velocity of cathode

ray particles is given by $v = \frac{E}{B}$. Calculate this velocity when $B = 0.01T$ and $E = 50,000V/m$.

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9. A non-relativistic enters into a right-handed coordinate space with velocity $10^4 ms^{-1}$ at an angle of 60° with the x-axis in the xy-plane. There is a uniform magnetic field of 50 mT along the y-axis. Find the pitch of the helical trajectory. What is the axis of the helix?

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10. A non-relative proton enters at right angles to a uniform magnetic field of $30mT$. What is the frequency of revolution of the particle if the field is sufficiently deep?

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11. A nonrelativistic electron enters a uniform magnetic field of 50 mT with a speed of $10^6 m/s$ at right angles to it and emerges

from the field after 0.1 nanosecond. What is the deviation produced the field ? Show that it does not depend on the initial speed of the electron.

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12. Hall effect measurements were made using a sodium conductor. The strength of the Hall field was found to be $E = 500 \times 10^{-6} Vm^{-1}$ with a current density $J = 2 \times 10^{6} A/m^{2}$ and magnetic induction $B = 1T$. Find the

concentration of the conduction electrons in sodium.

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13. Find the mobility of the conduction electrons in a copper conductor if in Hall effect measuremaents performed in the magnetic fileld of induction $B = 100mT$ the transverse electric field strength of the given conductor turned out be $\eta = 3.1.10^3$times less than that of the longtudinal electric field.

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14. A parallel plate capacitor with area of each plate equal to S and the separation between them to d is put into a stream of conducting liquid with respectivity ρ. The liquid moves parallel to the plates with a constant velocity v . The whoel system is located in a unifrom magentic field of induction B, vector B being parallel to the plates are interconnected by means of an exteranal resistance R. What amount of power is genrated in that

resistance? At what value of R is the generated power the highest? What is this highest power equla to ?

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15. A straight round copper conductor of radius $R = 5.0mm$ carries a current $I = 50A$ Find the potentail difference between the axis of the conductor and its surface. The concentration of the conduction electrons in copper is equal to $n = 0.9.10^{33}cm^{-3}$.

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16. The resistivity of indium arsenide arsenide is $\rho = 2.5 \times 10^{-3} \Omega m$ and its Hall constant is $C_H = 10^{-2} m^3 / c$. Find the concentration and mobility of the charge carriers in this material.

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17. Electrons are observed to be ejected in various directions with negligible speed from the negative plate of a parallel plate capacitor

when the plate is illuminated by a certain wavelength. The plates are separated by a distance d and a potential difference V is maintained between them. Show that none of these electrons will reach the positive plate if a magnetic field is applied at right angles to the electric field and that the magnetic induction has a value $B > \left(\frac{2mV}{ed^2}\right)^{\frac{1}{2}}$ where m and e are the electron mass and charge respectively.

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18. Electrons accelerated by a p.d. of $V = 5000$ volts are allowed to impinge normally on a plate. If the current constituted by the impinging electrons be $I = 0.02mA$, find the force experienced by the plate. Assume complete absorption of electrons by the plate. $m = 9.0 \times 10^{-31} kg$ and $e = 1.6 \times 10^{-19} C$

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19. A thick wire of radius $r = 5mm$ carries a steady current $I = 10A$. An electron leaves its

surface perpendicularly with velocity $v_0 = 10^6 m/s$. Find the maximum distance from the surface of the wire before it turns back.

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20. An electron starting at angle $\alpha = 60^\circ$ with a uniform magnetic induction $B = 0.1T$ moves with velocity $v = 10^6 ms^{-1}$. A screen is held at right angles to the field at a distance $l = 5cm$ from the strating point. Find the

distance r from the straight point to the point on the screen where the electron strikes.

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21. An electron beam accelerated by a p.d. of $V = 100V$ enters into a magnetic field perpendicular out the plane of the page. The space occupied by the field is width $d = 10cm$. A screen is held at right angles to the initial direction of motion of the beam at a distance $b = 20$ cm from the nearer edge of the field.

find the distance $'\delta'$ of the point where the beam strikes the screen from the point where it whould strike had there been no field.

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