BITS, PILANI – DUBAI
International Academic City, Dubai

I-Year II-Semester 2009-10
Comprehensive Exam

Course Name:	Physics II;	**Course No.:**	PHY C132;
Date:	24^{h} May 10;	**Weightage:**	40%;
Duration.:	3hrs;	**Max Marks:**	120

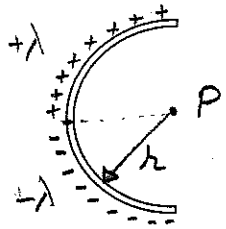
All questions are compulsory
Each Question carries 10 marks
Answer all sections in separate booklet

{$c = 2.998 \times 10^{8}$ m·s^{-1} ; $\mu_0 = 4\pi \times 10^{-7}$ N A^{-2}; $\varepsilon_0 = 8.85 \times 10^{-12}$ F·m^{-1};

$h = 6.63 \times 10^{-34}$ J·s; $e = 1.602 \times 10^{-19}$ C; $m_e = 9.1 \times 10^{-31}$ kg; $m_p = 1.67 \times 10^{-27}$ kg

Section A

1. A thin glass rod is bent into a semicircle of radius r = 2.7 cm. A charge +q = 6.0 x10^{-6} C is uniformly distributed along the upper half, and a charge -q is uniformly distributed along the lower half, as shown. Find the magnitude and direction of the electric field E at P, the center of the semicircle.



2. A thick spherical shell of inner radius 'a' and outer radius 'b' has a volume charge density $\rho = ks^2 \hat{s}$ where s is the distance from the centre. Find the electrostatic energy inside the shell.

3. A conducting sphere of radius R and carrying a charge Q is surrounded by a shell of linear dielectric material having a susceptibility χ_e and extending up to a radius of R_0. Find the electric field inside, the polarization, and the bound charge densities ρ_b and σ_b. What is the total bound charge on the surface?

4. An air filled cylindrical capacitor has a capacitance of 10.0 pF and is 6.0 cm in length. If the radius of the outside conductor is 1.5 cm, what is the required radius of the inner conductor? If the capacitor is charged with 250 μC of charge and gap between the inner and the outer cylinder is filled with a linear dielectric material of susceptibility χ_e = 0.3, what is the change in stored energy?

Given : Divergence $\nabla \cdot \mathbf{v} = \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 v_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \theta}(\sin\theta\, v_\theta) + \frac{1}{r\sin\theta}\frac{\partial v_\phi}{\partial \phi}$

Section C

9. A surface has a light of wavelength 550nm incident on it, causing the ejection of photoelectrons for which stopping potential is 0.19V. Suppose the radiation of wavelength 190nm were incident on the surface calculate the stopping potential?

10. X-rays of wavelength 10pm are scattered from an electron.
a) Find the wavelength of the X-rays scattered through 45^0
b) Find the maximum kinetic energy of the recoil electron

11. Find the momentum and wavelength of a photon having energy of 10 MeV.

12. A typical atomic nucleus is about $5x10^{-15}$m in radius. Use the uncertainty principle to place a lower limit on the momentum electron must have if it is to be part of a nucleus.

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I-Year II-Semester 2009-10
Test II (Open Book)

Course Name:	Physics II;	**Course No.:**	PHY C132;
Date:	25th Apr 10;	**Weightage:**	20%;
Duration.:	50 minutes;	**Max Marks:**	60

1. A proton traveling from left to right with a velocity of 1.5×10^6 m/s enters a region of uniform electric and magnetic field. The electric field has strength of 2500 N/C and runs from top to bottom. (The proton mass is 1.67×10^{-27} kg)
   a. What should be the magnitude and direction of the magnetic field so that it selects only those protons that are traveling with the above mentioned velocity (4)

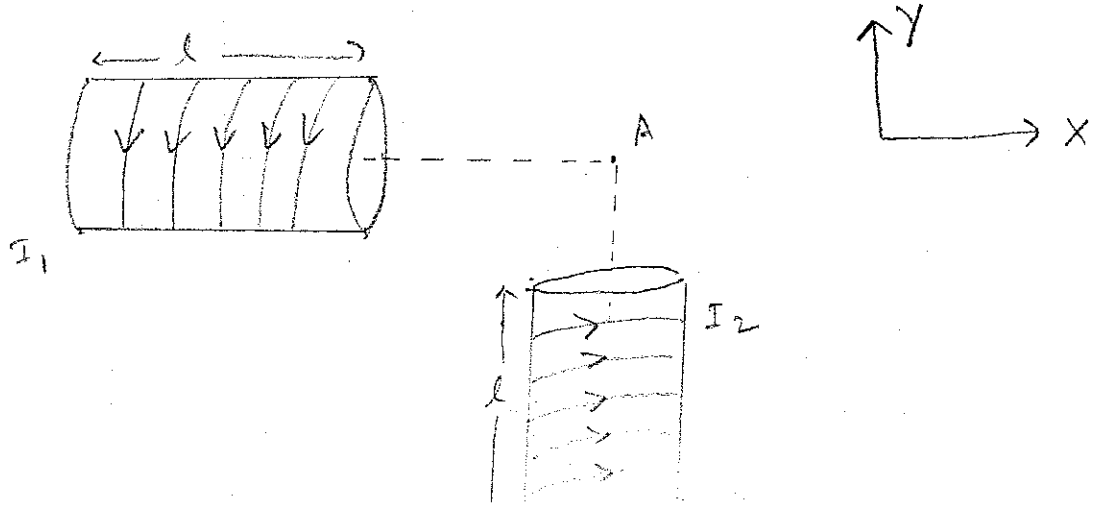
   Furthermore, this proton enters a region with uniform magnetic field of 3T coming outward, ⊙,
   b. What should be the resultant direction of the proton motion and the radius of the consequent path? (4)
   c. How many revolutions would the proton go through in 25ms. (4)

2. Consider a long straight wire of radius R carrying a current I of uniform current density. Find the magnetic field inside and outside the wire. (12)

3. An infinitely long cylinder of radius R, carries magnetization parallel to the axis $M = 3ks^3 \hat{Z}$ where k is a constant and s is the distance from the axis.
   a) Calculate J_b and K_b
   b) Calculate total bound currents
   c) Find the magnetic field due to M for point inside and outside. (5+5+5)

4. A toroid consisting of N total no turns carrying current I, is filled up with a magnetic material of susceptibility χ. What is the magnetic field at any point inside the coil and at a point outside the coil. (3+6)

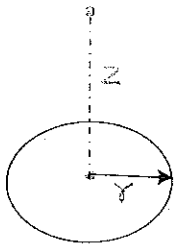
5. There are two solenoids given below, they have n number of turns per unit length and equal lengths .Current $I_1 = 4$ amps and $I_2 = 3$ amps. Find the magnitude and the direction of the magnetic field vector at point A. Show the $\vec{B}$ vectors on a vector diagram. (12)



BITS, PILANI – DUBAI
International Academic City, Dubai
I-Year II-Semester 2009-10
Test I (Closed Book)

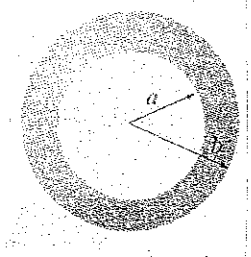
Course Name:	Physics II;	**Course No.:**	PHY C132;
Date:	14 Mar'10;	**Weightage:**	25%;
Duration.:	50 minutes;	**Max Marks:**	75

1. Find the electric field a distance Z above the center of a circular loop of radius r which carries a uniform line charge λ. (15)



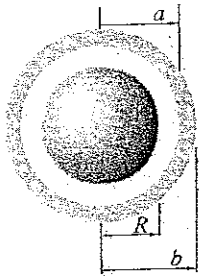
2. A long cylinder carries a charge density that is proportional to the distance from the axis : $\rho = kr$, for some constant k and r is the distance from the axis. Using Gauss law, find the electric field inside this cylinder. (15)

3. A hollow spherical shell carries charge density $\rho = k/r^2$ in the region $a \leq r \leq b$. Calculate the potential in the region $a < r < b$ (15)



4. Find the energy stored in a uniformly charged solid sphere of radius R and charge q. (15)

5. A metal sphere of radius R, carrying charge q, is surrounded by a thick concentric metal shell (inner radius a and outer radius b). The shell carries no net charge. Find the potential at the centre using infinity as reference point. (15)



BITS, PILANI – DUBAI
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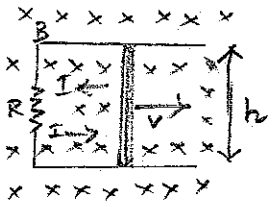
I-Year II-Semester 2009-10
Quiz II

A

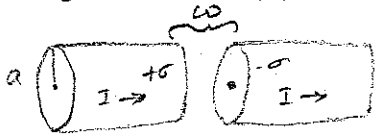
NAME:		ID no:	
Course Name:	Physics II;	**Course No.:**	PHY C132;
Date:	13th May 10;	**Weightage:**	7%;
Duration.:	20 minutes;	**Max Marks:**	21

Q1. Consider a flat square coil with N= 5 loops. The coil is 20 cm on each side, and has a magnetic field of 0.3 T passing through it. The plane of the coil is perpendicular to the magnetic field, the field points out of the page. a) If nothing is changed, what is the induced emf ? b)The magnetic field increases uniformly from 0.3 T to 0.8 T in 1 second. While the change is taking place, what is the induced emf in the coil ? (3+4)

Q2.A metal bar slides frictionlessly on two parallel conducting rails. Suppose the height h in the figure is 0.1 m, the velocity v is 2.5 m/s, the total resistance of the loop is 0.03 Ω and B is 0.6T. Calculate the motional emf, the induced current and the force acting on the rod. (3+2+2)



Q3.A fat wire of radius a, carries a constant current I, uniformly distributed over its cross section. A narrow gap in the wire of width w << a, forms a parallel plate capacitor, as shown in figure.Find the magnetic field in the gap , at a distance s<a from the axis. (7)



Name :

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BITS, PILANI – DUBAI
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I-Year II-Semester 2009-10
Quiz I

A

Course Name:	Physics II;	**Course No.:**	PHY C132;
Date:	1st Apr 10;	**Weightage:**	8%;
Duration.:	30 minutes;	**Max Marks:**	24

1. A hydrogen atom with bohr radius of half an angstrom ($R = 0.5 \times 10^{-10}$m) is situated between two metal plates 1mm apart, which are connected to opposite terminals of a 500V battery. What fraction of the atomic radius does the separation distance d amount to roughly? (Given Atomic polarizabilty of $H = 0.66 \times 10^{-30}m^3$) (6)

2. A sphere of radius R carries a polarization $\mathbf{P}(\mathbf{r}) = \mathbf{kr}$ where $\mathbf{k}$ is a constant and r is the vector from the center. Calculate the bound charges σ_b and ρ_b. (6)

Given : Divergence $\nabla \cdot \mathbf{v} = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2 v_r\right) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\, v_\theta\right) + \frac{1}{r\sin\theta}\frac{\partial v_\phi}{\partial\phi}$

3. A thick spherical shell (inner radius a, outer radius b) is made of dielectric material with a frozen- in polarization $\mathbf{P(r) = k/r^3}$ where **k** is a constant and r is the distance from the centre. There is no free charge. Calculate the Electric displacement D and electric field E. (6)

4. The diameter of the external surface of a spherical capacitor is 30 cm while that of the internal sphere is 20 cm. Calculate the capacitance of the capacitor. The space between them is filled up by a liquid of dielectric constant 2. Find the new capacitance of the capacitor. (6)