BITS, PILANI – DUBAI
International Academic City, Dubai

I-Year II-Semester 2008-09
Comprehensive Examination

Course Name:	Physics II;	**Course No.:**	PHY C132;
Date:	28th May'09;	**Weightage:**	40%;
Duration.:	3hrs;	**Max Marks:**	120

* This paper consist of three **Sections, A, B and C**
* **Answer all sections in separate booklets provided**
(Sec A – Blue, Sec B – Green, Sec C – Red)
* **Answer all questions sequentially**

{$c = 2.998 \times 10^8$ 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}

In Spherical

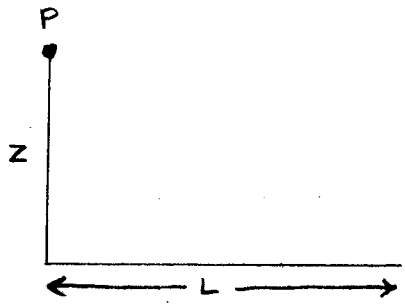
Divergence : $$\nabla \cdot \mathbf{v} = \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 v_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \theta}(\sin\theta\, v_\theta) + \frac{1}{r\sin\theta}\frac{\partial v_\phi}{\partial \phi}$$

In cylindrical

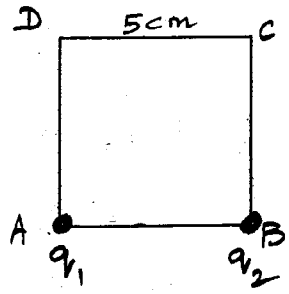
Curl : $$\nabla \times \mathbf{v} = \left[\frac{1}{s}\frac{\partial v_z}{\partial \phi} - \frac{\partial v_\phi}{\partial z}\right]\hat{\mathbf{s}} + \left[\frac{\partial v_s}{\partial z} - \frac{\partial v_z}{\partial s}\right]\hat{\boldsymbol{\phi}} + \frac{1}{s}\left[\frac{\partial}{\partial s}(s v_\phi) - \frac{\partial v_s}{\partial \phi}\right]\hat{\mathbf{z}}$$

SECTION A

Q1. Calculate the electric field at point P (magnitude and direction) at a distance Z above one end of a straight line segment of length L which carries a uniform line charge density λ. [10]



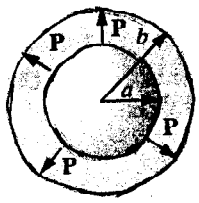
Q2. Charges 2 x 10^{-6} C and 1 x 10^{-6} C are placed at corners of A and B of a square of side 5cm. as shown in figure. How much work will be done against the electric field in moving a charge of 1 x 10^{-6} C from C to D. [10]



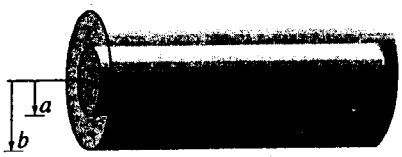
Q3. A thick spherical shell (inner radius a, outer radius b) is made of linear dielectric material with polarization $\mathbf{P}(\mathbf{r}) = k/r\,\hat{\mathbf{r}}$ where k is a constant and r is the distance from the center. There is no free charge in the sphere.

a) Calculate the bound charges σ_b and ρ_b.

b) Find D and E inside and outside the sphere. [4+6]

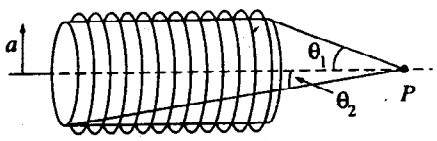


Q4. Find the capacitance per unit length of two coaxial metal cylindrical tubes of radii a and b. [10]

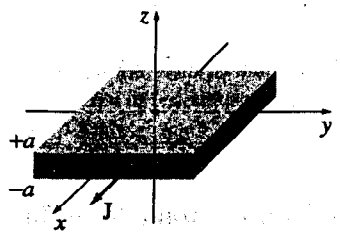


SECTION B

Q5. Find the magnetic field at point P on the axis of a tightly wound solenoid (helical coil) consisting of n turns per unit length wrapped around a cylindrical tube of radius a and carrying current I . Consider the turns to be essentially circular. [10]



Q6. A large thick slab extending from z = -a to z = +a carries a uniform volume current $\mathbf{J} = J\,\hat{\mathbf{x}}$. Find the magnetic field , as a function of z, inside the slab. What is the magnetic field outside the slab? [5+5]



Q7.An infinite long cylinder, of radius R carries a magnetization parallel to the axis, M= ks z where k is a constant and s is the distance from the axis. There is no free current anywhere. (a) Locate all the bound currents (b) Calculate magnetic filed inside at any point r. [5+5]

Q8. An infinite solenoid (n turns per unit length, current I) is filled with linear material of susceptibility χ_m . Find the magnetic field inside the solenoid. [10]

SECTION C

Q9. i) A toroid having a 5.2 cm square cross-section and an inside radius of 15.3 cm has 536 turns of wire and carries a current of 810 mA. Calculate the magnetic flux through a cross-section (a single turn) and energy stored in the toroid. [2+3]

ii) If this toroid is surrounded by another toroid of 6.0 cm square cross-section and inner radius 14.9 cm having 1020 turns of wire. What would be the emf, ξ, induced in the outer toroid if the current in the inner toroid changes from 810 mA to 700 mA in 2.3 secs. [5]

Q10. When light of wavelength 254 nm falls on Cesium, the required stopping potential is 3V. If a light of 436 nm is used, what is the stopping potential. Determine the cutoff frequency for Cesium. [6+4]

Q11. A 0.45 nm X-ray photon is deflected through a 23° angle after scattering from a free electron i) What is the kinetic energy of the recoiling electron? ii) What is its speed. [6+4]

Q12. Assuming Planck's constant is 0.60J.s, what would be the uncertainty in the position of a 0.50 kg baseball moving at 20m/s with an uncertainty in velocity of 1.2m/s? (Take Uncertainty relation - $\geq h/2\pi$) [10]

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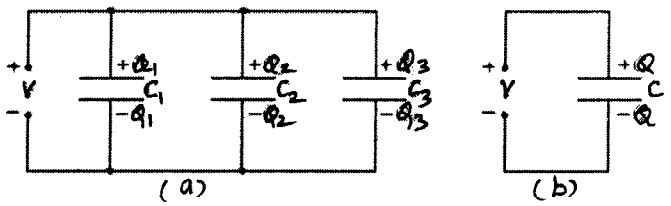
International Academic City, Dubai

I-Year II-Semester 2008-09
Test II (Open Book)

Course Name:	Physics II;	**Course No.:**	PHY C132;
Date:	15th April'09;	**Weightage:**	20%;
Duration.:	50 minutes;	**Max Marks:**	60

1. The diagram below shows three capacitors of capacitance C_1, C_2 and C_3 connected in parallel to a potential difference V.



(a) Write down expressions for the following:

(i) C_1 in terms of V and Q_1

(ii) C_2 in terms of V and Q_2

(iii) C_3 in terms of V and Q_3

(iv) C in terms of V and Q *form fig. b*

(b) What is the total charge Q of all three capacitors in terms of Q_1, Q_2 and Q_3?

(c) Using your answers to (a) and (b), obtain an expression for C *(total capacitance)* in terms of C_1, C_2 and C_3. **(4+3+3=10)**

2. The capacitance of an empty capacitor is **1.2μF**. The capacitor is connected to a **12V** battery and charged up. With the capacitor connected to the battery, a slab of dielectric material is inserted between the plates. As a result, **2.6 x 10^{-5} C** of additional charge flows on the plates. What is the dielectric constant of the material. **(10)**

3. A sphere of radius R is made of linear dielectric material with polarization $P(r) = A r^4$ where A is constant and r is the distance from the center. There is no free charge. Find

(a) All the bound charges densities
(b) Sum of all the bound charges
(c) D and E inside and outside the sphere
(d) Electrical susceptibility of the material **(4 x5=20)**

P. T. O.

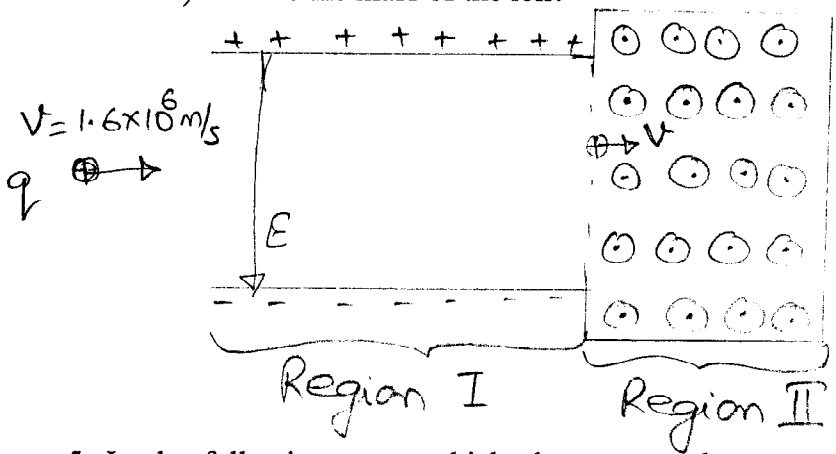
4. In the following setup of velocity selector and mass spectrometer. Two regions are shown. In region I where a positive ion of charge 3.2×10^{-19} C is made to pass through a region of Electric field and magnetic field such that the particle moves ahead undeflected.

a) If the electric field direction is as shown and magnitude is 4.8×10^{6} N/C, calculate the magnitude and direction of magnetic field applied in the region.

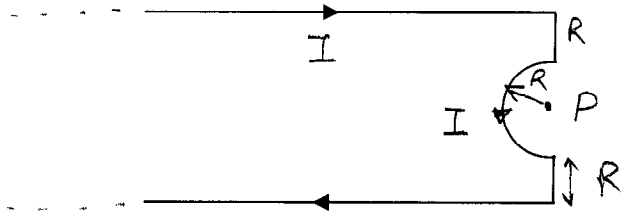
After the particle moves through this region, it enters Region II which has a magnetic field of 2 T coming out of the paper such that the ion moves in a radius of 2 cm.

b) What is the direction in which the particle would move (draw it in the answer book)?

c) What is the mass of the ion? **(5+2+5=12)**



5. In the following setup, which shows a conductor carrying current I, calculate the magnetic field at point P. **(8)**



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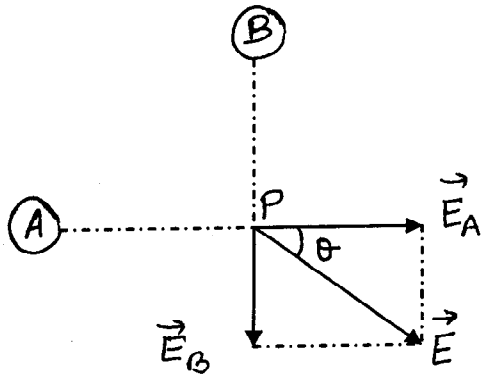
I-Year II-Semester 2008-09
Test I (Closed Book)

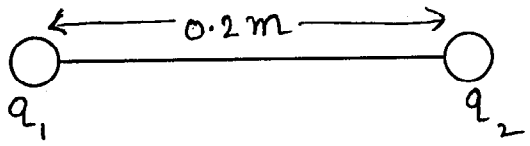
Course Name:	Physics II;	**Course No.:**	PHY C132;
Date:	22nd Feb'09;	**Weightage:**	25%;
Duration.:	50 minutes;	**Max Marks:**	75

1. a) Find the divergence for the following vector field v ,
   $v = (y^2 + z^2)(x + y)\hat{x} + (z^2 + x^2)(y + z)\hat{y} + (x^2 + y^2)(z + x)\hat{z}$
   b) Find the curl at a point (1,1, 2) for the following vector field v ,
   $v = yz^2\hat{x} + x\hat{y}$ **(5 + 5)**

2. a) Figure shows two charged objects A and B. Each contribute as follows to the net electric field at point P: E_A = 3.00 N/C directed to the right and E_B = 2.00 N/C directed downward. Thus E_A and E_B are perpendicular. What is the net electric field at P and angle θ. **(5 + 5)**

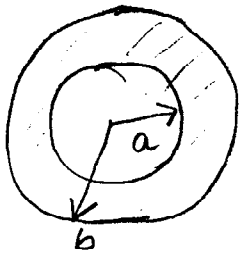


   b) There is an isolated point charge of q_1 =+15μC in a vacuum at the left in figure shown. Determine the force experienced by charge q_2 = +0.80 μC..
   (5)

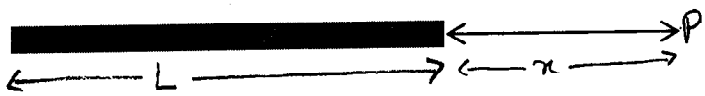


3. A cylinder of length L and radius b has its axis coincident with x-axis. The electric field in this region is $E=200\hat{i}$. Find the flux through (a) the left end of the cylinder (b) the right end (c) the cylindrical wall (d) the closed surface area of the cylinder (10)

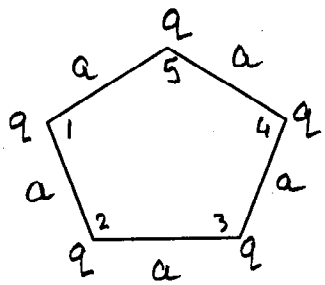
4.. A hollow spherical shell carries charge density $\rho = k / r^3$ in the region $a \leq r \leq b$. Find the electric field in the three regions (i) $r < a$ (ii) $a < r < b$ (ii) $r > b$ (15)



5. A rod of length L has a uniform linear charge density λ. Calculate the potential at point P a distance x from the right end of the rod. (15)



6. Calculate the energy of the system of equal charges shown below. (10)



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Quiz III

Section IX **Date: 28.04.2009**

Student Name:	**ID NO:**

1. An infinitely long cylinder of radius R carries a magnetization $M = ks\,\hat{Z}$, where k is a constant, s is the distance from the axis and there is no free current anywhere. Find the magnetic field inside and outside the cylinder by locating all the bound currents. use $(\nabla \times V = (\partial V_z/\partial z - \partial V_z/\partial s)\hat{\phi})$ (10)

2. A toroid has a mean radius R equal to $10/\pi$ cm and a total of 200 turns of wire carrying a current of 1.0A. , If the magnetization M is 2.8×10^{-2} A/m. Find the susceptibility of the material. (5)

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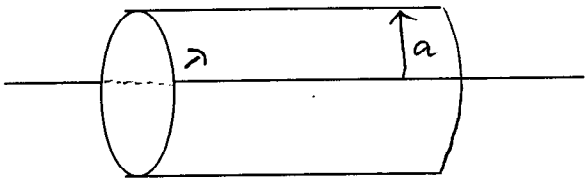
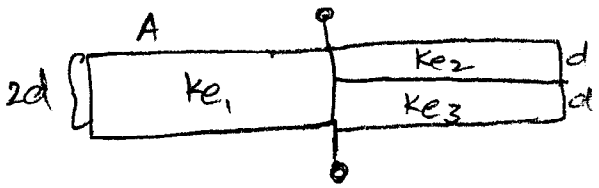
Quiz II

Section IX	**Date: 24.03.2009**
Student Name:	**ID NO:**

1. A long straight wire, carrying uniform line charge λ is surrounded by rubber insulation out to a radius a. Find the electric displacement by applying a gaussian surface of radius s and length L.



2. What is the capacitance of the capacitor?



3. A circular coil of radius 1.5cm carries a current of 1.5A. If the coil has 25turns, find the magnetic field at the centre. (given $\mu_0 = 4\pi \times 10^{-7}$ T.m/A)

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Quiz I

Section IX	**Date: 02.03.2009**
Student Name:	**ID NO:**

1. It requires 50μJ of work to carry a 2μC charge from point R to S. what is the potential difference between the points. Which point is at higher potential (5)

2. A capacitor is charged with 9.6nC and has a 120V potential difference between its terminals. Compute its capacitance and the energy stored in it.. (5)

3. A certain parallel plate capacitor consists of two plates each with area 200cm^2, separated by a 0.4cm air gap. a) Compute its capacitance b) If the capacitor is connected across a 500V source what are the charge on it, the energy stored in it . (5)

II^nd Sem 2008-09 6/5/09

Quiz-3, Physics-II Sec. 8

Q1. X-rays of wavelength 10 pm are scattered from a target.

(a) Find the wavelength of the X-rays scattered through 45° in pm.

(b) Find the maximum wavelength present in the scattered X-rays in pm.

(c) Find the maximum K.E. of the recoil electron in Joules. [5+5+5]

BITS, Pilani - Dubai

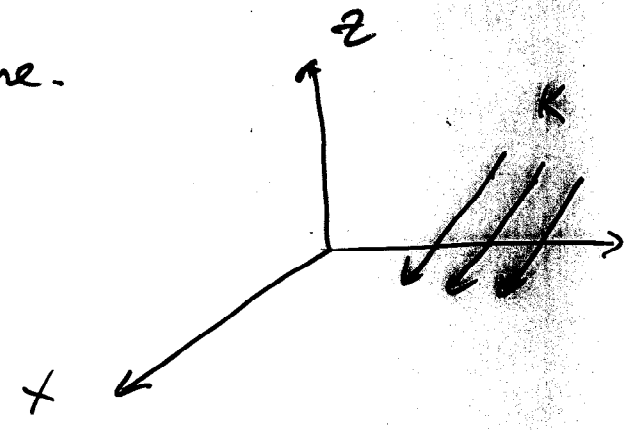
II - Semester 2008-09

Quiz - 2, Physics II,

Sec. 8

Q1. Using Ampere's law, find the magnetic field of a very long solenoid, consisting of n closely wound turns per unit length on a cylinder of radius R and carrying current I.

Q2. Using Ampere's law, find the magnetic field of an infinite uniform surface current $K\hat{x}$ flowing over the x-y plane.



Quiz - 1 Sec - 8 Physics - II

II nd Sem 2008-09

Q1. Calculate divergence of vector $\vec{v}$

$$\vec{v} = y^2 \hat{x} + (2xy + z)\hat{y} + 2yz\hat{z}$$

(7)

Q2. For a solid sphere of radius R, volume charge density $\rho = kr$, where k is constant, Calculate total charge on the sphere.

(8)

BITS, Pilani Dubai
II nd Sem 2008-09
Quiz-3 Physics-II

Sec-7

Q1. An electron has a de broglie wavelength of 2 pm. Find

(a) its kinetic energy in KeV

(b) phase velocity of wave

(c) group velocity of wave. (5+5+5)

Note: Consider relativity into consideration

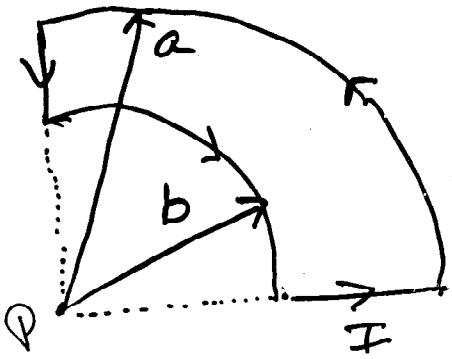
BITS, Pilani- Dubai

Sec-7

II Semester 2008-09

Quiz-2, Physics-II

Q1. Find the magnetic field at point P for the steady current configuration given below (7)



Q2. A steady current I flows down a long cylindrical wire of radius a. The current is uniformly distributed over the outside surface of the wire. Find the magnetic field, both inside and outside the wire. (8)

Quiz-1 Sec-7. Physics II

2nd Sem 2008-09

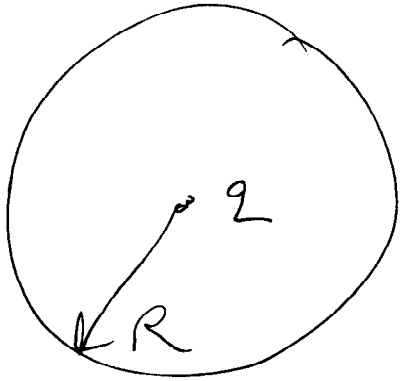
Q1. Calculate the integral

$$\int_0^L \frac{dx}{(x^2+z^2)^{3/2}}$$

(7)

Q2. Calculate the flux (electric) coming out of the sphere due to a point charge at the centre of sphere of radius R.

(8)



BITS PILANI DUBAI

Sec-6

II nd Sem 2008-09

Quiz-3 Physics-II

1. An electron falls from rest through a potential difference of 100 V. What is the de Broglie wave length. (8)

2. A golf ball has a mass of 50 g and travels horizontally with a velocity of 30 m/s. What limit of uncertainity is placed on a measurement of its position if the uncertainity in measuring the velocity is 0.01 m/s ? (7)

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II - semester 2008-09

Quiz-2 - Physics-II

see-6

23/3/09

: A wire of radius a carries volume current density ($J = kS$) proportional to the distance from the axis. Find the total current the wire. (k is constant). (10)

:: A current I flows down a wire of radius a. If it is uniformly distributed over the surface, what is the surface current density ? (5)

Quiz-1. Sec-6, Physics II

2nd Sem 2008-09

Q1. Derive differential form of Gauss's law starting from integral form. (7)

Q2. Prove that $\vec{\nabla} \times \vec{E} = 0$ (8)

Quiz III

Sec V

30/4/09

1. A long wire carrying current 'i' is surrounded by a cylindrical linear magnetic material of susceptibility χ_m & radius R. i) Calculate the bound currents in the material. ii) Calculate H, B, M inside and outside the material. [8]

2. A solenoid with n number of turns per unit length and length L is surrounded by another solenoid which has twice the number of turns as the inner solenoid and 1.5 times the radius of inner solenoid. If the n = 10, L = 30 cm and r_{inner} = 6 cm and the current in the inner solenoid is changing by 3.5 Amps in 6 secs. Calculate
   1) Emf in the outer solenoid
   2) Mutual inductance
   3) Current in the outer solenoid if the resistance is 2 Ω.

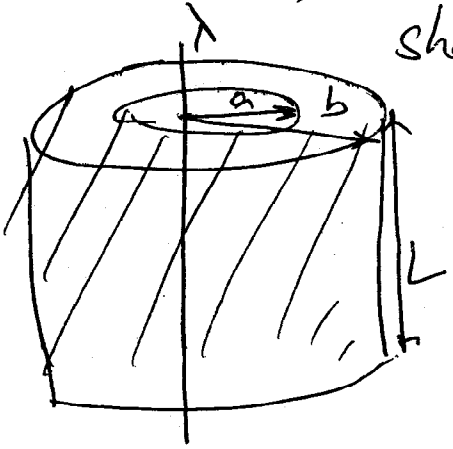
Quiz II

Sec V

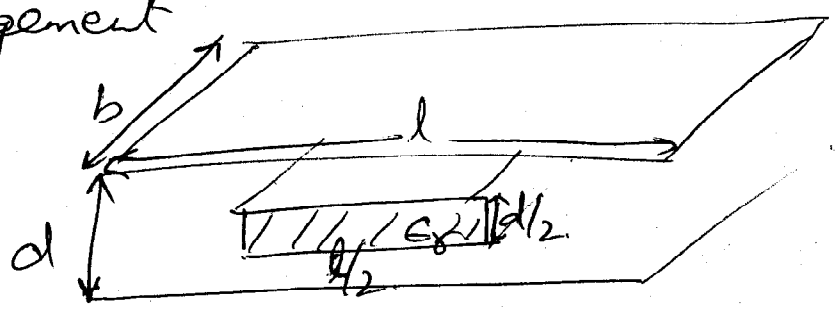
25th March '09

Name: _____ ; ID: _____

1. A linear charge density is surrounded by a cylindrical dielectric shell with $P = k r \hat{r}$
   (a) Calculate the bound charges
   b) Calculate D, E & P in the regions shown.



2. Calculate the equivalent capacitance of the following arrangement



2/3/09

QUIZ I **SEC V**

Name: _____

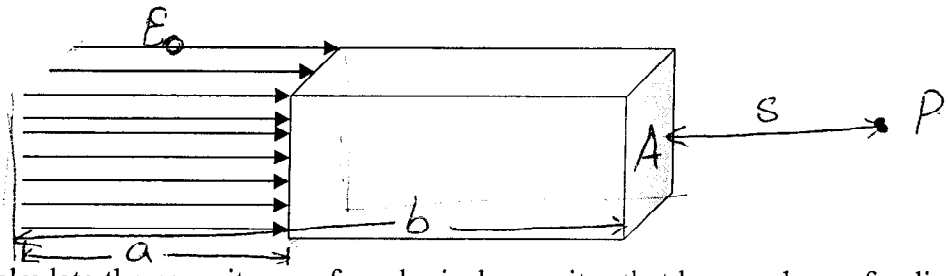
ID: _____

1. In the following situation a neutral metal block of crossectional area A is placed in a field that is originating from Q charges. Calculate the charge densities σ_a and σ_b. What would be the electric field inside the block and outside at point P? **[6]**

σ_a = _____

σ_b = _____

E = _____



2. Calculate the capacitance of a spherical capacitor that has a sphere of radius a and charge q at the center surrounded by a spherical shell of radius b. Hence Calculate the capacitance of Earth that has the radius R= 6400 km. **[9]**

QUIZ III

SEC IV

29/4/09

Q1. A long circular cylinder of radius R carries magnetization $M = k\sqrt{s}\,\hat{z}$. It is placed in a solenoid carrying current I and number of turns per unit length 'n'. Calculate bound currents & H, B, M inside & outside the solenoid [8]

Q2. Long solenoid has a diameter 12.6 cm. When a current i is passed through its windings, a uniform magnetic field B = 28.6 mT is produced inside. $\frac{dB}{dt} = -6.51$ mT/s. Calculate the

i) Self inductance, ii) magnitude of electric field induced at pts a) 2.20 cm and b) 8.20 cm $L = 30$ cm

Solu 1. $K_b = M \times \hat{n} = k\sqrt{R}\,\hat{\phi}$, $J_b = \nabla \times M = -\left[\frac{d}{ds} k\sqrt{s}\right]$

$= +\frac{1}{2} k s^{-1/2} (-\hat{\phi})$

$H_{inside} = nI\hat{z}$, $M_{inside} = k\sqrt{s}\,\hat{z}$, $B = \mu_0 [nI + k\sqrt{s}]\hat{z}$

$H_{outside} = 0$, $M_{out} = 0$, $B = 0$

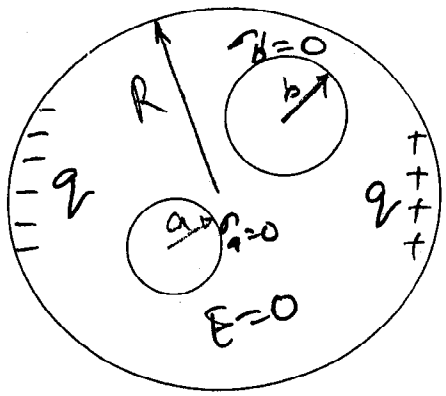
12:30

QUIZ I SEC IV

Name: _____

ID: _____

1. In the following situation a neutral metal sphere has two cavities cut in it. The cavities have radii a and b. A q charge is placed as shown. Show the charges on the big sphere and hence calculate the charge densities σ_a and σ_b. What would be the electric field inside the big sphere and outside at point P?[8]



2. Calculate the capacitance of a parallel plate capacitor that has a charge density σ and area of the plate is A. Calculate by deducing the potential difference between the plates that are separated by a distance d. [7]

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Quiz II

Section III **Date: 23.03.2009**

Student Name:	**ID NO:**

1 A sphere of radius R carries a polarization of P (r)= k r where k is a constant and r is the vector from the center. Calculate the bound charges. (Given $\nabla \cdot v = \frac{1}{r^2} \frac{\partial}{\partial r}(r^2 v_r)$) (5)

2 A dielectric slab of thickness b is inserted between the plates of a parallel plate capacitor of plate separation d air filled with thickness x. All plates have an area A. Show that the capacitance C is given by

$$C = k_e \varepsilon_o A / k_e d - b(ke-1)$$ (5)

3. A current I is uniformly distributed over a wire of circular cross section with radius a. find the volume current density J and suppose the current density in the wire is proportional to the distance from the axis J = ks (for some constant k). Find the total current in the wire. (5)

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Quiz I

Section III **Date: 25.02.2009**

Student Name:	**ID NO:**

1. Three capacitors of equal capacitance have a net capacitance C_1 when connected in series and a net capacitance C_2 when connected in parallel. What is the ratio of C_1/C_2. (5)

2. A parallel plate capacitor of capacity of 100μF is charged by a battery of 50 volts. The battery remains connected and if the plates are brought closer so that the distance between them becomes half the original distance. What is the additional energy supplied by the battery to the capacitor in Joules. (5)

3. A charged sphere of diameter 4cm has a charge density of 10^{-4} C/cm^2. What is the work done in joules when a charge of 40×10^{-9}C is moved from infinity to a point which is at a distance of 2cm from the surface of the sphere. (5)

Quiz III

Sec II

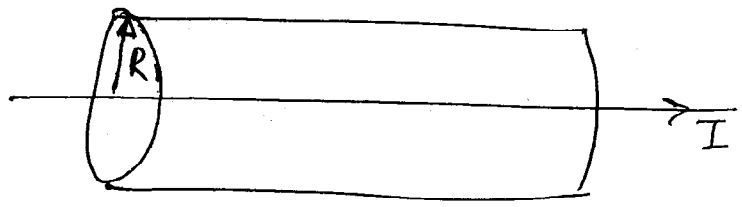
4/5/09

1. A wire carrying current I is surrounded by a cylindrical material having a Magnetization $M = ks^2 \hat{\phi}$. Radius R

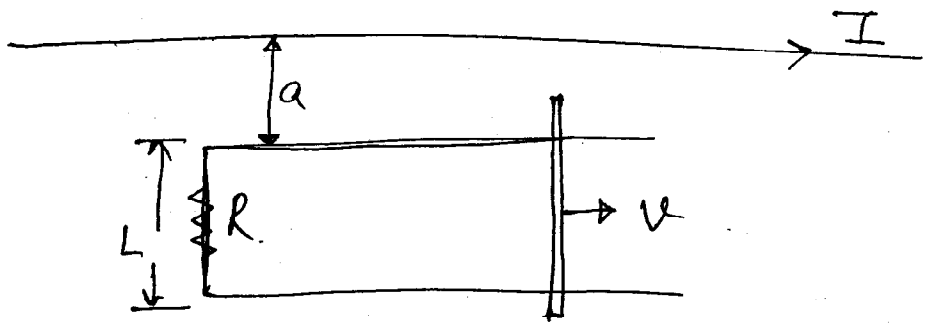
a) Calculate the bound currents

b) Calculate H, B & M at $s < R$ & $s > R$

[8]



2.



a) Calculate emf $\mathcal{E}$ & current [magnitude & direction] in the rectangular loop.

b) Calculate the energy dissipated through the resistor in time 't'.

[7]

QUIZ II

SEC II

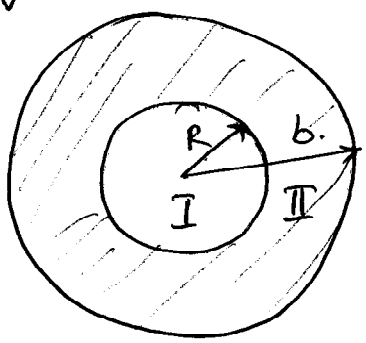
24th March '09

Name: _____ ; ID: _____

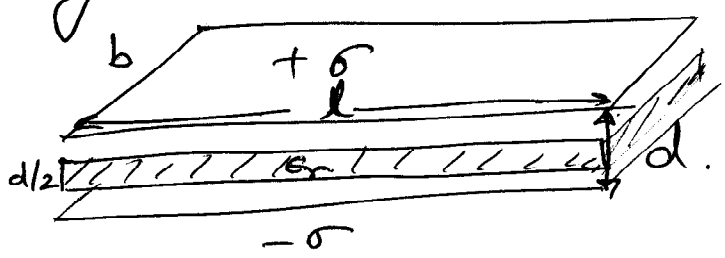
1. In a dielectric with uniform polarization $\vec{P}$ along lay the surface bound charges are _____ and the volume bound charges are _____. [2]

2. A spherical conductor of radius R, is surrounded by a dielectric upto a radius of 'b'. The polarization in dielectric is $\frac{k}{r}\hat{r}$. Calculate D, E & P in the three regions i) $r < R$ ii) $b > r > R$ and iii) $r > b$ [6]

carrying q charges



3. Calculate the capacitance of the following arrangement. [7]



2/3/09

QUIZ I **SEC II**

Name: _____

ID: _____

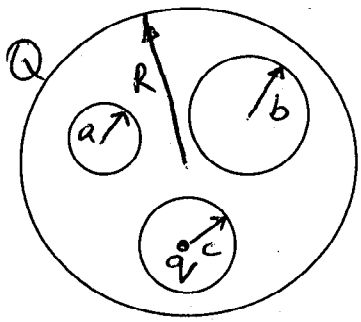
1. In the following situation a charged metal sphere with Q charges has three cavities cut in it. The cavities have radii a, b and c. The cavity with radius c has q charges placed at its center. Calculate the charge densities σ_a σ_b and σ_c & σ_R What would be the electric field inside the block and outside at point P?**[8]**

$\sigma_a =$

$\sigma_b =$

$\sigma_c =$

$\sigma_R =$



P

2. Calculate the capacitance of a cylindrical capacitor that has a rod of radius a and charge q at the center surrounded by a cylindrical shell of radius b. **[7]**

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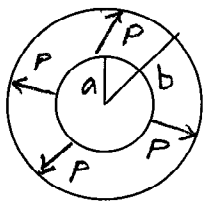
Quiz II

Section I **Date: 24.03.2009**

Student Name:	**ID NO:**

1. A thick spherical shell (inner radius **a** and outer radius **b**) is made of dielectric material with a frozen in polarization $\mathbf{P(r) = k/r\,\hat{r}}$ where **k** is a constant and **r** is the distance from the centre. Locate all the bound charges. (5)

[Given $\nabla \cdot V = \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 V_r) + \cdots$]



2. A parallel plate capacitor having plate area $100cm^2$ and separation 1.00mm holds a charge of $0.12\mu C$ when connected to a 120V battery. Find the dielectric constant of the material filling the gap. ($\epsilon_0 = 8.85 \times 10^{-12}$ F/m) (5)

3. Figure shows two long straight wires carrying electric currents in opposite directions. The separation between the wire is 5.0cm. Find the magnetic field at a point **P** midway between the wires. ($\mu_0 = 4\pi \times 10^{-7}$ T m/A) (5)