UNIVERSITY OF FORT HARE

University of Fort Hare
Together In Excellence

ELECTRICITY AND MAGNETISM
(PHY 121)

SUPPLEMENTARY EXAMINATIONS

JANUARY 2019

DURATION: 3 HOURS

MARKS: 100

INTERNAL EXAMINER	MODERATOR
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INSTRUCTIONS FOR CANDIDATES

Read the question more than once and clearly write down your data

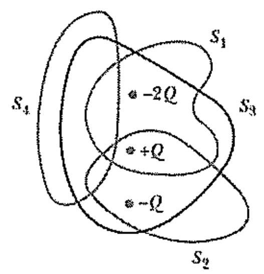
Answer all questions

Useful information are provided at the end of the question paper

GAUSS'S LAW (25marks)

1.1 A solid sphere of radius 40.0 cm has a total positive charge of 26.0 μC uniformly distributed throughout its volume. Calculate the magnitude of the electric field (a) 0 cm, (b) 10.0 cm, (c) 40.0 cm, and (d) 60.0 cm from the center of the sphere.

1.2 Four closed surfaces, S1 through S4, together with the charges -2Q , Q , and -Q are sketched in Figure below. (The colored lines are the intersections of the surfaces with the page.) Find the electric flux through each surface.



1.3 On a clear, sunny day, a vertical electric field of about 130 N/C points down over flat ground. What is the surface charge density on the ground for these conditions? (ε_0 = 8.8542 x 10^{-12} C^2/Nm^2).

ELECTRIC POTENTIAL (25marks)

2.1 At a certain distance from a point charge, the magnitude of the electric field is 500 V/m and the electric potential is -3.00 kV. (a) What is the distance to the charge? (b) What is the magnitude of the charge?

2.2 The three charges in Figure 2 are at the vertices of an isosceles triangle. Calculate the electric potential at the midpoint of the base, taking q = 7.00 +C.

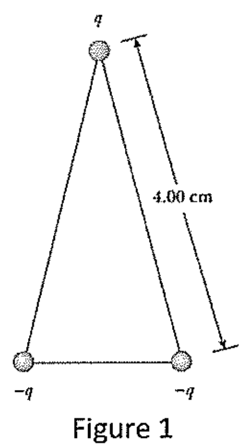


Figure 1

2.3 An ion accelerated through a potential difference of 115 V experiences an increase in kinetic energy of 7.37×10^{-17} J. Calculate the charge on the ion.

CAPACITANCE AND DIELECTRIC (25marks)

3.1 Determine (a) the capacitance and (b) the maximum potential difference that can be applied to a Teflon-filled parallel-plate capacitor having a plate area of 1.75 cm^2 and plate separation of 0.040 0 mm (Dielectric constant for Teflon is 2.1 and dielectric strength for Teflon is 60×10^6 V/m).

3.2 A 3.00µF capacitor is connected to a 12.0-V battery. How much energy is stored in the capacitor? (b) If the capacitor had been connected to a 6.00-V battery, how much energy would have been stored?

3.3 How much charge is on each plate of a 4.00µF capacitor when it is connected to a 12.0-V battery? (b) If this same capacitor is connected to a 1.50-V battery, what charge is stored?.

CURRENT AND RESISTANCE (25marks)

4.1 An experiment is conducted to measure the electrical resistivity of Nichrome wire with different lengths and cross-sectional area of $7.30 \times 10^{-8} m^2$. The obtained data is shown below, find the resistance and resistivity for the three length.

L (m)	ΔV (V)	I (A)	R(Ω	P (Ωm)
0.540	5.22	0.500		
1.028	5.82	0.276		
1.543	5.94	0.187		

4.2 In a particular cathode ray tube, the measured beam current is 30.0 /A. How many electrons strike the tube screen every 40.0 s?

4.3 A 10.0-V battery is connected to a 120Ω resistor. Ignoring the internal resistance of the battery, calculate the power delivered to the resistor.

Formula Sheet (PHY121)

$\vec{F}_{12} = k_e \frac{q_1 q_2}{r_{12}^2}\hat{r}$, $\vec{E} = \frac{\vec{F}}{q}$, $\vec{E} = k_e \frac{q}{r^2}\hat{r}$, $\vec{E} = k_e \sum_i \frac{q_i}{r_i^2}\hat{r}$, $\vec{E} = k_e \int \frac{dq}{r^2}\hat{r}$, $q = \pm Ne$,

$dq = \rho dV$, $dq = \sigma dA$, $dq = \lambda dl$, $\rho = \frac{Q}{V}$, $\sigma = \frac{Q}{A}$, $\lambda = \frac{Q}{l}$, $\vec{a} = \frac{q\vec{E}}{m}$,

$v_{xf} = v_{xi} + a_x t$, $v_{xf}^2 = v_{xi}^2 + 2a_x(x_f - x_i)$, $x_f = x_i + v_x t + \frac{1}{2}a_x t^2$, $x_f = x_i + \frac{1}{2}(v_{xi} + v_{xf})t$

$\Phi_E = EA\cos\theta$, $\Phi_E = \int_{surface} \vec{E}.d\vec{A}$, $\Phi_E = \oint \vec{E}.d\vec{A} = \frac{q_{enc}}{\varepsilon_0}$, $A_{sphere} = 4\pi r^2$, $A_{cylinder} = 2\pi rl$

$V_{sphere} = \frac{4}{3}\pi r^3$, $\vec{F} = q\vec{E}$, $\Delta U = -q\vec{E}\cdot d\vec{s}$, $\Delta U = -q\int_A^B \vec{E}\cdot d\vec{s}$, $\Delta V = \frac{\Delta U}{q}$, $\Delta V = -\int_A^B \vec{E}\cdot d\vec{s}$,

$\Delta V = Ed$, $V = k_e \frac{q}{r}$, $V = k_e \sum_i \frac{q_i}{r_i}$, $U = k_e \frac{q_1 q_2}{r_{12}}$, $U = k_e \sum_i \frac{q q_i}{r_i}$, $E_x = \frac{\partial V}{\partial x}$, $E_y = \frac{\partial V}{\partial y}$,

$E_z = \frac{\partial V}{\partial z}$, $C = \frac{Q}{\Delta V}$, $\sigma = \frac{Q}{A}$, $C = \frac{\varepsilon_o A}{d}$, $Q_{eq} = Q_1 + Q_2$, $C_{eq} = C_1 + C_2$,

$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$, $\Delta V_{eq} = \Delta V_1 + \Delta V_2$, $W = U = \frac{Q^2}{2C} = \frac{1}{2}Q\Delta V = \frac{1}{2}C(\Delta V)^2$, $U = \frac{1}{2}\varepsilon_o AdE^2$,

$u_E = \frac{1}{2}\varepsilon_o E^2$, $C = \kappa C_o$, $C = \kappa \frac{\varepsilon_o A}{d}$, $Q = \kappa Q_o$, $V = \frac{V_o}{\kappa}$, $I_{avg} = \frac{\Delta Q}{\Delta t}$, $I_{ins} = \frac{dQ}{dt}$,

$I_{avg} = nqv_d A$, $J = nqv_d$, $J = \frac{I}{A}$, $J = \sigma E$, $\rho = \frac{1}{\sigma}$, $V = IR$, $R = \rho \frac{l}{A}$, $a = \frac{qE}{m}$,

$v_d = \frac{qE}{m}\tau$, $\sigma = \frac{nq^2\tau}{m}$, $\rho = \frac{m}{nq^2\tau}$, $\rho = \rho_0[1 + \alpha(T - T_0)]$, $R = R_0[1 + \alpha(T - T_0)]$, $\Delta V = \varepsilon - Ir$,

$P = I\Delta V$, $\rho = \frac{m}{V}$ $P = I^2(R + r)$, $R_{eq} = R_1 + R_2 + R_3 + \ldots$, $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$,

$\sum_{junction} I = 0$, $\sum_{closed\ loop} V = 0$, $q(t) = Q\left(1 - e^{-t/RC}\right)$, $I(t) = \frac{\varepsilon}{R}e^{-t/RC}$, $Q = C\varepsilon$, $\tau = RC$,

$q(t) = Qe^{-t/RC}$, $I_i = \frac{Q}{RC}$ $I(t) = -I_i e^{-t/RC}$, $\vec{F} = q\vec{v}\times\vec{B}$, $F = |q|vB\sin\theta$,