Date: April 2018

Duration: 90 minutes

SUBJECT: **PHYSICS 3**	
Chair of Department of Physics: Signature: Full name: Phan Bảo Ngọc	Lecturer: Signature: Full name: Phan Bảo Ngọc

INSTRUCTIONS: This is a closed book examination. Use of cell phones, laptops and dictionaries is not allowed.

1/ (20 pts) Two 0.5-g spheres are charged equally and place 2.0 cm apart. When we released them, each sphere begins to accelerate at 250 m/s^2. Find the magnitude of the charge on each sphere. ($k = 9.0\times10^9$ N.m^2/C^2)

2/ (20 pts) The work done by an applied force to turn an electric dipole 180^0 in a uniform electric field is 2.0×10^{-23} J. Find the magnitude of electric field if the dipole moment $p = 3.0\times10^{-25}$ C.m, and the initial angle of the dipole with respect to the electric field direction is 65^0. ($W_{applied} = \Delta U$; $U = -pE\cos\theta$)

3/ (20 pts) A solid insulating sphere has a charge of 314×10^{-7} C uniformly distributed throughout its volume. The magnitude of the electric fields inside the sphere at r = 3 cm and outside the sphere at r = 10 cm, measured from the center of the sphere, are equal. Determine the volume charge density of the sphere.

4/ (20 pts) A circuit is shown in Figure 1. The currents in each branch are assumed to move in the directions as shown. Find the rate of energy dissipation in R_3 if R_1 = 2.0 Ω, R_2 = 4.0 Ω, R_3 = 8.0 Ω, ε_1 = 2.0 V, ε_2 = 4.0 V, and ε_3 = 6.0 V.

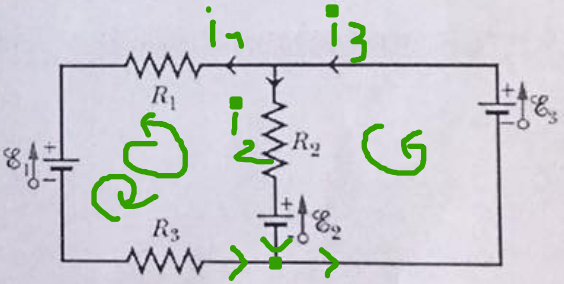

Figure 1

5/ (20 pts) A 5.0-μF capacitor is fully charged by a battery of 12 V. After disconnecting the battery, the capacitor is discharged through a simple RC circuit of time constant 4.0 s.

(a) Find the charge on the capacitor after two time constants of time have elapsed.

(b) The resistance R.

END OF QUESTION PAPER

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1)

$F = m.a = 0{,}0005 . 250 = 0{,}125\ (N)$

$F = k . \frac{q^2}{r^2} \Rightarrow q = \sqrt{\frac{F.r^2}{k}} = \sqrt{\frac{0{,}125 . 0{,}02^2}{8{,}99.10^9}} = 7{,}46.10^{-8}\ (C)$

2)

$\Delta U = U_g - U_i = -pE\cos\theta_g + pE\cos\theta_i = pE(\cos 245^\circ - \cos 65^\circ)$

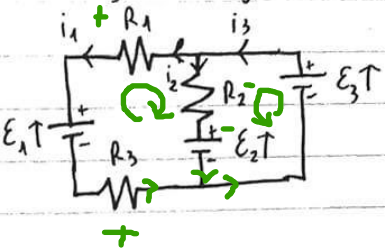
$\Rightarrow E = \frac{-\Delta U}{p(\cos 245^\circ - \cos 65^\circ)} = 78{,}87\ (N/C)$

3)

$E_3 = E_{10} \Leftrightarrow \frac{q}{4\pi\varepsilon_0 R^3} r_3 = \frac{q}{4\pi\varepsilon_0 r_{10}^2} \Rightarrow R^3 = r_3 . r_{10}^2 = 0{,}0003\ (m^3)$

$\theta = \frac{Q}{\frac{4}{3}\pi R^3} = \frac{3{,}14.10^{-7}}{\frac{4}{3}\pi . 0{,}0003} = 0{,}025\ (C/m^3)$

4)



$+\varepsilon_3 - u_2 - \varepsilon_2$

$$\begin{cases} i_1 + i_2 = i_3 \\ \varepsilon_1 + i_1 R_1 - i_2 R_2 + i_3 R_3 - \varepsilon_2 = 0 \\ \varepsilon_2 + i_2 R_2 - \varepsilon_3 = 0 \end{cases}$$

$$\Rightarrow \begin{cases} i_1 = 0{,}4\ (A) \\ i_2 = 0{,}5\ (A) \\ i_3 = 0{,}9\ (A) \end{cases}$$ ✗

5)

$q_0 = C.V = 5.10^{-6} . 12 = 60.10^{-6}\ (C)$

a) $\begin{cases} q = q_0 . e^{-t/RC} \\ \text{two time constant} \end{cases} \Rightarrow q = q_0 . e^{-2} = 60.10^{-6} . e^{-2} = 8{,}12.10^{-6}\ (C)$

b) $RC = 4s \Rightarrow R = \frac{4}{C} = 800.000\ (\Omega)$