**KING ABDULAZIZ UNIVERSITY- FACULTY OF SCIENCE**

**PHYSICS DEPARTMENT- ELECTRICITY & MAGNETISM (PHYS 202)**

**A**

**EXAM II** **SUMMER TERM 2011** **TIME: 90 MINS**

**Student Name:** ……………………………… **Student Number:** ………………………… **Section:** ……………………

***Encircle the correct answers for the following problems.***

**1.** The electric field at 5 cm from a point charge is 36 kN/C. The electric potential at 2 cm from the charge is:

(a) 4.5 kV (b) 3 kV (c) 2.25 kV (d) 1.5 kV (e) zero

**2.** The electric potential at the surface of a solid sphere of radius 4 cm and charge 16 nC is:

(a) 3.6 kV (b) 4.8 kV (c) 7.2 kV (d) 14.4 kV (e) zero

**3.** The electric potential at the center of a conducting sphere of radius 5 cm is 360 V. The magnitude of the electric field at the center of the sphere is:

(a) 7200 N/C (b) 72 N/C (c) 18 N/C (d) 1800 N/C (e) zero

**4.** In **Fig. 1**, the work needed to bring a charge of 3 mC from infinity ($V_\infty$=0) to point A is:

(a) 24 J (b) 18 J (c) 36 J (d) 30 J (e) 42 J

**5.** A parallel-plate capacitor, of plate area 2 $m^2$, has a charge of 5 nC when it is connected to a potential difference of 10 V. The separation between the capacitor's plates is:

(a) 2.95 cm (b) 3.54 cm (c) 2.21 cm (d) 8.85 cm (e) 1 cm

**6.** An isolated sphere of radius 4 cm is connected to a potential difference of 12 V. The energy stored in the sphere is:

(a) $2\times10^{-11}$ J (b) $8\times10^{-11}$ J (c) $3.2\times10^{-10}$ J (d) $1.8\times10^{-10}$ J (e) zero

**7.** A parallel-plate capacitor is fully charged to 16 μC when connected to an 8 V battery. If the battery is removed and a dielectric (κ=2.0) is inserted in entire space, the potential difference across the plates will be:

(a) 3.2 V (b) 1 V (c) 4 V (d) 1.6 V (e) 2 V

**8.** In **Fig.2**, the charge on the capacitor $C_1$ is:

(a) 48 μC (b) 64 μC (c) 8 V (d) 16 μC (e) 16 V

**9.** A current of 0.5 A passes through a cylindrical wire of radius 0.5 mm and length 3 m if a voltage of 3.25 V is applied. The resistivity of the wire (in SI units) is:

(a) $1.7\times10^{-6}$ (b) $8.5\times10^{-7}$ (c) $3.4\times10^{-6}$ (d) $1.3\times10^{-7}$ (e) zero

**10.** In **Fig. 3**, the current passing through the resistor $\mathbf{R_1}$ is:

(a) 12 V (b) 30 V (c) 10 V (d) 2 A (e) 1 A

**11.** The power dissipation rate through a 16 Ω-resistor is 4.0 W. The voltage across the resistor is:

(a) 18 V (b) 4 V (c) 12 V (d) 11 V (e) 8 V

**12.** In RC circuit, the current passing through the circuit during charging process is:

(a) increasing (b) constant (c) decreasing (d) oscillating (e) zero

**13.** An uncharged 10 μF capacitor is connected to a battery and a resistor R. If it takes 4 s to reach half its maximum current, the value of R is:

(a) 577 kΩ (b) 721 kΩ (c) 1.4 MΩ (d) 289 kΩ (e) 14 Ω

**14.** The internal resistance of an ideal battery is always:

(a) greater than zero (b) 1 Ω (c) smaller than zero (d) voltage dependent (e) zero

**15.** According to Kirchhoff's roles, the correct statement is:

(a) For any closed loop, the summation of currents is always zero.

(b) For any junction point, the summation of currents leaving and entering is always greater than zero.

(c) For any closed loop, the summation of potentials is always less than zero.

(d) For any junction point, the summation of currents leaving and entering is zero.

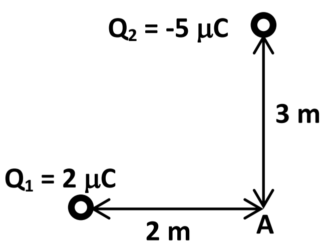



Fig. 1

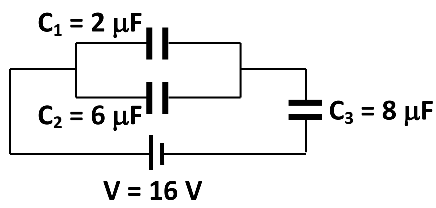



Fig. 2

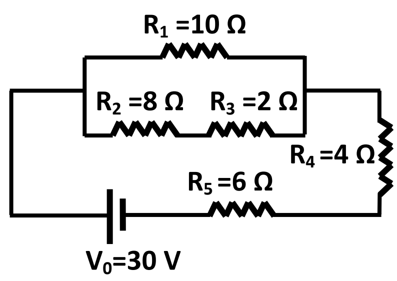



Fig. 3

| Physical quantity | Value | Physical quantity | Value |
|---|---|---|---|
| Charge of electron | $\|e\|= 1.6\times10^{-19}$ C | Charge of proton | $e= 1.6\times10^{-19}$ C |
| Mass of electron | $m_e=9.11\times10^{-31}$ kg | Mass of proton | $m_p=1.67\times10^{-27}$ kg |
| Coulomb's constant | $k=9\times10^{9}$ N.m²/C² | Permittivity constant | $\varepsilon_o=8.85\times10^{-12}$ C²/(N.m²) |

| English Word | Arabic meaning | English Word | Arabic meaning | English Word | Arabic meaning |
|---|---|---|---|---|---|
| **Conducting** | موصل | **Dissipation** | التبديد (الهدر) | **Separation** | مسافة |
| **Dielectric** | عازل | **Ideal** | مثالي | **Solid** | مصمت |

# Exam II summer 2011

① $E = \frac{kq}{r^2} \Rightarrow q = \frac{E r^2}{k} = \frac{36\times10^{3} \times (0.05)^2}{9\times10^9} = 10\ nC$

Then

$V = \frac{kq}{r} = \frac{9\times10^{9} \times 10\times10^{-9}}{0.02} = 4.5\ kV$

② $V = \frac{kq}{r} = \frac{9\times10^{9} \times 16\times10^{-9}}{0.04} = 3.6\ kV$

③ لدي كرة موصلة conductor فإن المجال داخلها يساوي صفر
لعدم وجود شحنة داخلها $E = 0$

④ اولاً، نحسب الجهد الكلي عند النقطة A

$V = \frac{kQ_1}{r_1} + \frac{kQ_2}{r_2} = k\left(\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right) = 9\times10^{9}\left(\frac{-5\times10^{-6}}{3} + \frac{2\times10^{-6}}{2}\right)$

$V = -6\ kV$

وبالتالي يكون الشغل اللازم يساوي

$W = -qV = -3\times10^{-3} \times (-6\times10^{3}) = 18\ J$

⑤ $C = \frac{Q}{V} = \frac{5\times10^{-9}}{10} = 5\times10^{-10}\ F$

$C = \frac{A\epsilon_0}{d} \Rightarrow d = \frac{A\epsilon_0}{C} = \frac{2\times 8.85\times10^{-12}}{5\times10^{-10}} = 3.54\ cm$

⑥ $C = 4\pi\epsilon_0 R = 4\pi \times 8.85\times10^{-12} \times 0.04 = 4.45\ pF$

$U = \frac{1}{2}CV^2 = \frac{1}{2} \times 4.45\times10^{-12} \times (12)^2 = 3.2\times10^{-10}\ J$

⑦ $C = \frac{Q}{V} = \frac{16\times10^{-6}}{8} = 2\times10^{-6}\ F$

$C' = kC = 2\times2\times10^{-6} = 4\times10^{-6}\ F$

Hence

$V' = \frac{Q}{C'} = \frac{16\times10^{-6}}{4\times10^{-6}} = 4\ V$

(8) أولاً، نحسب الشحنة الكلية وذلك بحساب السعة المكافئة للدائرة

$$C_{eq} = \frac{(C_1 + C_2)\cdot C_3}{(C_1 + C_2) + C_3} = 4\ \mu F$$

$$Q_{tot} = C_{eq} V = 4\times10^{-6} \times 16 = 64\times10^{-6}\ C$$

بما أن $C_1$ ، $C_2$ متصلتان على التوازي، فإن الجهد عليهما ثابت. الآن نحسب الجهد عليهما

$$V_{12} = \frac{Q_{tot}}{C_{12}} = \frac{64\times10^{-6}}{8\times10^{-6}} = 8\ V$$

وبالتالي تكون الشحنة على المكثف $C_1$ تساوي

$$Q_1 = C_1 V_{12} = 2\times10^{-6} \times 8 = 16\ \mu C$$

(9) $R = \frac{V}{I} = \frac{3.25}{0.5} = 6.5\ \Omega$

$$\rho = \frac{RA}{L} = \frac{6.5 \times \pi(0.5\times10^{-3})^2}{3} = 1.7\times10^{-6}\ \Omega.m$$

(10) التيار الكلي المار في الدائرة يساوي الجهد على المقاومة المكافئة

$$R_{eq} = \frac{R_1(R_2+R_3)}{R_1+(R_2+R_3)} + R_4 + R_4 = \frac{10(10)}{20} + 4 + 6 = 15\ \Omega$$

وحيث أن $R_1$ مربوطة على التوازي مع $R_2$ ، $R_3$ فإن الجهد عليهما متساوي

$$i = \frac{V}{R_{eq}} = \frac{30}{15} = 2\ A$$

$$V_{123} = i R_{123} = i\left(\frac{R_1(R_2+R_3)}{R_1+(R_2+R_3)}\right) = 2\times\left(\frac{10\times10}{10+10}\right) = 10\ V$$

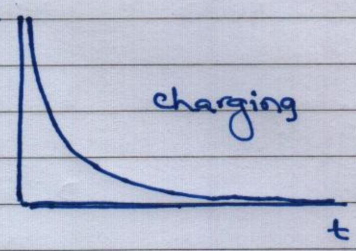
وبالتالي يصبح التيار المار في $R_1$ يساوي

$$i_1 = \frac{V_{123}}{R_1} = \frac{10}{10} = 1\ A$$

(11) $P = \frac{V^2}{R} \Rightarrow V = \sqrt{RP} = \sqrt{16\times4} = 8\ V$

(12)

خلال شحن المكثف ، يكون التيار اقصى ما يمكن في البداية
ثم يبدأ بالتناقص decreasing




(13)

$$I = I_0 \, e^{-t/RC}$$

بعد 4 ثوان يصبح $I = \frac{1}{2} I_0$

$$\Downarrow$$

$$\frac{I}{I_0} = e^{-t/RC} \Rightarrow \ln\left(\frac{I}{I_0}\right) = -t/RC$$

$$R = \frac{-t}{C \ln(I/I_0)} = -\frac{4}{10\times10^{-6} \ln\left(\frac{\frac{1}{2}I_0}{I_0}\right)} = 577 \text{ k}\Omega$$

(14) لأن البطارية مثالية ideal فإن المقاومة الداخلية لها تساوي صفر

(15) ينص قانون كيرشوف على أن مجموع التيارات الداخلة يساوي مجموع التيارات الخارجة وبالتالي تكون المحصلة عند العقدة تساوي صفراً.