University of Bahrain **PHYCS 102** **Summer 02/03**
College of Science **Test Two** **Date: 10/8/2003**
Dept of Physics ***Time:50 min.***

Name:--ID no.------------------------------------Sec.no.--------

Use: g = 10 m/s², $\varepsilon_o = 8.85\times10^{-12} C^2/N.m^2$, K = 9 x 10^9 N.m²/C²

---

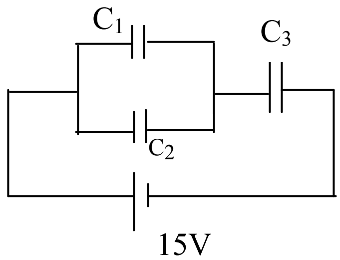
1) A parallel-plate capacitor of plate separation *d* = 1.0 mm is filled with an insulator of dielectric constant k = 2.5 (3.0, 3.5, 4.0). The capacitor is charged to a potential difference of 10V. Find the charge density σ of the capacitor (in nC/m²).

a) 221.2 b) 265.5 c) 309.7 d) 354.0

Ans: $Q = CV \ \therefore \sigma = \dfrac{\varepsilon_o kV}{d} = 221.2$

---

2) Three capacitors are connected as shown in the figure where C_1 = 0.25 μF, C_2 = 0.75 μF and C_3 = (1.0, 2.0, 3.0, 4.0) μF. Find the charge (in μC) on the capacitor C_3.

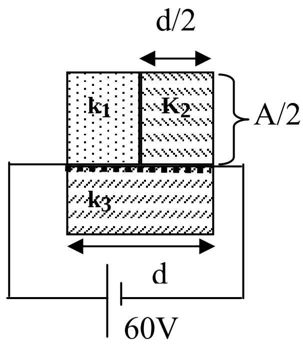


a) 7.5 b) 10.0 c) 11.3 d) 12.0

Ans: $C_{eq} = \{(C_1 // C_2) = C_3\} = \dfrac{1\times1}{1+1} = 0.5\,\mu F \ ; \ Q = Q_3 = C_{eq}\times 15 = 7.5\,\mu C$

---

3) A parallel-plate capacitor of plate area A = 10 cm² and plate separation d = 2 mm is constructed using three insulators of k_1 = 2.5 (3.5, 4.5, 6.5), k_2 = 5.0 and k_3 = 6.2, as shown in the figure. Find the voltage across the dielectric of constant k_1.

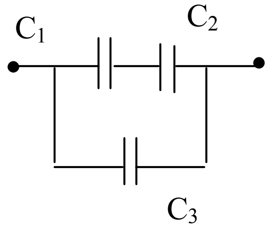


a) 40.0 b) 35.3 c) 31.6 d) 26.0

Ans: $C_1 = \dfrac{\varepsilon_o k_1 \left(\dfrac{A}{2}\right)}{(d/2)} = 11.06, \quad C_2 = 22.12$

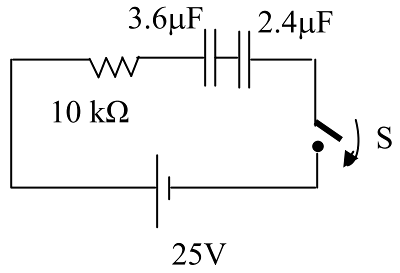
$V_1 + V_2 = 60 \ ; \quad C_1V_1 = C_2V_2$

$\therefore V_1 = 40V$



---

4) Starting from the uncharged state of the shown circuit, the time (in s) that it takes for the charge to reach the value 2.5 (3.3, 3.0, 2.0) x 10^{-5}C is :



a) 1.71 x 10^{-2} b) 3.58 x 10^{-2}

c) 2.58 x 10^{-2} d) 1.17 x 10^{-2}

Ans:

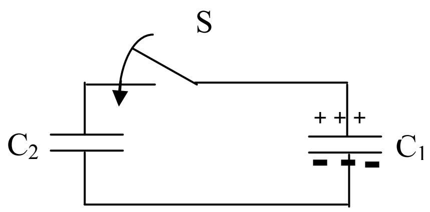
$$C_{eq} = \frac{3.6 \times 2.4}{3.6 + 2.4} = 1.44\mu F \ , \ \tau = RC = 1.44 \times 10^{-2} s,$$

$$Q_o = C_{eq}\varepsilon = 36\mu C \quad , \quad Q = Q_o\left(1 - e^{-t/\tau}\right)$$

$$t = -\tau \ell n\left(1 - \frac{Q}{Q_o}\right) = 1.71 \times 10^{-2} s$$

---

5) The capacitor C_1 = 3μF that was fully charged to a potential difference of 10V is now connected to another uncharged capacitor C_2 = 1.5 (1.0, 0.75, 0.6) μF by closing of the switch S as shown in the figure. Find the final charge of C_2 (in μC).



a) 10.0 b) 7.5 c) 6.0 d) 5.0

Ans:

$$\left.\begin{aligned} Q_o = C_1 V = 30\mu C \ , \ 30\mu = Q_1 + Q_2 \\ \frac{Q_1}{C_1} = \frac{Q_2}{C_2} \end{aligned}\right\} \begin{aligned} Q_1 = 2Q_2 \\ Q_2 = 10\mu C \end{aligned}$$

---

6) A battery with an electromotive force ε = (6, 7, 8, 9)V and internal resistance of 0.5 Ω is connected to 4.5 Ω resistor. The power (in Watt) consumed by the resistor has a value of:-

a) 6.48 b) 8.82 c) 11.52 d) 14.58

Ans:

$$P = I^2 R = \left(\frac{\varepsilon}{R + r}\right)^2 R = 6.48W$$

---

7) Nicrome wire of radius 0.32 mm, length 1m, and resistivity 150 μ Ω . cm. If the electric power dissipated in the wire is 73.6 (95.4, 120.3, 150.7)W, find the electric field in (V/m) inside the wire.

a) 18.5 b) 21.1 c) 23.7 d) 26.5

Ans:

$$R = \frac{\rho \ell}{A} = 4.66\Omega \ , \ \rho = \frac{V^2}{R} = \frac{E^2 \ell^2}{R} \ , \ E = \frac{\sqrt{PR}}{\ell} = 18.5V/m$$

---

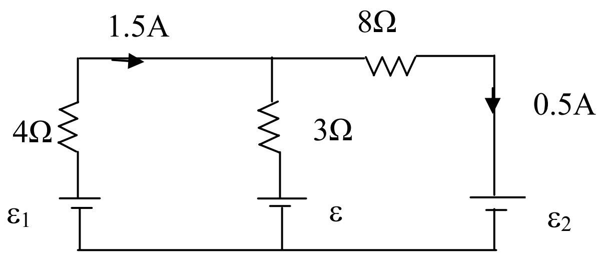
8) A certain light bulb has a tungsten filament with a resistance of 19.0 Ω when cold (20°C) and of (140, 120, 90,70) Ω when hot. Find the temperature (°C) of the filament when hot. (the temperature coefficient of resistivity α is 4.5 x 10^{-3} °C^{-1}).

a) 1.44 x 10^3 b) 1.20 x 10^3 c) 850.4 d) 616.5

Ans: $R_h = R_c\left[1+\alpha\left(T-20\right)\right]$, $T = \dfrac{R_h - R_c}{\alpha R_c} + 20 = 1435.2^o C$

---

9) In the shown circuit, if ε_1 = 21 (18,15,12)V and ε_2 = 11(8,5,2) V, then ε(in volt) is:

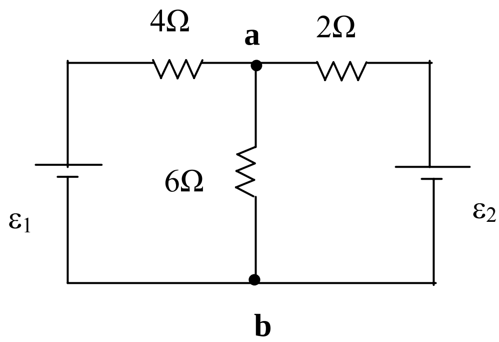


a) 12 b) 9 c) 6 d) 3

Ans: $V_{ab} = -1.5\times4+21 = 15V$, $15 = +1\times3+\varepsilon$, $\varepsilon = 12V$

---

10) In the shown circuit , ε_1 = 9(8,6,5)V and ε_2 = 12V. The potential difference V_{ab} across the resistance 6Ω (in volts) is:



a) 9.0 b) 8.73 c) 8.18 d) 7.90

Ans:
$$\left.\begin{aligned} I_1 &= I_2 + I_3 \\ 4I_2 - 6I_3 &= -9 \\ 2I_1 + 6I_3 &= 12 \end{aligned}\right\} \Rightarrow I_3 = 1.5A \,,\, V_{ab} = 1.5\times6 = 9V$$