

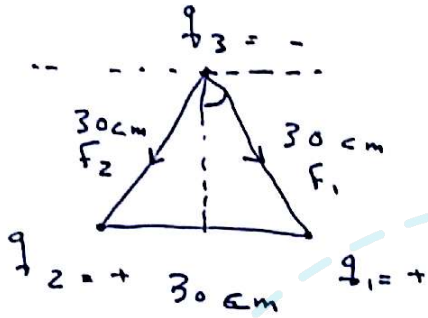
$$1 - F = \frac{k q_1 q_2}{r^2} = \frac{9 \times 10^9 \times 5 \times 10^{-6} \times 20 \times 10^{-6}}{(50 \times 10^{-2})^2}$$

$$F = 3.6 \text{ N}$$

→

$$a = \frac{F}{m} = \frac{3.6}{50 \times 10^{-3}} = 72$$

2 -



$$F_1 = F_2 = \frac{k q^2}{r^2} = \frac{9 \times 10^9 \times (20 \times 10^{-6})^2}{(30 \times 10^{-2})^2}$$

$$F_1 = F_2 = 40 \text{ N}$$



$$\sum F_x = 0$$

$$\sum F_y = F_1 \cos 30 + F_2 \cos 30$$

$$\sum F_y = 69$$

3 -

$$L = x_2 - x_1 = 3 - (-2) = 5 \text{ m}$$

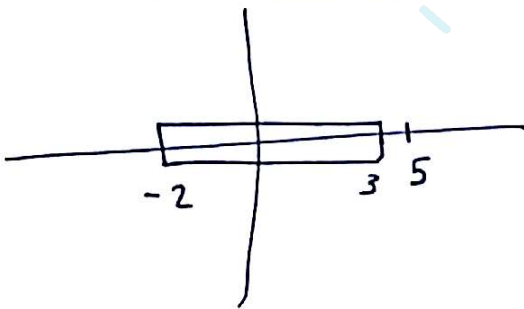
$$a = 2 \text{ m}$$

$$\lambda = \frac{-\lambda \cdot k \cdot \cos \alpha}{5} = 4 \text{ nC/m}$$

$$Q = \lambda L = 20 \text{ nC}$$

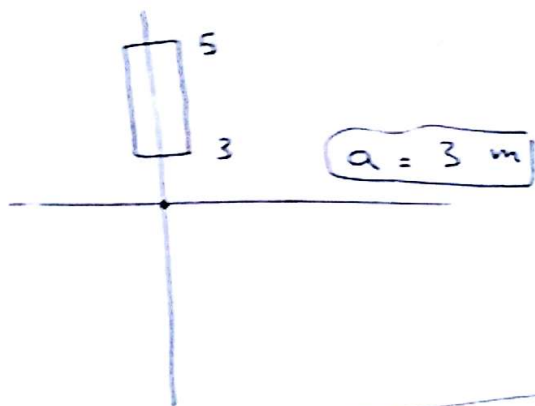
$$E = \frac{k Q}{a(a+L)} = \frac{9 \times 10^9 \times 20 \times 10^{-9}}{2(2+5)}$$

$$E = 13 \text{ N/C}$$



4. $Q = 50 \mu C$

$L = 5 - 3 = 2 m$



$$E = \frac{kQ}{a(a+L)} = \frac{9 \times 10^9 \times 50 \times 10^{-6}}{3(3+2)}$$

$E = 30 N/C$

5. $F_{12} = \frac{kQ_1Q_2}{r^2} = F_{21} = -\frac{kQ_1Q_2}{r^2}$

* عكس الاتجاه

7. $Q = 25 \mu C$

$r = 2 m$

$\theta = 90$

سؤال 6

$L = 2\pi r \times \frac{1}{4} = \frac{\pi r}{2}$

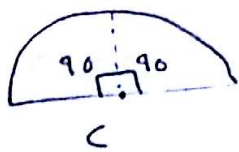
ربع دائرة

$E = \frac{kQ}{R} \left[\sin 45 + \sin 45 \right] = 50.6 \approx 51 N/C$

8 - Semicircle

$r = a$

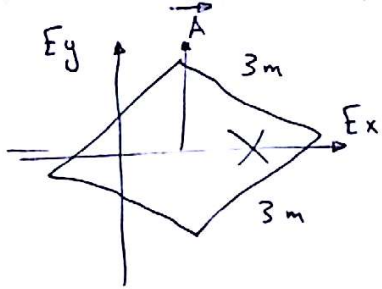
$L = 2\pi a \times \left(\frac{1}{2}\right) = \pi a$



نصف دائرة

$E = \frac{k(\lambda)}{R} \left[\sin 90 + \sin 90 \right] = \frac{1}{4\pi\epsilon_0} \times \frac{Q \times 2}{\pi a^2 \times a}$

$E = \frac{2Q}{\pi a^2} \times \frac{1}{4\pi\epsilon_0} \rightarrow F = \frac{1}{4} E$



$$E = 8\hat{i} + 2y\hat{j}$$

$$\phi_E = \vec{E} \cdot \vec{A} = 2y * (3*3) = 18y$$

~~phi = 18(3) = 54 N.M^2/C~~

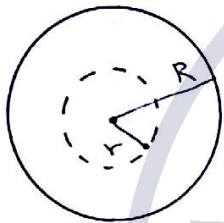
$$\phi = 18(3) = 54 \text{ N.M}^2/\text{C}$$

10 - $\rho = 5 \text{ nC/m}^3$

$r = 5 \text{ cm}$

$R = 12 \text{ cm}$

$$Q_{\text{enclosed}} = \rho * V_{\text{enclosed}}$$



$$Q_{\text{enclosed}} = 5 * 10^{-9} * \pi (5 * 10^{-2})^2 h$$

$$Q_{\text{enclosed}} = 40 * 10^{-2} * h$$

$$E A = \frac{Q_{\text{enclosed}}}{\epsilon_0}$$

$$E * 2\pi (5 * 10^{-2}) * h = \frac{40 * 10^{-2} * h}{\epsilon_0}$$

$$E = 14.4 \approx 14 \text{ N/C}$$

11 -

12 - Conducting sheet

$$E = \frac{G}{\epsilon_0} \rightarrow$$

$$G = 1.5 * \epsilon_0 = 13 * 10^{-12} \text{ C/m}^2$$

13 - $\phi = \frac{Q_{\text{enclosed}}}{\epsilon_0} \rightarrow -5 = \frac{Q_{\text{enclosed}}}{\epsilon_0}$

$$Q_{\text{enclosed}} = -44 \text{ pC}$$

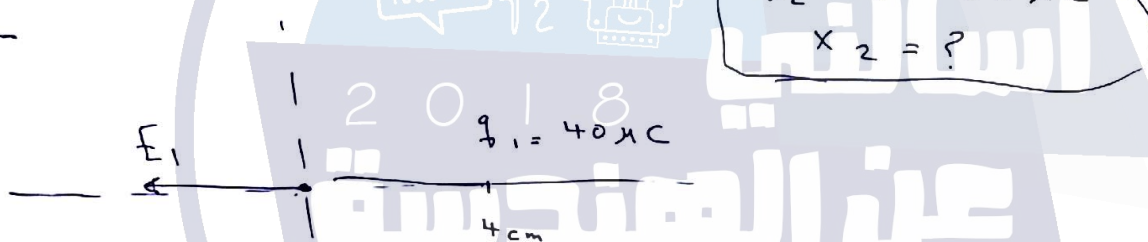
$$14 - \phi_{\text{total}} = \frac{Q_{\text{net}}}{\epsilon_0} = \frac{0.80 \times 10^{-9}}{8.85 \times 10^{-12}} = 90 \text{ N} \cdot \text{m}^2 / \text{C}$$

$$\phi_{\text{one face}} = \frac{\phi_{\text{total}}}{6} = 15 \text{ N} \cdot \text{m}^2 / \text{C}$$

15 - Conducting Shell



6 -



$$q_2 = -60 \mu\text{C}$$

$$X_2 = ?$$

$$E_1 = \frac{k \times 40 \times 10^{-6}}{(0.04)^2} = 225 \times 10^6 \hat{r}$$

$$E_2 = 225 \times 10^6 \hat{r}$$

$$225 \times 10^6 = \frac{k \times 60 \times 10^{-6}}{r^2} \rightarrow r = 0.05$$

$$= 5 \text{ cm}$$

$$X_2 = 5 \text{ cm}$$

Chapter 23: Electric Potential

1. $q = -8 \text{ mC}$

A \rightarrow B

$V_A = 0 \rightarrow k_A = 0$

$K_{f(B)} = 4.8 \text{ Joule}$

~~$q(V_A - V_B) = k_B - k_A$~~

$q(V_A - V_B) = k_B - k_A$

$q(V_A - V_B) = 4.8$

$V_A - V_B = \frac{-4.8}{8 \times 10^{-3}}$

$V_B - V_A = -\left(\frac{-4.8}{8 \times 10^{-3}}\right) = +0.6 \text{ kV}$

2. $\vec{B} - \vec{A} = (5\hat{i} - 2\hat{j}) + (7\hat{i} - 3\hat{j}) = 3\hat{i} + 4\hat{j} = \Delta r$

$V = \Delta r \cdot (E) = (3 \cdot 4 + 4 \cdot 3) = 12 + 12 = 24 \text{ volt}$

3. $m = 1.67 \times 10^{-27}$ $q = 1.6 \times 10^{-19}$

A \rightarrow B

$V_A = 50 \times 10^3$

$V_B = 80 \times 10^3$

$qV_A + k_A = qV_B + k_B$

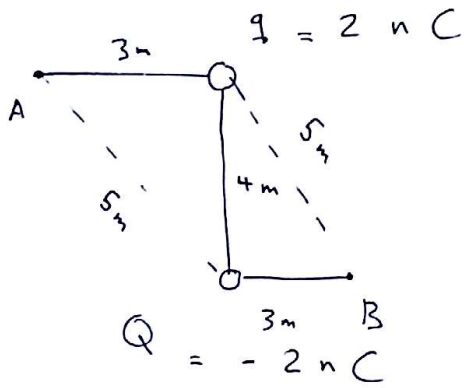
$qV_B - qV_A = k_A - k_B$

$V_B - V_A = \frac{\frac{1}{2} m \cdot (V_A^2 - V_B^2)}{q} = -20 \text{ volt}$

$$4 - \Delta r = (8 - 3)\hat{i} + (-3 - 6)\hat{j} = 5\hat{i} - 9\hat{j}$$

$$V = \Delta r \cdot E = (5 \times 12) + (-9 \times 0) = +60 \text{ volt}$$

5 -



$$V_{A1} = \frac{2 \times 10^{-9} \times 9 \times 10^9}{3} = 6 \text{ volt}$$

$$V_{A2} = \frac{-2 \times 9 \times 10^9 \times 10^9}{5} = -3.6 \text{ volt}$$

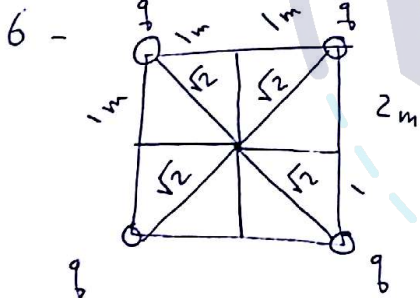
$$V_A = 2.4$$

$$V_{B1} = \frac{-2 \times 10^{-9} \times 9 \times 10^9}{3} = -6 \text{ volt}$$

$$V_{B2} = \frac{2 \times 10^{-9} \times 9 \times 10^9}{5} = 3.6 \text{ volt}$$

$$V_B = -2.4 \text{ volt}$$

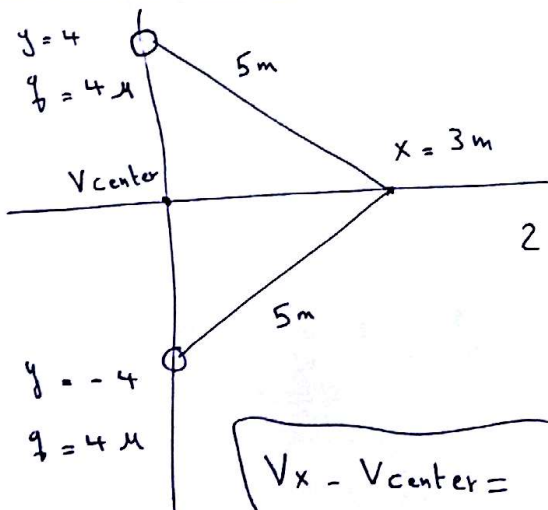
$$V_A - V_B = 2.4 - (-2.4) = 4.8 \text{ volt}$$



$$V_{\text{center}} = \frac{4}{\sqrt{2}} \times \left(\frac{2 \times 10^{-6} \times 9 \times 10^9}{\sqrt{2}} \right)$$

$$V_{\text{center}} = 51 \text{ kV}$$

7 - $y = 4$
 $q = 4 \mu$



$$V_x - V_{\text{center}} = ?$$

$$2 \times \left(\frac{9 \times 10^9 \times 4 \times 10^{-6}}{5} \right) - 2 \times \left(\frac{9 \times 10^9 \times 4 \times 10^{-6}}{4} \right)$$

$$V_x - V_{\text{center}} = -3600 \text{ volt}$$

$$8 - \frac{k}{r_{\text{ext}}} + q_1 V_a = k_B + q_1 V_B$$

$$\left. \begin{aligned} r_1 &= 1 \text{ m} \\ r_2 &= 3 \text{ m} \\ q_1 &= Q \\ q_2 &= 5Q \end{aligned} \right\} Q = 12 \mu\text{C}$$

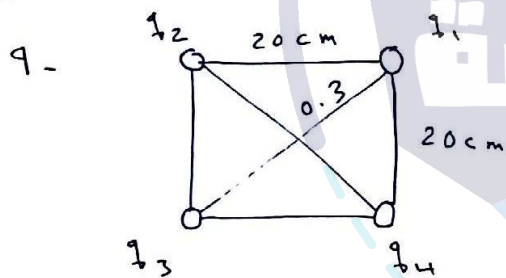
$$q_1 \left(\frac{k q_2}{r_1} \right) = k_B + q_1 \left(\frac{k q_2}{r_1} \right)$$

$$\frac{k q_1 q_2}{r_1} - \frac{k q_1 q_2}{r_2} = k_B$$

$$k q_1 q_2 \left(\frac{1}{1} - \frac{1}{3} \right) = k_B \rightarrow k_B = 4.32$$

for the system

$$k \text{ for one of the particles} = \frac{4.32}{2} = 2.2 \text{ Joule}$$



$$q = 4 \mu\text{C}$$

$$U = k \left(\frac{q_1 q_2}{0.2} + \frac{q_1 q_3}{0.2} + \frac{q_1 q_4}{0.3} + \frac{q_2 q_3}{0.2} + \frac{q_2 q_4}{0.3} + \frac{q_3 q_4}{0.2} \right)$$

$$U = 3.9 \text{ Joule}$$

$$\left. \begin{aligned} 10 - Q &= 3 \mu\text{C} \\ r &= 20 \text{ cm} \\ q &= 25 \mu\text{C} \end{aligned} \right\}$$

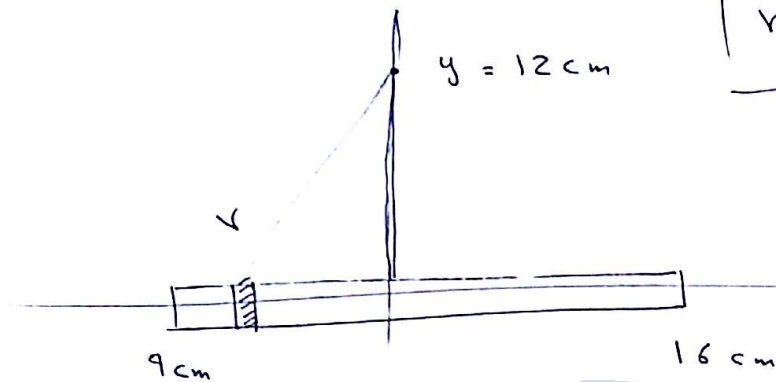
$$W_{\text{ext}} = q (V_f - V_i) \text{ at infinity}$$

$$= 25 \times 10^{-6} \left(\frac{9 \times 10^9 \times 3 \times 10^{-6}}{0.2} \right)$$

$$W_{\text{ext}} = 3.4 \text{ Joule}$$

11 - $\lambda(x) = b x = 12 \times 10^{-9} \times x$

$L = 16 - 9 = 7 \text{ cm}$



$$r = \sqrt{y^2 + x^2}$$

$$\lambda = \frac{dq}{dx}$$

$$dq = \lambda dx$$

$$V = k_e \int \frac{dq}{r} = k_e \int \frac{\lambda dx}{\sqrt{(12\text{cm})^2 + x^2}}$$

$$= k_e \int_{9\text{cm}}^{16\text{cm}} \frac{12 \times 10^{-9} \times x dx}{\sqrt{(12\text{cm})^2 + x^2}} = 5.4 \text{ Volt}$$

12 -

$a = 6 \text{ m}$
 $L = 5 \text{ m}$

$Q = 45 \times 10^{-9}$



$$E = \frac{k \times Q}{L} \times \ln\left(\frac{a+L}{a}\right)$$

$$E = 49 \text{ volt}$$

13 -

$$V = k \int \frac{dq}{r} = \frac{k \lambda}{R}$$

$dq = \lambda d\theta$ (constant)

$\frac{k \lambda}{R}$ (constant)

$\frac{\pi}{3} \rightarrow 60^\circ$

$$\int_0^{\pi/3} d\theta = \frac{k \lambda}{R} \times \frac{\pi}{3}$$

$$V = 33 \text{ volt}$$

السؤال ناقص

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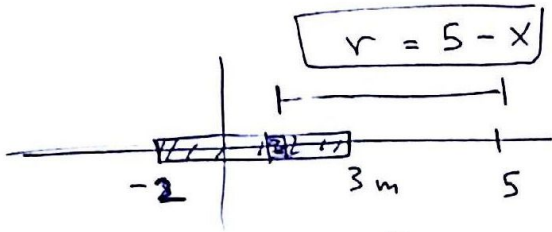
14 - $Q = 10 \text{ nC}$

$$V = k \int \frac{dq}{r}$$

$$\lambda = \frac{Q}{L} = \frac{10 \times 10^{-9}}{5}$$

$$dq = \lambda dx$$

$$\lambda = 2 \times 10^{-9}$$



$$V = k \int_{-2}^3 \frac{\lambda dx}{5-x} = \int_{-2}^3 \frac{18 dx}{5-x}$$

15 -

$R = 5 \text{ cm}$

$Q = 0.25 \text{ nC}$

$r_1 = \text{center}$

$r_2 = 15 \text{ cm}$

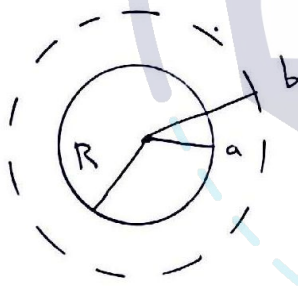
Find $|\Delta V|$

$$V_{\text{center}} = V_{\text{surface}} = \frac{kQ}{5 \times 10^{-2}} = 45$$

$$V_2 = \frac{kQ}{15 \times 10^{-2}} = 15 \text{ volt}$$

$$\Delta V = 45 - 15 = 30 \text{ volt}$$

17 -



$R = a = 2 \text{ cm}$

$b = 4 \text{ cm}$

$\rho = 90 \times 10^{-9} \text{ C/m}^3$

$$\Delta V_{ba} = \int_a^b E \cdot dr$$

$$EA = \frac{\rho \times \text{Volume}}{\epsilon_0}$$

$$E \cdot 2\pi r t = \frac{\rho \cdot \pi R^2 t}{\epsilon_0}$$

$$\Delta V = \int_{4 \times 10^{-2}}^{2 \times 10^{-2}} \frac{\rho \pi R^2}{2\pi r \epsilon_0} dr$$

$\Delta V = 1.4 \text{ volt}$

$$E = \frac{\rho \cdot \pi R^2}{2\pi r \epsilon_0}$$

$$15 - G = 2 \text{ nC/m}^2$$

$$r = 8 \text{ cm}$$

$$V = E \times r = \frac{G}{\epsilon_0} \times r = \frac{2 \times 10^{-9}}{8.85 \times 10^{-12}} \times 0.08 = 18 \text{ volt}$$

$$18 - V_b - V_a = + \int_b^a E \cdot dr$$

$$V_b - V_a = \int_5^3 3x \, dx = -24 \text{ volt}$$

19 - 26

~~27 - $q_1 = 3 \text{ } \mu\text{C}$
 $x = 0$
 $V_1 = V_2$
 $\frac{3 \text{ } \mu\text{C}}{r} = \frac{-2 \text{ } \mu\text{C}}{r}$~~

~~$q_2 = -2 \text{ } \mu\text{C}$
 $x = 15 \text{ m}$~~

$$28 - R = 10 \times 10^{-2}$$

$$\rho = 100 \text{ nC/m}^3$$

$$r_1 = 0$$

$$r_2 = 4 \text{ cm}$$

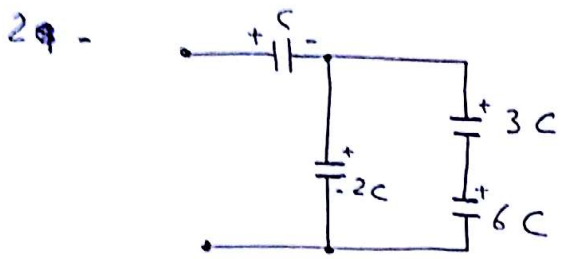
$$V_{\text{center}} - V_2 = - \int_0^{4 \times 10^{-2}} E \cdot dr = - \int_0^{4 \times 10^{-2}} \frac{\rho r}{3 \epsilon_0} dr$$

$$E A = \frac{\rho \times \text{Volume}}{\epsilon_0}$$

$$\Delta V = 3.0 \text{ volt}$$

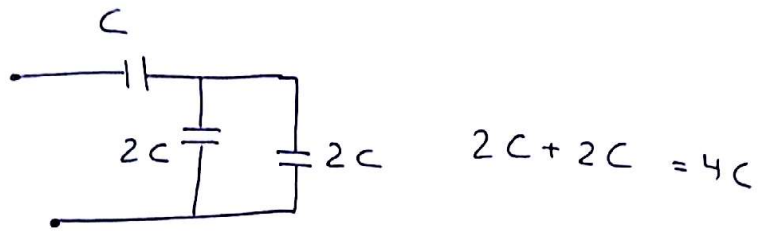
$$E \cdot \pi r^2 = \frac{\rho \times \frac{4}{3} \pi r^3}{\epsilon_0}$$

$$\rightarrow E = \frac{\rho r}{3 \epsilon_0}$$



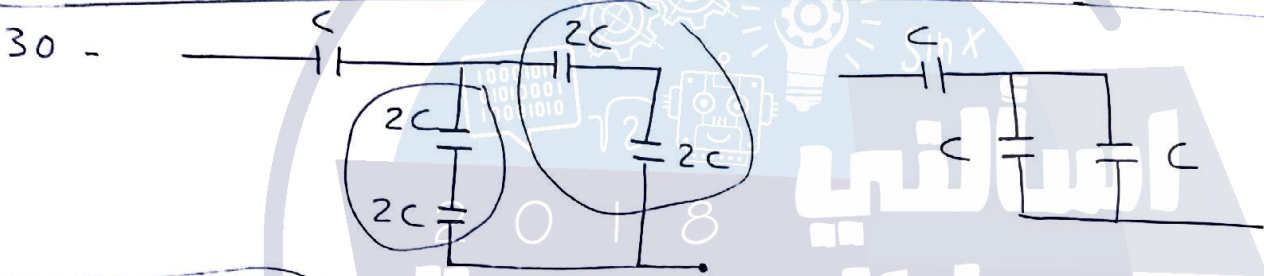
$$\frac{1}{3C} + \frac{1}{6C} = \frac{2}{6C} + \frac{1}{6C} = \frac{2C}{6C^2}$$

$$C = 45 \mu\text{F}$$

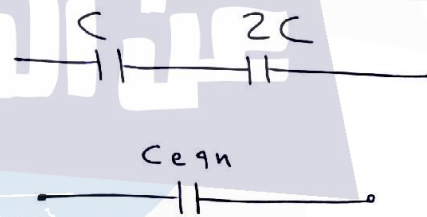


$$\frac{1}{C} + \frac{1}{4C} = \frac{5}{4C} = \frac{4C}{5}$$

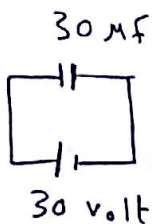
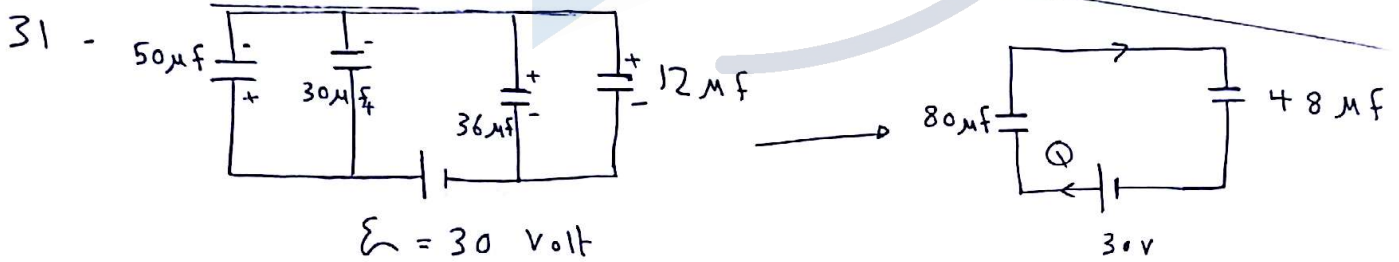
$$C_{eq} = 36 \mu\text{F}$$



$$C_{eqn} \quad \frac{1}{C} + \frac{1}{2C} = \frac{3}{2C} = \frac{2C}{3}$$



$$C_{eqn} = 16 \mu\text{F}$$



$$Q_{total} = C V = 30 \mu\text{F} \times 30 = 9 \times 10^{-4} \text{ C}$$

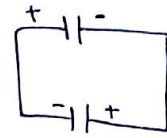
$$Q_{12} = 9 \times 10^{-4} = Q_{34}$$

$$V_{34} = \frac{Q}{C} = \frac{9 \times 10^{-4}}{48 \times 10^{-6}} = 18.75 \text{ volt} \approx -V_3 = V_4$$

$$E_3 = \frac{1}{2} C_3 V_3^2 = 0.5 \times 34 \mu \times (19)^2 = 6.3 \text{ mJ}$$

$$32 - C_1 = 3 \mu\text{F} \quad V_1 = 40 \text{ volt}$$

$$C_2 = 5 \mu\text{F} \quad V_2 = 18 \text{ volt}$$



توالي

$$V_{\text{total}} = V_1 + V_2 = 58 \text{ volt}$$

$$C_{\text{total}} = \frac{1}{3} + \frac{1}{5} = \frac{15}{8} \mu\text{F}$$

$$Q_{\text{total}} = Q_1 = Q_2 = \frac{15}{8} \times 10^{-6} \times 58 = 11 \mu\text{C}$$

$$33 - ~~C_1 = 25 \mu\text{F}~~ \quad C_1 = 25 \mu\text{F} \quad V_1 = 50 \text{ volt}$$

$$C_2 = C \quad V_2 = 20 \text{ volt}$$

$$V_{\text{signal}} = 36 \text{ volt}$$

~~$20 \times C + 50 \times 25 \times 10^{-6} = (25 \times 10^{-6} + C) \times 36$~~

$Q_{\text{before}} = Q_{\text{after}}$

$$20 * C + 50 * 25 * 10^{-6} = (25 * 10^{-6} + C) * 36$$

$$34 = C = \frac{Q}{V} = \frac{80 * 10^{-6}}{16} = 5 * 10^{-6} \text{ f}$$

at $V = 42$

$$E = \frac{1}{2} C (V)^2 = 4.4 \text{ m Joule}$$