New 2018

Civilittee

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دفتر

الفيزياء العامة 2

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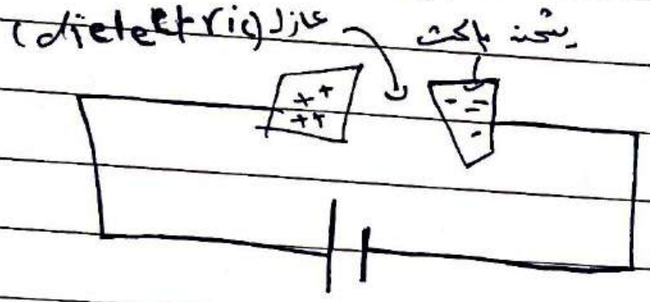
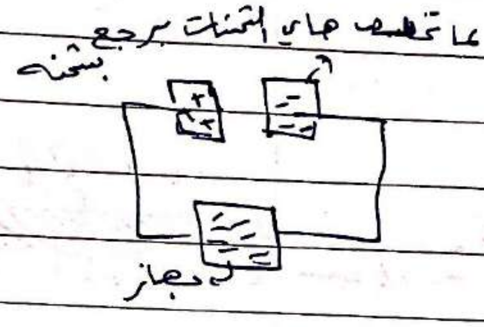
ch.26

*capacitance and dieletric

capacitance: it is adivece that store electrical charges (electrical energy)





$$Q \propto V \Rightarrow Q = \text{cnst.}\, V$$

$Q = CV$ C: capacitance

$C = \dfrac{Q}{V}$ بيعطي العلاقة بين Q و V

C = ratio between Q and V

* C dependes only on the geomitry of the capacitor.

i.e.

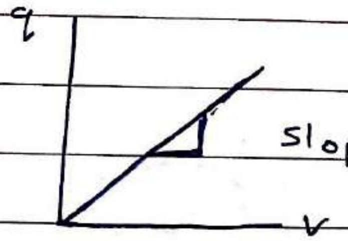
$$C = \frac{q}{V}, \quad V = \frac{kq}{R} \Rightarrow C = \frac{qR}{kq}$$

$$C = 4\pi\epsilon_0 R$$

let the earth to be the capacitor $R = 6400$ km

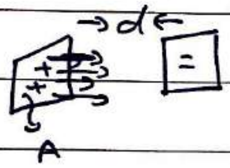
$$C_{earth} \cong 7 \times 10^{-4}\ f < 1\,mf$$

* $C = \frac{q}{V}$



* Calculating the capacitance.

[1] parallel plate capacitor



From G.L :-

the electric field for a plate $E = \frac{\sigma}{2\epsilon_\circ}$

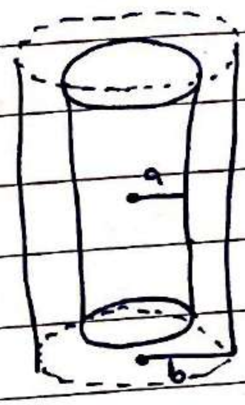
for parallel plate capacitor

$E = E_1 + E_2 = \frac{\sigma}{\epsilon_\circ}$

and $V = Ed = \frac{\sigma}{\epsilon_\circ} d = \frac{qd}{A\epsilon_\circ}$

$\Rightarrow C_p = \frac{q}{V} = \frac{q A \epsilon_\circ}{q d} \Rightarrow \boxed{C_p = \frac{\epsilon_\circ A}{d}}$ $C_p \propto \frac{A}{d}$

2 Cylindrical capacitor



$$V_b - V_a = -\int \vec{E} \cdot d\vec{r}$$

but $E = \dfrac{2 k_e \lambda}{r}$

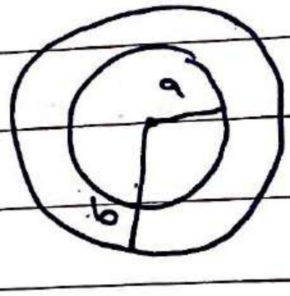
$$\Delta V = -2 k_e \lambda \int_a^b \frac{dr}{r}$$

$$= -2 k_e \lambda \ln r \Big]_a^b$$

$$\Delta V = -2 k_e \lambda \ln(b/a)$$

$$|C| = \frac{q}{\Delta V} = \frac{\lambda L}{2 k_e \lambda \ln\left(\frac{b}{a}\right)} \Rightarrow C_{cy} = \frac{L}{2 k_e \ln(b/a)}$$

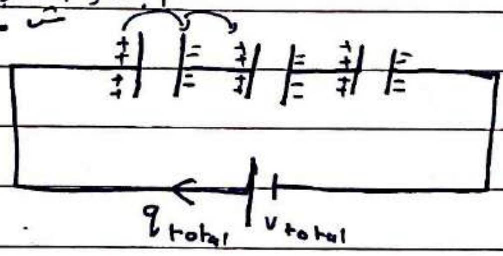
H.W. 3 Spherical capacitor. $\boxed{C = \dfrac{ab}{k_e(b-a)}}$



* Combination of capacitors :

1 series connection

كلهم بشحنو بعض بالحث لهيك
ش متساوية =
ش الكلية



$$q_{total} = q_1 = q_2 = q_3$$

$$V_{total} = V_1 + V_2 + V_3 \quad \text{but} \quad V = \frac{q}{C}$$

$$\frac{\cancel{q_{total}}}{C_{total}} = \frac{\cancel{q_1}}{C_1} + \frac{\cancel{q_2}}{C_2} + \frac{\cancel{q_3}}{C_3}$$

C_s تقل

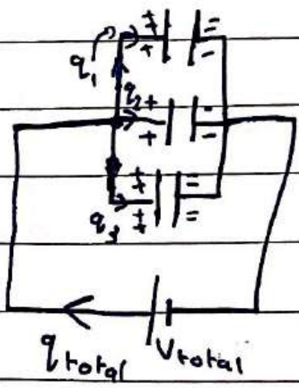
س المكافئة أقل من أقل مواسعة

$$\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

2 parallel connection

C_p تزداد

س المكافئة أكبر من أكبر مواسعة



$$q_{total} = q_1 + q_2 + q_3$$

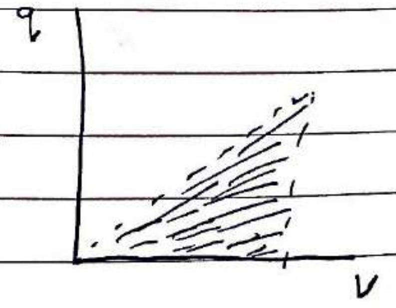
$$V_{total} = V_1 = V_2 = V_3$$

$$\text{but } q = CV$$

$$C_{total} \times \cancel{V_{total}} = C_1\cancel{V_1} + C_2\cancel{V_2} + C_3\cancel{V_3}$$

$$\boxed{C_p = C_1 + C_2 + C_3}$$

Energy stored in capacitor



$$U = \frac{1}{2}\frac{q^2}{c}$$

$w = qv$

$dw = q\,dv$

$\int dw = \int cv\,dv$

$W = \frac{1}{2}cv^2$

Energy = Area

$U = \frac{1}{2}qv$ $\qquad q = cv$

$U = \frac{1}{2}cV^2$

For parallel plate capacitor

$c = \frac{\epsilon_\circ A}{d}$ $\qquad V = Ed$

$U = \frac{1}{2}cV^2 = \frac{1}{2}\frac{\epsilon_\circ A}{\cancel{d}} \cdot E \cdot d^{\cancel{2}}$

$U = \frac{1}{2}\epsilon_\circ A E^2 d$

$= \frac{1}{2}\underbrace{(Ad)}_{\text{Volume}}\epsilon_\circ E^2$

$\Rightarrow$ Define :- energy density u

$u = \frac{U}{Ad} \Rightarrow \boxed{u = \frac{1}{2}\epsilon_\circ E^2} \rightarrow$ energy density

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* capacitor with ~~..~~ dielectric :

ثابت العزل

dielectric constant $K > 1$

$\boxed{\epsilon_0}$ ثابت السماحية

* $K_{هواء} = 1$

dielectric increases the capacitors

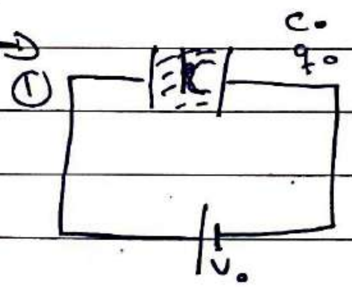
$C_0 \Rightarrow \boxed{C = K C_0} \rightarrow$ ما الكم دخل من ديناليت

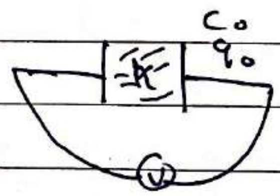
~~Ex~~ $C_0 = \frac{\epsilon_0 A}{d}$ (air)

$C = K C_0 = \underbrace{K \epsilon_0}_{\epsilon_{المادة}} \frac{A}{d}$

$\boxed{\underset{المادة}{\epsilon} = K \epsilon_0} \Rightarrow \epsilon > \epsilon_0$

شحن $\Rightarrow$

① 

② 

$C = K C_0$

$q = K q_0$

$V = \frac{q}{c} = \frac{\cancel{K} q_0}{\cancel{K} C_0}$

$V = V_0$

$C = K C_0$

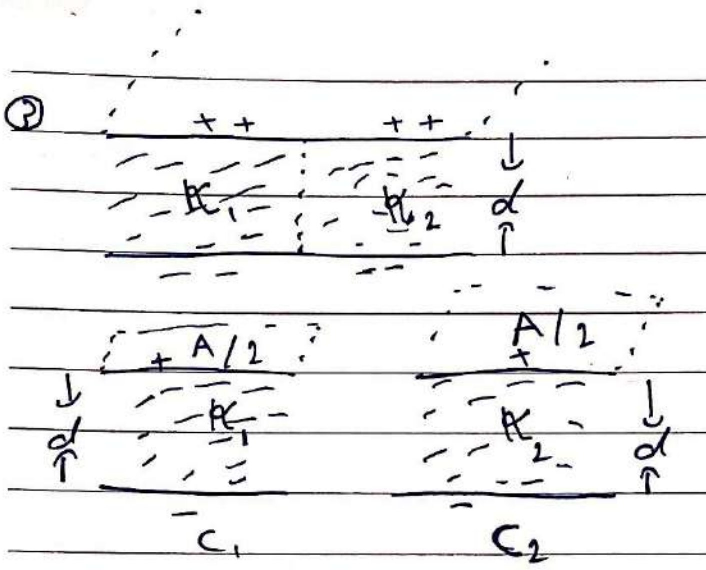
$q = q_0$

$V = \frac{q}{c}$

$V_0 = \frac{q_0}{K C_0}$

$V = \frac{V_0}{K}$

2



* ممكن ما يكون بالنص
فاوته حسب المساحة

$$C_1 = \frac{K\epsilon_0 A/2}{d}$$

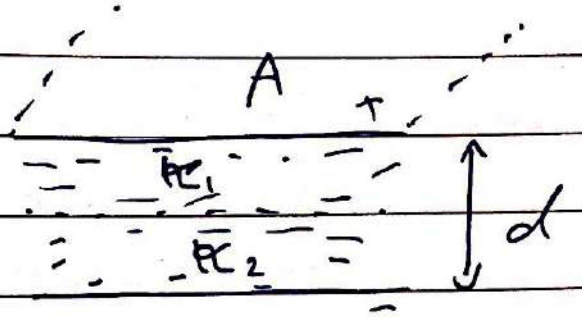
$$C_2 = \frac{K\epsilon_0 A/2}{d}$$

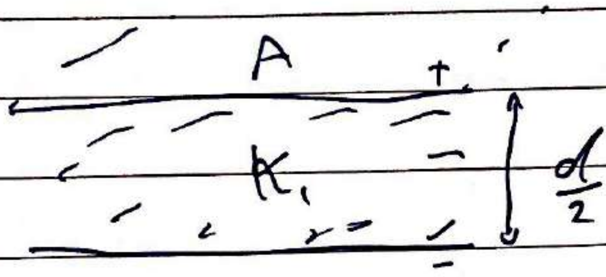
$C_{total} \Rightarrow c_1$ and c_1 in parallel

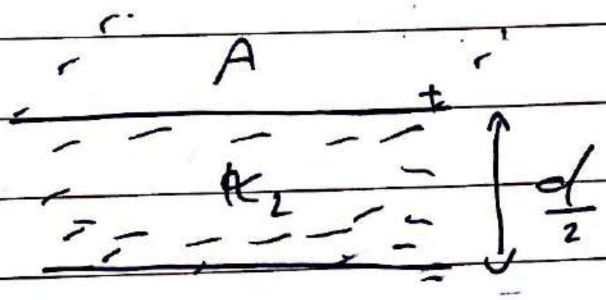
$C_{total} = c_1 + c_2$

$$= \frac{K\epsilon_0 A}{2d} + \frac{K\epsilon_0 A}{2d} = \frac{\epsilon_0 A}{2d}(K_1 + K_2)$$

4





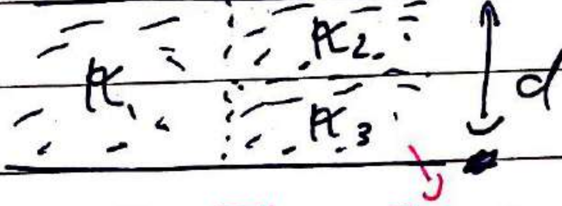


$$C_1 = \frac{2 k_1 \epsilon_0 A}{d} \quad , \quad C_2 = \frac{2 k_2 \epsilon_0 A}{d}$$

$C_{total} \Rightarrow C_1$ and C_2 in series

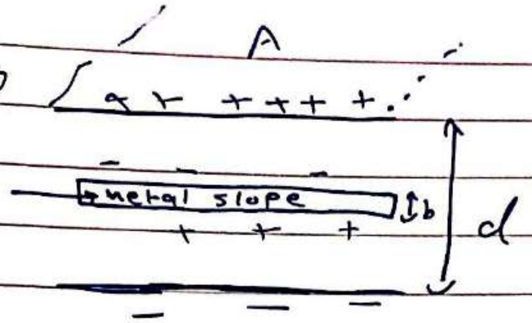
$$\frac{1}{C_{total}} = \frac{1}{C_1} + \frac{1}{C_2}$$

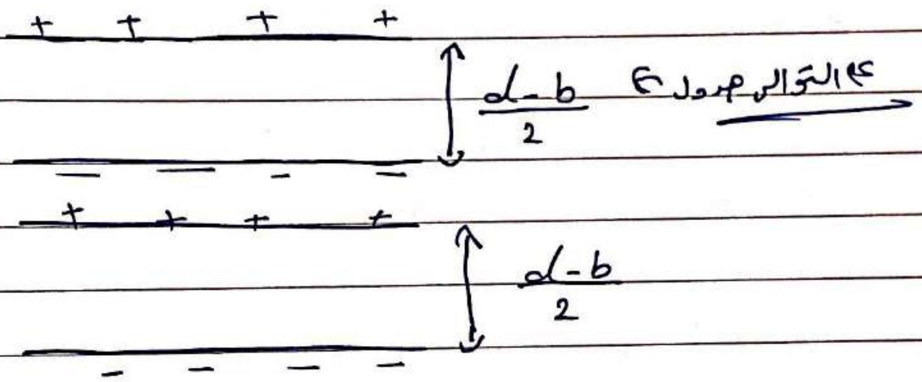
5



2 , 3 توالي ← مع $\boxed{1}$ في التوازي

(6)





* dilectric strength:-
max eletric field that can be applied to the dielectric before breaking

	K	Emax X10^6
Air	1.00059	3
Teflon	2.1	60
porcelian	6	12

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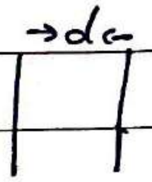
7. $V = 150\,V$ $\qquad \sigma = 30\,nc/cm^2$ $\qquad d = ??$



$$V = \frac{q}{C} = \frac{\sigma A d}{\epsilon_\circ A} = \frac{\overbrace{\sigma}^{E}}{\epsilon_\circ} d$$

4- كانت باعتبار وحدات بالبسط

$$150 = \frac{30\times10^{-9}\times10^{+4}}{8.85\times10^{-12}} \times d \Rightarrow d = 4.4\,Mm$$

9. $A = 7.6\,cm^2$ $\qquad d = 1.8\,mm$ $\qquad V = 20\,V$

[a] $E = \frac{V}{d} = \frac{20}{1.8\times10^{-3}} = 1.1\times10^{+4}$

[b] $E = \frac{\sigma}{\epsilon_\circ} \Rightarrow \sigma = 1.1\times10^{4} \times 8.85\times10^{-12}$

$\sigma = 9.8\times10^{-8}\,c/m^2$

[c] $C = \frac{\epsilon_\circ A}{d} = 3.7\,pf \rightarrow$ بيكوفاراد 10^{-12}

[d] $q = \sigma A = CV$

$9.8\times10^{-8} \times 7.6\times10^{-4} = 7.5\times10^{-11}$

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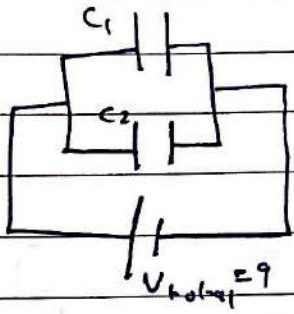
13 $C_1 = 5 \mu f$ $C_2 = 12 \mu f$ $V = 9 V$



a) $C_p = C_1 + C_2 = 17 \mu f$

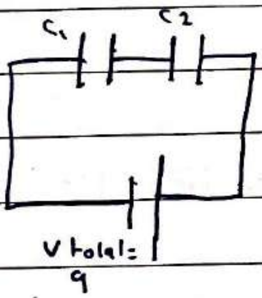
b) $V_1 = V_2 = 9 V$

c) $q_1 = C_1 V_1$

$= 5 * 9 = 45 \mu c$

• $q_2 = C_2 V_2 = 12 * 9 = 108 \mu c$

14 $C_1 = 5 \mu f$ $C_2 = 12 \mu f$ $V = 9 V$



a) $\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{5} + \frac{1}{12} = 3.5 \mu f$

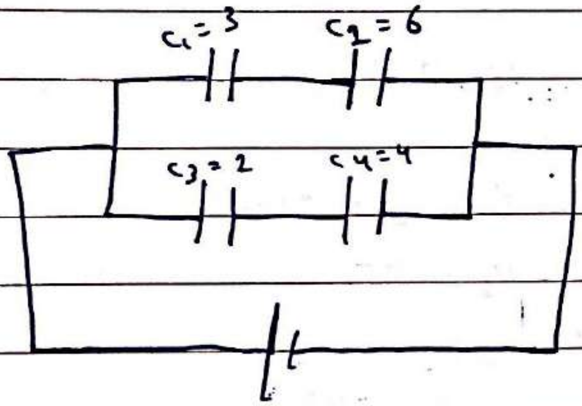
b) $q_1 = q_2 = q_{total} = C_s * V_{total}$

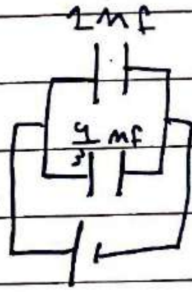
$= 9 * 3.5 = 31.5 \mu c$

c) $V_1 = \frac{q_1}{C_1} = \frac{31.6}{5} \approx 6.3 V$

$V_2 = \underbrace{9 - 6.3}_{V_{total} - V_1} = \frac{q_2}{C_2} = 2.7 V$

19





[a] $(C_1, C_2) \to s \Rightarrow \frac{1}{Cs_1} = \frac{1}{c_1} + \frac{1}{c_2} \Rightarrow \boxed{C_{s1} = 2Mf}$

$(C_3, C_4) \to s \Rightarrow \frac{1}{cs_2} = \frac{1}{c_3} + \frac{1}{c_4} \Rightarrow \boxed{Cs2 = \frac{4}{3}\ Mf}$

$(C_{s_1}, C_{s_2}) \to p \Rightarrow C = \frac{10}{3}$ Mf

[b] $q_1 = q_2 = q_{cs_1} = V_{cs_1} = 90 * 2 \Rightarrow q_1 = q_2 = 180$ Mc

$q_3 = q_4 = q_{cs_2} = V_{cs_2} = 90 * \frac{4}{3} \Rightarrow q_3 = q_4 = 120$ Mc

[c] $V_1 = \frac{q_1}{c_1} = \frac{180}{3} = 60v$ so $V_2 = 90 - 60 = 30v$

$V_3 = \frac{q_3}{c_3} = \frac{120}{2} = 60v$ so $V_4 = 90 - 60 = 30v$

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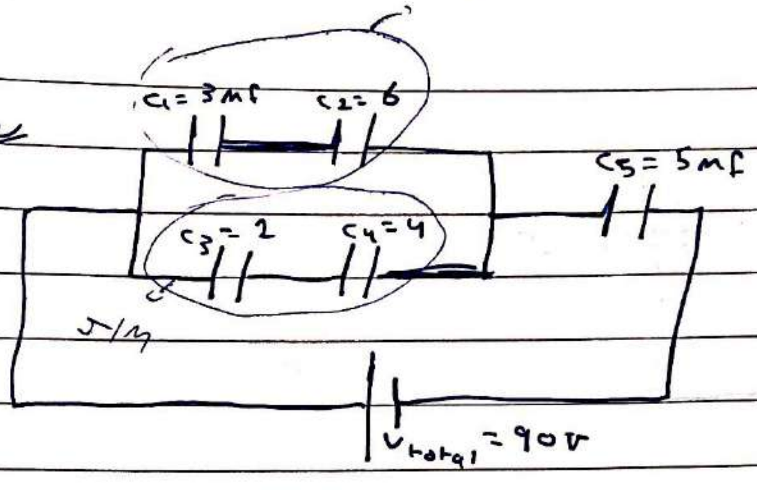
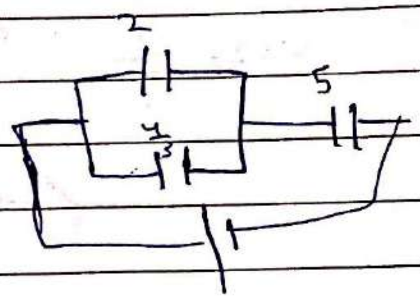
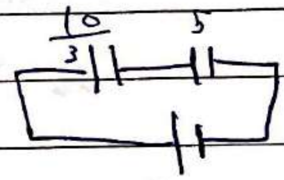
2

H.w







$C_s = \cancel{\ } \frac{3}{10} + \frac{1 \times 2}{5 \times 2} = \frac{5}{10} = \frac{10}{5} = \boxed{2}$

$q = 90 * 2 = 180$

$C_5 \Rightarrow q = 180 \Rightarrow V = \frac{180}{5} = 36$

$C_{(\frac{10}{3})} \Rightarrow V = 90 - 36 = 54v \Rightarrow q = 180\,mc$

$C_{(2)} \Rightarrow \underline{V = 54} \Rightarrow q = 54 * 2 = 108\,mc$

$C(\frac{4}{3}) \Rightarrow \underline{V = 54} \Rightarrow q = 54 * \frac{4}{3} = 72\,mc$

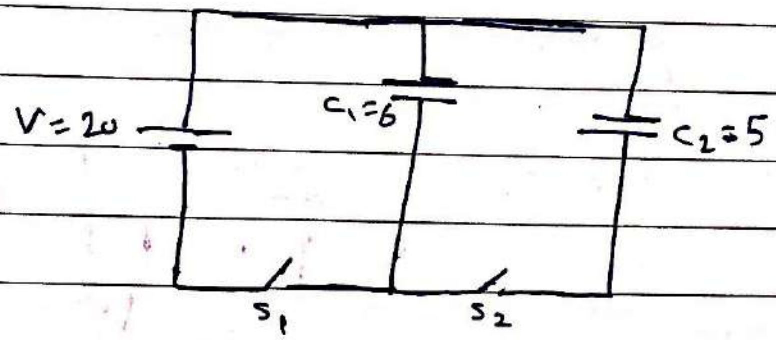
$C_1 \Rightarrow q = 108 \Rightarrow V = \frac{108}{3} = 36$

$C_2 \Rightarrow q = 108 \Rightarrow V = \frac{108}{6} = 18$

$C_3 \Rightarrow q = 72 \Rightarrow V = \frac{72}{2} = 36$

$C_4 \Rightarrow q = 72 \Rightarrow V = \frac{72}{4} = 18$

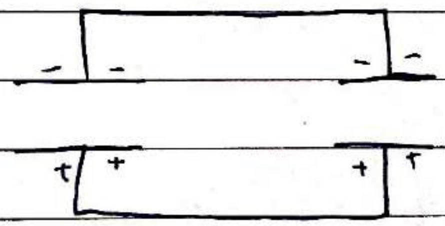
24



S_1 close, S_2 open

$q_s = C_1 V = 120\ mc$

S_1 open, S_2 close



$V_1 = V_2$

$\frac{q_1}{c_1} = \frac{q_2}{c_2} \Rightarrow \frac{q_1}{6} = \frac{q_2}{3}$

$2q_2 = q_1$

but $\sum q_i = \sum q_f$

$120 + 0 = q_1 + q_2$

$120 = 3q_2 \Rightarrow q_2 = 40\ mc$

$q_1 = 120 - 40 = 80\ mc$

$V_1 = \frac{q_1}{c_1} = \frac{80}{6} = \frac{40}{3}\ v$

$V_2 = \frac{q_2}{c_2} = \frac{40}{3}\ v$

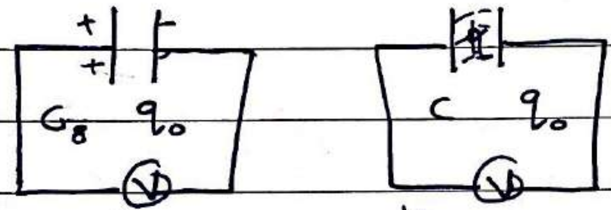
43 $A = 5\,cm^2$ $\quad E_{max} = 3\times10^6\ V/m$

$q_{max} = ?$

$$E_{max} = \frac{\sigma_{max}}{K\epsilon_0} = \frac{q_{max}}{K.\epsilon_0.A}$$

$$q_{max} = E_{max} * K * \epsilon_0 * A = 13.3\ nC$$

44



V_0 85 V $\qquad$ V 25 V

$K = ?$

$$V_0 = \frac{q_0}{C_0} \qquad V = \frac{q_0}{C} = \frac{q_0}{KC_0}\ V_0$$

$$V = \frac{V_0}{K} \Rightarrow K = \frac{85}{25} = 3.4$$

Ch.27.

Current and Resistance.

current: flow of charges between two points due to a potential difference.

I = charge per unit of

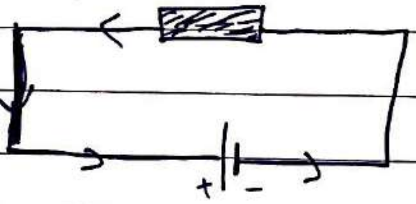
$$I = \frac{\Delta q}{\Delta t} \qquad\qquad \frac{\Delta \text{ش}}{\Delta \text{ن}} = \text{ت}$$

$$I = \frac{dq}{dt} \Rightarrow \int_{q_i}^{q_f} dq = \int_{a}^{t} I \cdot dt$$

$$\boxed{\Delta q = \int_{0}^{t} I \cdot dt}$$

if I constant $\Rightarrow \boxed{\Delta q = I \Delta t}$

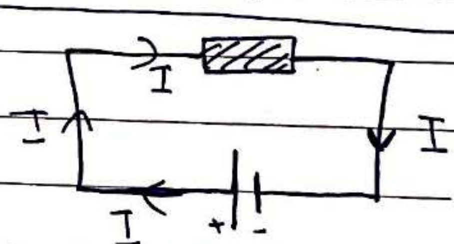
current direction



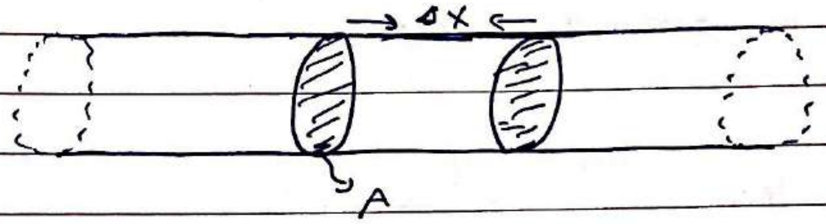
Power supply

real direction $- \rightarrow +$

$\checkmark$ conventional direction $+ \rightarrow -$



* the charges flow from high potential to low potential



n free charge density ⇒ number of free charges per unit volume

⇒ number of charge = n * Volume = n * $A \Delta X$

but $\Delta X = V \Delta t$

⇒ number of charges = $n A V \Delta t$

charge = number of charge * e

$$\frac{q}{\Delta t} = \frac{n A V \Delta t\, e}{\Delta t}$$

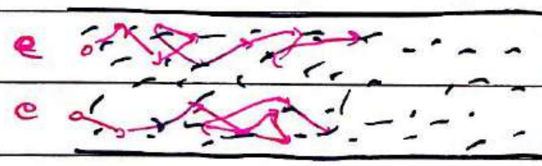
$$\boxed{I = n A V e}$$ ت = ن م ع شع

$n \equiv$ Charge density electron/m^2

$A \equiv$ cross-section area m^2

$e \equiv 1.6 \times 10^{-9}$ C

$V_d \equiv$ drift velocity m/s



⇒ electrical Resistance R and ohm's low

*Define :- the current density $\vec{J}$

$\vec{J} = \frac{I}{A}$ current per unit of Area

*ohm's low

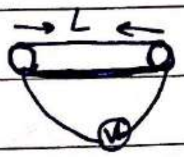
$\vec{J}$ and $\vec{E}$ relation

He founds that

$\vec{J} \propto \vec{E} \Rightarrow \boxed{\vec{J} = \sigma \vec{E}}$ → ohm's low

σ :- is the conductivity of the

$E = \frac{V}{L}$



$\therefore \frac{I}{A} = \sigma \frac{V}{L}$

$J = \frac{I}{A}$

$\Rightarrow V = \frac{L I}{\sigma A}$

$V = \frac{L}{\sigma A} I$

$\boxed{V = \frac{\rho L}{A} I}$ → resistance R

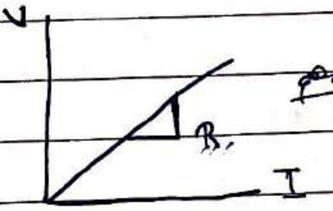
ρ resistivity
المقاومية

$V = I R$

where $R = \frac{\rho L}{A}$

$I = \frac{\Delta q}{\Delta t}$; $J = \frac{dq}{dt}$

$I = n \vec{v} A e$



$\vec{J} = \sigma \vec{E}$ (ohimc) (linear) meterials.

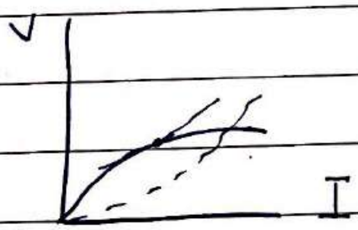
$V = IR$

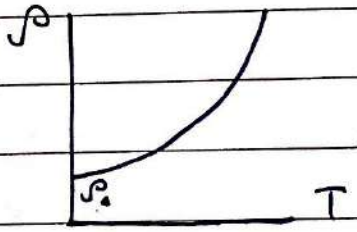
$R = \frac{\rho L}{A}$, $R = \frac{V}{I}$ const (I , V متغيرين)

$\rho = \frac{1}{\sigma}$

$\rho = \frac{RA}{l}$

* ρ depends only on material type and temp





non-ohimc meterials

*Resistance and tempereture:

$\boxed{\rho = \rho_0 [1 + \alpha \Delta T]}$ معتمد على الحرارة $\frac{L}{A}$

ρ_0 :- resistivity at known tempereture

Δt :- tempere tue difference $T_f - T_i$

α :- temperetuve Cofficient of Resistivity.

$R = R_0 [1 + \alpha \Delta T]$

*Electric power القدرة

$P \equiv$ work (energy) done per unit of time.

$$\boxed{P = \frac{U}{t}} \qquad P = \frac{dU}{dt} = \frac{d(qV)}{dt}$$

$$P = V\frac{dq}{dt} \Rightarrow \boxed{P = IV}$$

OR.

$$P = \frac{\vec{F}\cdot\vec{d}}{t} = \frac{q}{t}\,\vec{E}\cdot\vec{d}$$

$$\boxed{P = IV = I^2 R = \frac{V^2}{R} \Rightarrow U = Pt}$$

$[U] = W.s$

$= kW.h$

$Z \quad I = I_o \, e^{-t/\tau}$

$q = t \, s = 0 \longrightarrow t = \tau$

$I = \frac{dq}{dt} \Rightarrow dq = I \, dt$

$\int dq = \int I \, dt$

$q = \int_0^{\tau} I_o \, e^{-t/\tau} \, dt$

$= -\tau I_o \; - e^{-t/\tau} \Big]_0^{\tau}$

$= -\tau I_o \left[e^{-1} - 1 \right]$

$q = 0.63 \, I_o \tau$

b, c H.w

16 $V = 0.9\,v \quad L = 1.5\,m \quad A = 0.6\,mm^2 \quad I = ?$

$V = IR \;;\; R = \frac{\rho L}{A} = \frac{\rho * 1.5}{0.6 \times 10^{-6}}$ → from table.

18 $L_{Al} = L_{cu} \;,\; R_{Al} = R_{cu}$

$\frac{r_{Al}}{r_{cu}} = ?$

$\Rightarrow R_{Al} = R_{cu}$

$\frac{\rho_{Al} \cancel{L_{Al}}}{\cancel{\pi} r_{Al}^2} = \frac{\rho_{cu} \cancel{L_{cu}}}{\cancel{\pi} r_{cu}^2}$

$\frac{r_{Al}}{r_{cu}} = \sqrt{\frac{\rho_{Al}}{\rho_{cu}}}$

26 $T = 20\,c^\circ \quad R_0 = 19\,\Omega \Rightarrow T = hot \quad R = 140 \;,\; \boxed{T_f = ?} \quad \alpha = 4.5 \times 10^{-3}$ from table

$R = R_0 [1 + \alpha \Delta T]$ → $T_f - T_i$

$140 = 19 [1 + 4.5 \times 10^{-3} \Delta T]$

$\Delta T = 1415\,c^\circ \Rightarrow T_f = 1415 + 20$

$\boxed{T_f = 1435\,c^\circ}$

33) $r = 0.05\,mm$ $E = 0.2\,V/m$ $T = 50\,c°$ $l = 2\,m$

a) $R = \frac{\rho l}{A} = \frac{2.8 \times 10^{-8} * 2}{\pi (0.05 \times 10^{-3})^2} = 7.13\,\Omega$

b) $J = \sigma E$

$= \frac{1}{\rho} E = \frac{0.2}{2.8 \times 10^{-8}} \Rightarrow J = 7.14 \times 10^{6}\,A/m^2$

c) $J = \frac{I}{A} \Rightarrow I = JA = 7.14 \times 10^{6} * \pi (0.05 \times 10^{-3})^{2} *$

$I = 0.06\,A$

d) $n = 6 \times 10^{28}$ electron/m^2

$I = n v A e$

$0.06 = 6 \times 10^{28} \times v \times (\pi * (0.05 \times 10^{-3})^2) \times 1.6 \times 10^{-19}$

$v = 8 \times 10^{-4}\,m/s = 0.8\,mm/s$

e) $v = Ir = E.d$

$0.06 \times 7.13 = 0.43\,v$

35 at what T ⇒ $\rho_{Al} = 3\rho_{Cu}$

$\rho_{Al} = 3 * 1.7 * 10^{-8}$

$\rho = \rho_0 [1 + \alpha \Delta T]$

$3.17 \times 10^{-8} = 2.8 \times 10^{-8} [1 + 3.9 \times 10^{-3} \Delta T]$ $T_f - 20$

$T_f = ?$

47 $I = 1.7\,A$ $V = 110\,v$

$P = \frac{U}{t} \Rightarrow U = Pt = IVt$

$\boxed{P = 1.7 \times 110 \times 24 \times 3600 = 1.62 \times 10^{7}\ J}$ → مو هاد اللي بدنا اياه
صار واط/ث
بدي كيلو واط/ساعة

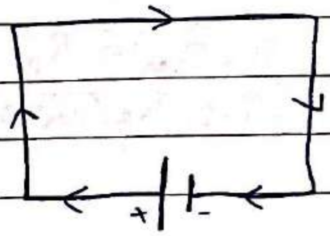
$P = \left(\underbrace{\frac{1.7 \times 110}{1000}}_{k.W}\right) \times \underbrace{24}_{h} = 4.5\ kw.h$

$cost = 4.5 \times 0.11\$ = 0.5\$$

Ch. 28

Direct current circuits

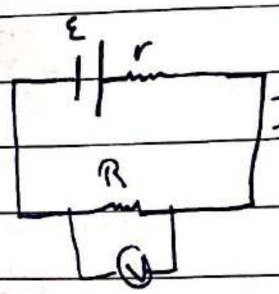
Electromotive force.



ε = e.m.f

e.m.f = work needed to move charg from $-$ to $+$ or from $+$ to $-$

inside the bettery — at side

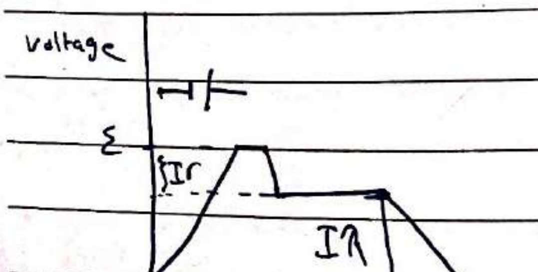


$\varepsilon = V_r + V_R$

$\varepsilon = Ir + IR$

$\Rightarrow V_R = \varepsilon - V_r$ Voltage drop

$V_R = \varepsilon - Ir$



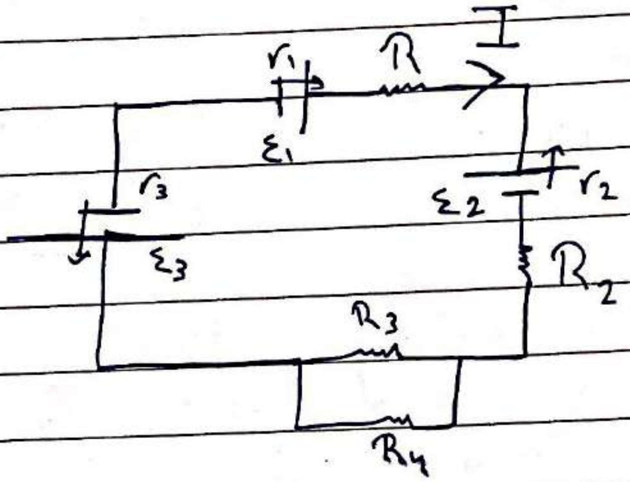
So $\varepsilon = I(r+R)$

$$I = \frac{\varepsilon}{r+R}$$

In general

$$\boxed{I = \frac{\sum \varepsilon}{\sum r + \sum R}}$$

ت = عقد / عم



$$\Rightarrow \quad I = \frac{\varepsilon_1 - \varepsilon_2 - \varepsilon_3}{(r_1+r_2+r_3) + \sum R}$$

$\sum R$:

$R_3, R_4 \Rightarrow R_p$

$R_p, R_2, R_1 \Rightarrow R_s$

$$* \left(\varepsilon = Ir + IR\right) * I$$

$$\underbrace{I\varepsilon}_{\text{Power}} = \underbrace{I^2 r + I^2 R}_{\text{dispanted power}}$$

$$* \left(\varepsilon = V_r + V_R\right) * q$$

$$\varepsilon q = \underbrace{q V_r}_{\text{الطاقة الضائعة}} + q V_R$$

* Resistance connection

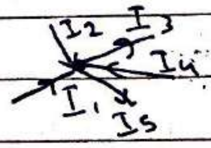
$R_s \Rightarrow R_1 + R_2 + R_3 + \ldots$

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

* Kirchoff's Rules :-

Rule 1 :-

$\sum I_{in} = \sum I_{out}$ of node



$\sum I_{in} - \sum I_{out} = 0$

$\sum I = 0$ at node

$I_1 + I_2 + I_4 = I_3 + I_5$

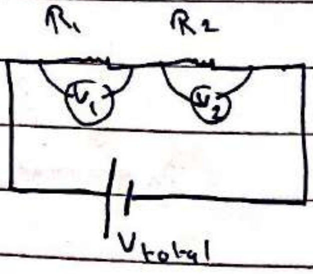
$I_1 + I_2 + I_4 - I_3 - I_5 = 0$ } at node

Conservation of charge

Rule 2 :-

$\sum V = 0$ closed track

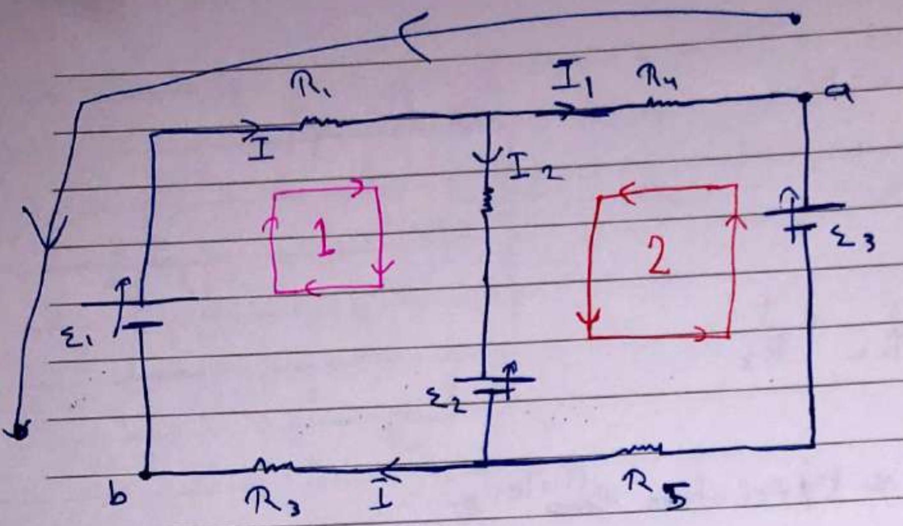
$\Rightarrow$ Conservation of energy



$V_{total} = V_1 + V_2$

$V_{total} - V_1 - V_2 = 0$

$\sum \Delta V = 0$



$$\boxed{I = I_1 + I_2}$$

loop 1:-

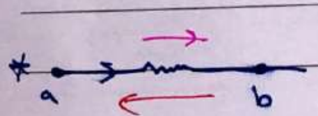
$-IR - I_2R_2 - \varepsilon_2 - IR_3 + \varepsilon_1 = 0$

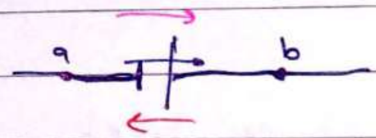
loop 2:-

$I_1R_4 - I_2R_2 - \varepsilon_2 + I_1R_5 + \varepsilon_3 = 0$

$V_{ab} = V_a - V_b$

$V_a + I_1R_4 + IR_1 - \varepsilon_1 = V_b$





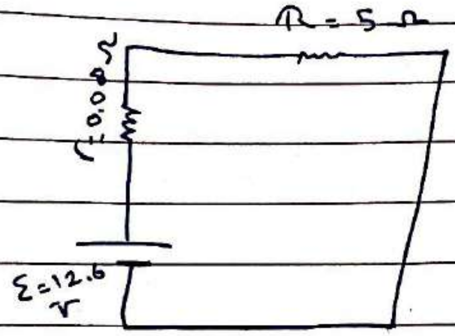
$V_a > V_b \Rightarrow \Delta V = V_b - V_a < 0$

$V_a > V_b \Rightarrow \Delta V = V_b - V_a > 0$

$V_a < V_b \Rightarrow \Delta V = V_b - V_a > 0$

$V_a < V_b \Rightarrow \Delta V = V_a - V_b < 0$

3/



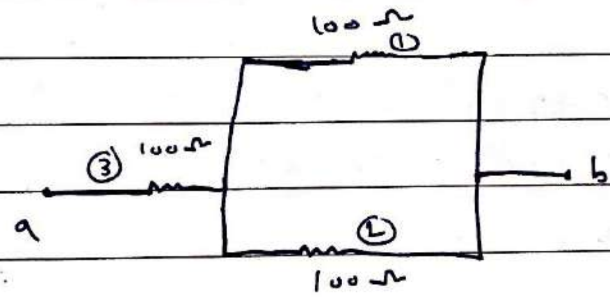
$V_R = \varepsilon - V_r$ but $I = \frac{\varepsilon}{R+r} = \frac{12.6}{5+0.08} = 2.48\ A$

$V_R = \varepsilon - Ir$

$= 12.6 - 2.48 * 0.08$

$= 12.4\ V$

5/



* max power = 25 W each

(a) $P_1 = I_1^2 R_1 \Rightarrow 25 = I^2 * 100$

$\Rightarrow I_1 = 0.5\ A = I_2$

$\Downarrow$

$V_1 = I_1 R_1 = 0.5 * 100 = 50\ V$

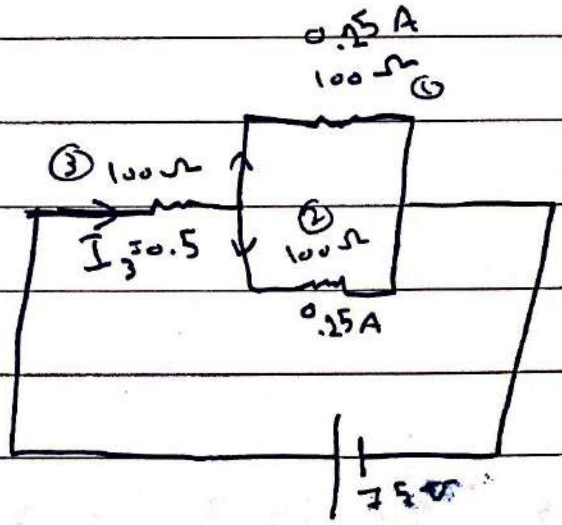
$I_3 = I_1 + I_2 = 0.5 + 0.5 = \boxed{1}\ A$

$P_3 = 25\ W = I_3 V_3 \Rightarrow 25 = 1 * V_3 \Rightarrow V_3 = 25\ V$

$\boxed{V_{ab} = 25 + 50 = 75\ V}$

5

(b)



$(1,2) \Rightarrow \frac{1}{R_P} = \frac{1}{100} + \frac{1}{100} \Rightarrow R_P = 50\ \Omega$

$(R_P, 3) \Rightarrow R_s = 100 + 50 = 150\ \Omega$

$I_{total} = \frac{V_{total}}{R_{total}} = \frac{75}{150} = 0.5\ A$

$P_1 = I^2 R_1 = (0.25)^2 * 100 = 6.25\ W$

$P_2 = I^2 R_2 = (0.25)^2 * 100 = 6.25\ W$

$P_3 = I^2 R_3 = (0.5)^2 * 100 = 25\ W$

15 $R_1, R_2 \Rightarrow R_s = 690\,\Omega$, $R_p = 150\,\Omega$

$$690 = R_1 + R_2 \quad \text{— ①}$$

$$\frac{1}{150} = \frac{1}{R_1} + \frac{1}{R_2} \quad \text{— ②}$$

$$\frac{1}{150} = \frac{1}{R_1} + \frac{1}{690 - R_1}$$

$$\frac{1}{150} = \frac{\cancel{R_1} + 690 - \cancel{R_1}}{R_1(690 - R_1)}$$

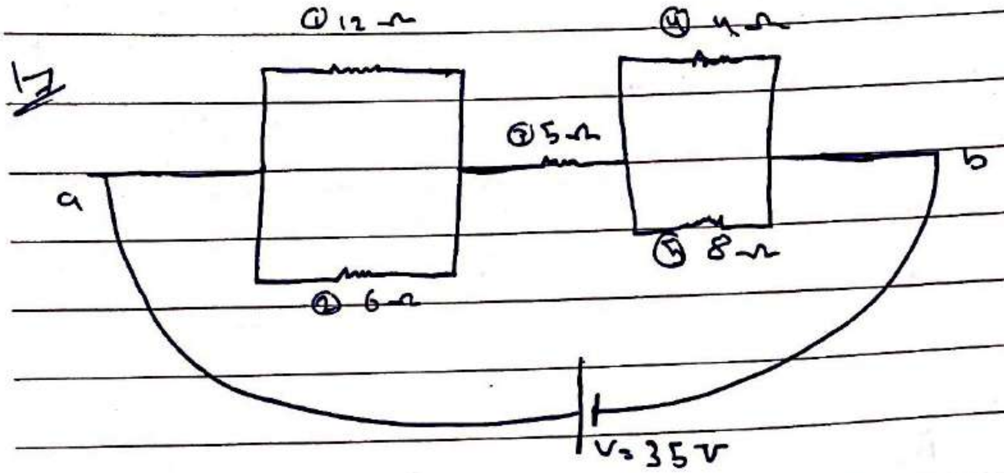
$$\frac{1}{150} = \frac{690}{690R_1 - R_1^2}$$

$$R_1^2 - 690R_1 + 103500 = 0$$

$R_1 = 469.5\,\Omega \qquad R_2 = 220.4\,\Omega$

Scanned with CamScanner

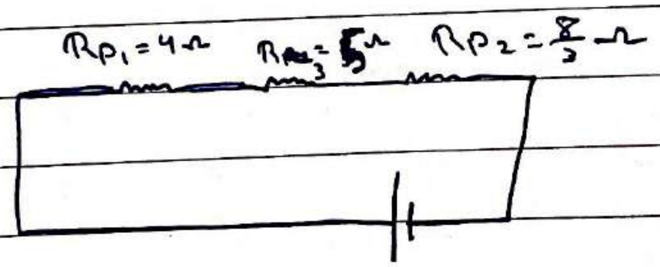
17



$(12, 6) \rightarrow P \Rightarrow \frac{1}{R_{p_1}} = \frac{1}{12} + \frac{1}{6} \Rightarrow R_{p_1} = 4\ \Omega$

$(4, 8) \rightarrow P \Rightarrow \frac{1}{R_{p_2}} = \frac{1}{4} + \frac{1}{8} \Rightarrow R_{p_2} = \frac{8}{3}\ \Omega$

$(R_{p_1}, R_{p_2}, 5) \rightarrow S \Rightarrow R_S = 4 + 5 + \frac{2}{3} = 11.6\ \Omega$



$I_{total} = \frac{35}{11.6} = 3\ A$

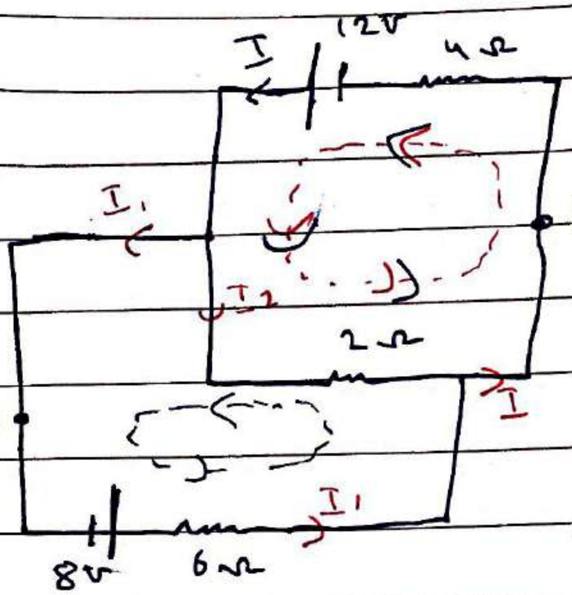
$V_{R_{p_1}} = 3 * 4 = 12 = V_1 = V_2$

$I_1 = \frac{12}{12} = 1\ A \quad , \quad I_2 = \frac{12}{6} = 2\ A$

$\Rightarrow V_{R_{p_2}} = 3 * \frac{8}{3} = 8\ V = V_4 = V_5$

$I_4 = \frac{8}{4} = 2\ A \quad , \quad I_5 = \frac{8}{8} = 1\ A$

24



$$I = I_1 + I_2$$

$$-4I + 12 - 2I_2 = 0$$

$$-4(I_1 + I_2) + 12 - 2I_2 = 0$$

$$-4I_1 - 6I_2 + 12 = 0$$

$$2I_2 + 8 - 6I_1 = 0$$

$$(-6I_1 + 2I_2 + 8 = 0) * 3$$

$$-18I_1 + 6I_2 + 24 = 0$$

$$-4I_1 - 6I_2 + 12 = 0$$

$$-22I_1 + 36 = 0 \Rightarrow I_1 = 1.6A$$

$$-4 * 1.6 - 6I_2 + 12 = 0 \Rightarrow I_2 = 0.93\ A$$

$$I = I_1 + I_2 = 1.6 + 0.93 = 2.53A$$

$V_{ab} = V_a - V_b$

$V_a - 2 I_2 = V_b$

$V_a - 2 * (0.93) = V_b$

$V_a - V_b = 1.86\ V$