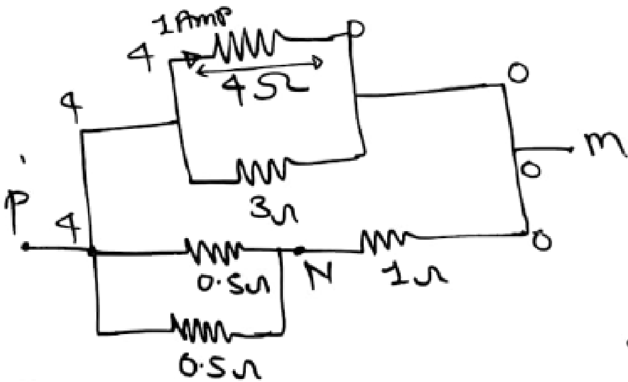
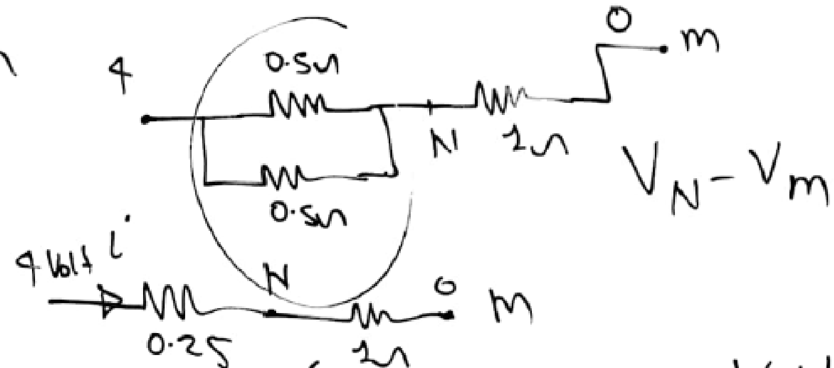
Q AIPMT

In the ckt shown, the current through the 4 Ω resistance is 1 Amp when the points P & M are connected to a d.c Voltage source. The potential difference b/w the point M & N is

$$\frac{1}{R_{eq}} = \frac{1}{0.5} + \frac{1}{0.5} = \frac{2}{0.5} = \frac{1}{R_{eq}} = 4 \qquad R_{eq} = \frac{1}{4} = 0.25$$



(a) 0.5 Volt.
(b) 3.2 Volt.
(c) 1.5 Volt.
(d) 1.0 Volt.



$V_N - V_m$

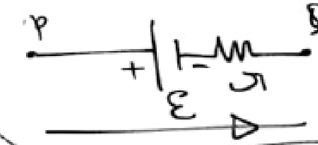
$R_{eq} = 1.25$

$iR = 3.2 \times 1 = 3.2$ Volt

$$i = \frac{4}{1.25} = \frac{400}{125} = \frac{16}{5} = 3.2 \text{ Amp}$$

⇒ Emf :- (ε) (Electromotive force) :- ⇒

⇓ (Volt)

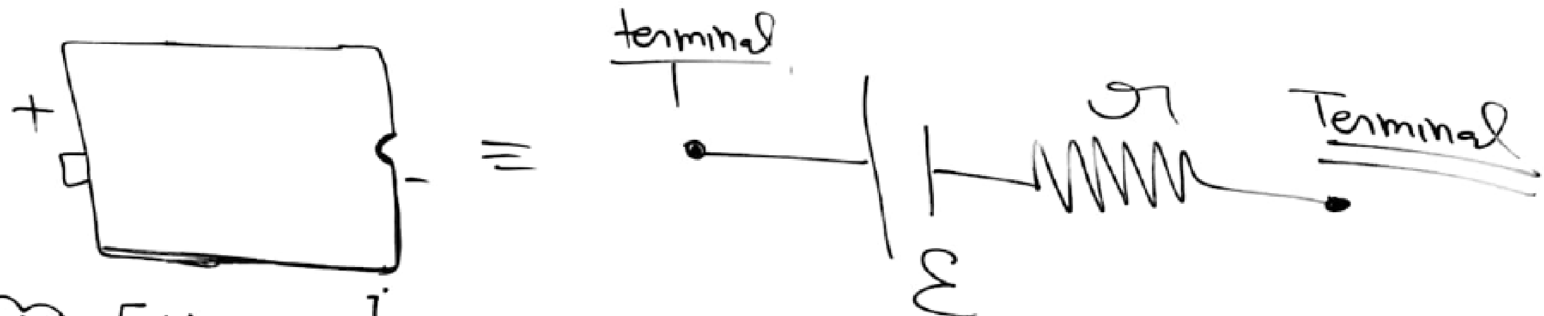


KVL

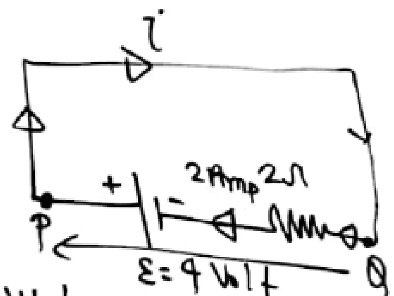
$V_P - \varepsilon = V_Q$

$V_P - V_Q = \varepsilon$

⇒ battery :- [Emf + internal resistance]



Ex :-



$i = \frac{\varepsilon}{r}$

$i = \frac{4}{2} = 2$ Amp

$V_P - V_Q = 0$

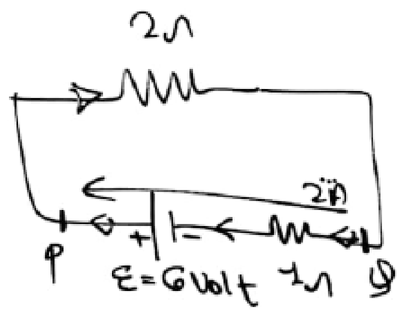
⇓

terminal potential

KVL move Q to P → $V_Q - 2\times2 + 4 = V_P$

Emf of battery :-

(1)



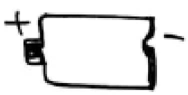
KVL

$$V_Q - 2\times 1 + 6 = V_P$$

$$V_P - V_Q = 4 \text{ Volt}$$

$\Rightarrow$ Emf of battery = 6 Volt

$V_P - V_Q$



$\Rightarrow$ Terminal potential = 4 Volt

$$R_{eq} = 2 + 1 = 3\,\Omega$$

$$i = \frac{\varepsilon}{R_{eq}} = \frac{6}{3} = 2 \text{ Amp}$$

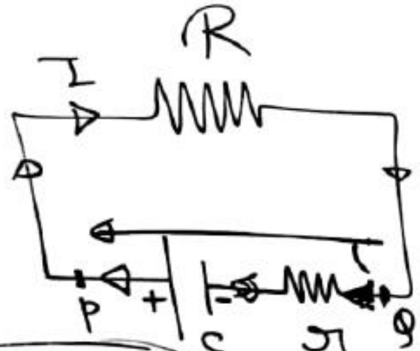
$\Rightarrow$ **Emf :-** If $i = 0$

$$T.P = \varepsilon$$

$$V_P - V_Q = 6 \text{ Volt}$$

When battery is connected with open ckt, then its terminal potential equal to its Emf.

(i) discharging of battery:-



r = internal resistance of battery

R = External Resistance

ε = Emf of battery.

$R_{eq} = r + R$

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

Terminal Potential (T.P) =

$V_Q - ir + \varepsilon = V_P$

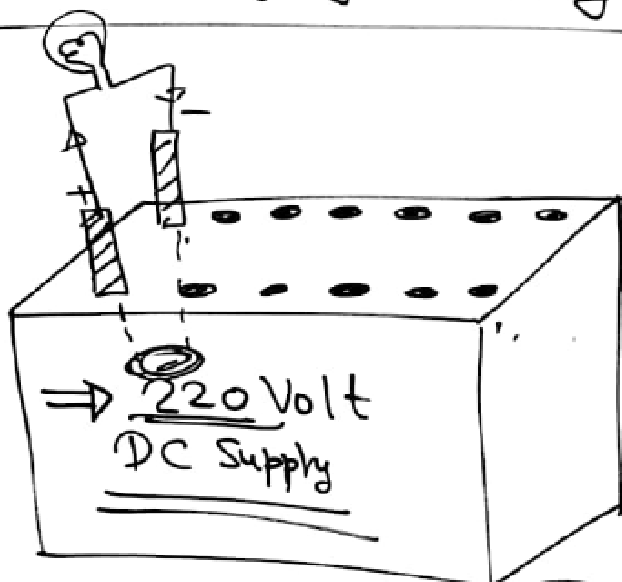
$T.P = V_P - V_Q = \varepsilon - \left(\dfrac{\varepsilon}{r+R}\right) r$

$T.P = \varepsilon - ir$

In Case of discharging of battery $T.P = V_P - V_Q = \varepsilon - ir$

$T.P < \varepsilon$ $\quad$ $T.P < \text{Emf}$

(i) discharging of battery-:



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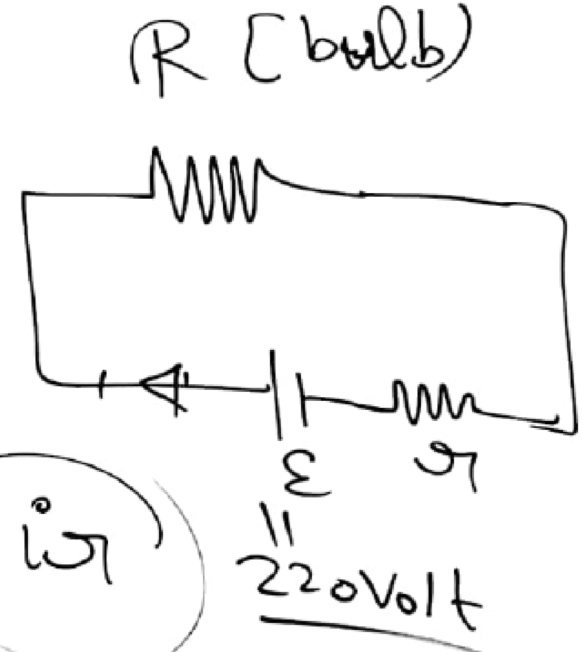
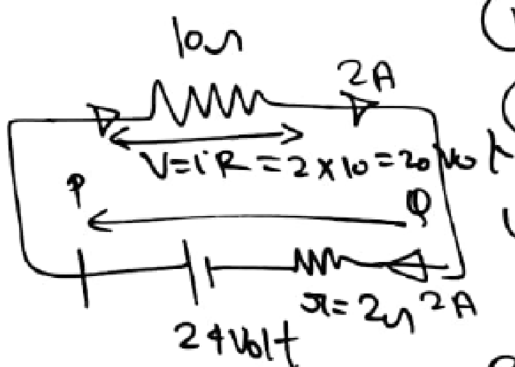


$$T.P = \varepsilon - ir$$

(i) discharging of battery-:

⟹ Q1) find terminal potential of battery.



① $i = 2$

(ii) T.P of battery = 20Volt

(iii) Potential across resistan R

$V_P - V_Q = \varepsilon - ir$

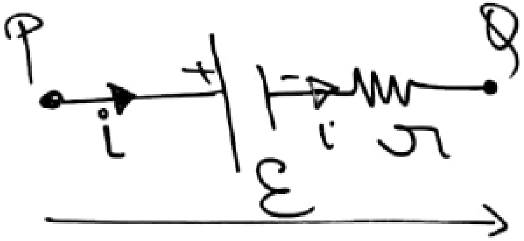
$= 24 - 2\times2$

T.P = 20 Volt

(a) $R_{eq} = 10 + 2 = 12\Omega$ $\quad i = \frac{24}{12} = 2$ Am

$\varepsilon_{eq} = 24$ Volt

⇒ ## Charging of battery



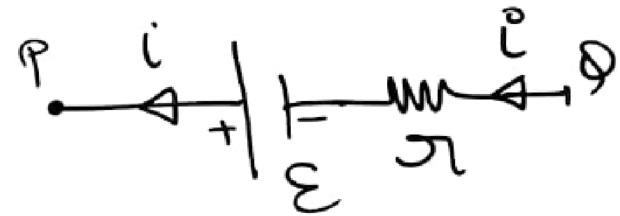
$$V_P - V_Q = T.P$$

$$V_P - \varepsilon - ir = V_Q$$

$$V_P - V_Q = \varepsilon + ir$$

$$T.P = \varepsilon + ir \quad [T.P = V_P - V_Q > \varepsilon]$$

Discharging of battery



$$T.P \Rightarrow V_P - V_Q = \varepsilon - ir$$

$$V_Q - ir + \varepsilon = V_P$$

$$V_P - V_Q = \varepsilon - iR$$

$$T.P = V_P - V_Q < \varepsilon$$

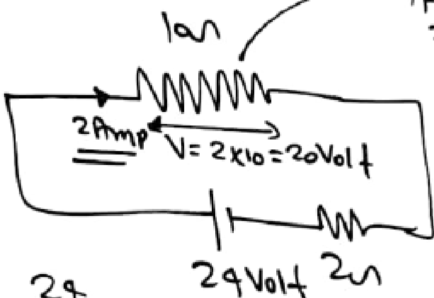
Electrical power (P) :-

$V = iR$ [from ohm's law) $\left[i = \frac{V}{R}\right]$

$$P = Vi = V\left(\frac{V}{R}\right) = \frac{V^2}{R} = Vi = (iR)i = i^2R$$

Power = (Potential drop across resistance) (Electric current through resistor)

$$P = Vi = \frac{V^2}{R} = i^2R$$



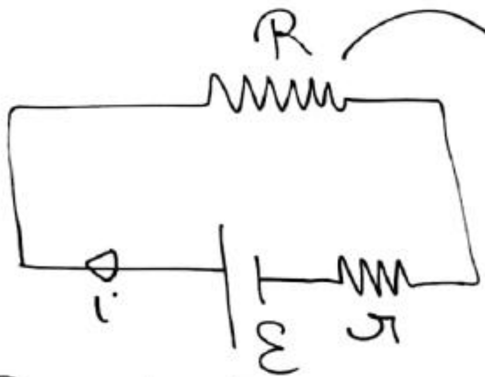
$P_R = Vi$
$= 20 \times 2$
$= 40$ J/sec
$= 40$ watt

$i = \frac{24}{12} = 2$ Amp

$$P_R = \frac{V^2}{R} = \frac{(20)^2}{10} = \frac{400}{10} = 40 \text{ J/sec} = 40 \text{ watt}$$

$$P_R = (2)^2 \times 10 = 4 \times 10 = 40 \text{ watt}$$

Value of R [external resistance for maximum power dissipation]



(i) R = external resistance
r = internal resistance
ε = Emf of battery.

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

Power $= i^2 R$

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

For maximum power $\frac{dP}{dR} = 0$

$$\frac{dP}{dR} = 0$$

Condition $r = R$ → For maximum Power dissipation

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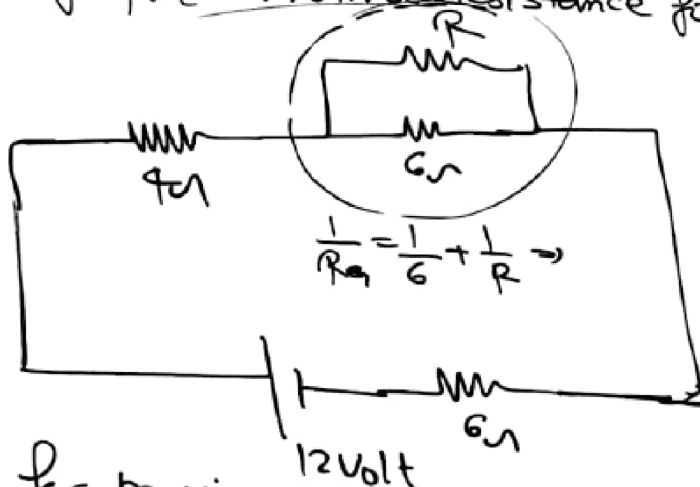
External resistance = Internal resistance

Value of R [external resistance for maximum power dissipation]

Q1)



$\frac{1}{R_{eq}} = \frac{1}{6} + \frac{1}{R} \Rightarrow$

* For maximum power consumption value of R is equal to

(a) 9Ω

(b) 3Ω

(c) 6Ω

(d) N.O.T.

Hint) for maximum power dissipation

$r = R_{ext}$

$R_{eq} = \frac{6R}{6+R}$

$R_{ext} = 4 + \frac{6R}{6+R} = 6$

$\frac{6R}{6+R} = 6 - 4$

$\frac{6R}{6+R} = 2$

$6R = 12 + 2R$

$4R = 12$

$R = 3\Omega$