بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِيْمِ

বিস্‌মিল্লাহির রাহ্‌মানির রাহীম

উদ্ভাস

একাডেমিক এন্ড এডমিশন কেয়ার

Class 12: Physics 2nd Paper (Chapter-3)

Current electricity

Lecture : P-08

Today's Topics:

- Electric Cell
- Internal Resistance and E.M.F
- Relation between internal Resistance and E.M.F
- Mathematical Example
- Combination of cells
- Mathematical Problems

Electric Cell

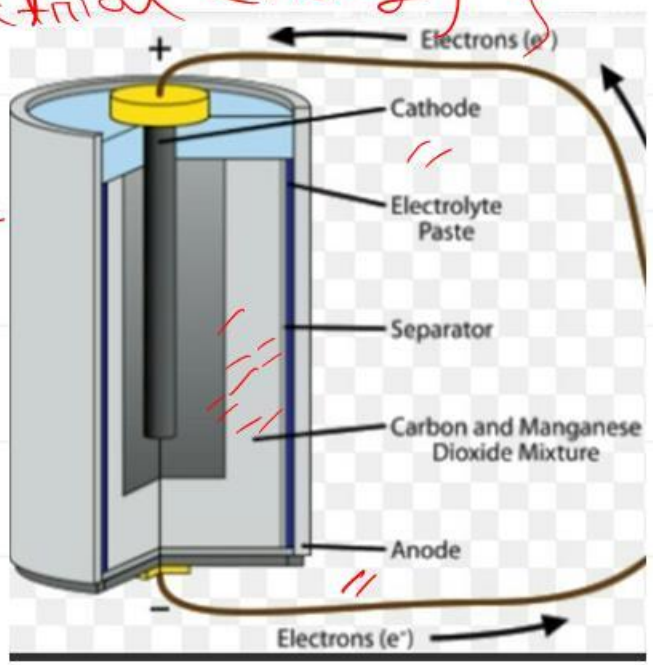
An electrical cell is an "electrical power supply". It converts stored chemical energy into electrical potential energy, allowing a current to flow from the positive terminal to the negative one via an external circuit. The positive terminal is called a cathode and the negative terminal is called an anode.

They are 2 types.

Ex:

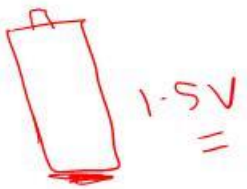
a) Primary Cell

b) Secondary Cell



POLL QUESTION 01

Which type of cell is dry cell?



(a) Secondary Cell

(b) Primary Cell

Internal Resistance and E.M.F

E.M.F

Electromotive force is the characteristic of any energy source capable of driving electric charge around a circuit. It is abbreviated E in the international metric system but also, popularly, as emf.

Voltage difference < E.M.F

Internal Resistance

Internal Resistance is the resistance which is present within the cell that resists the current flow when connected to a circuit. Thus it causes a voltage drop when current flows through it.

It depends on-

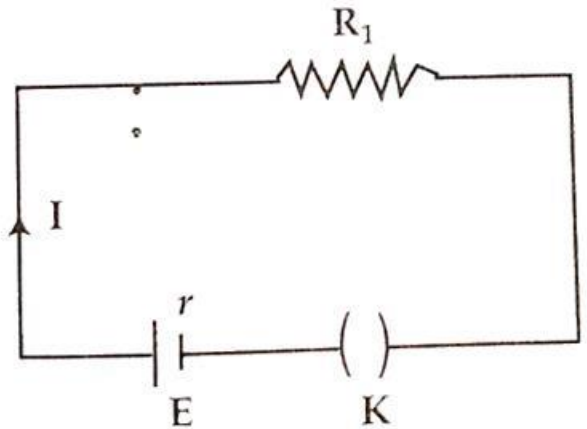
→ Chemical properties of materials inside the cell

→ Distance between electrodes

→ Temperature

→ Shape and size of electrodes

Relation between internal Resistance and E.M.F



$R_s = R_1 + r$

$E = IR_s$

$E = IR_1 + Ir$

$E = V + Ir$

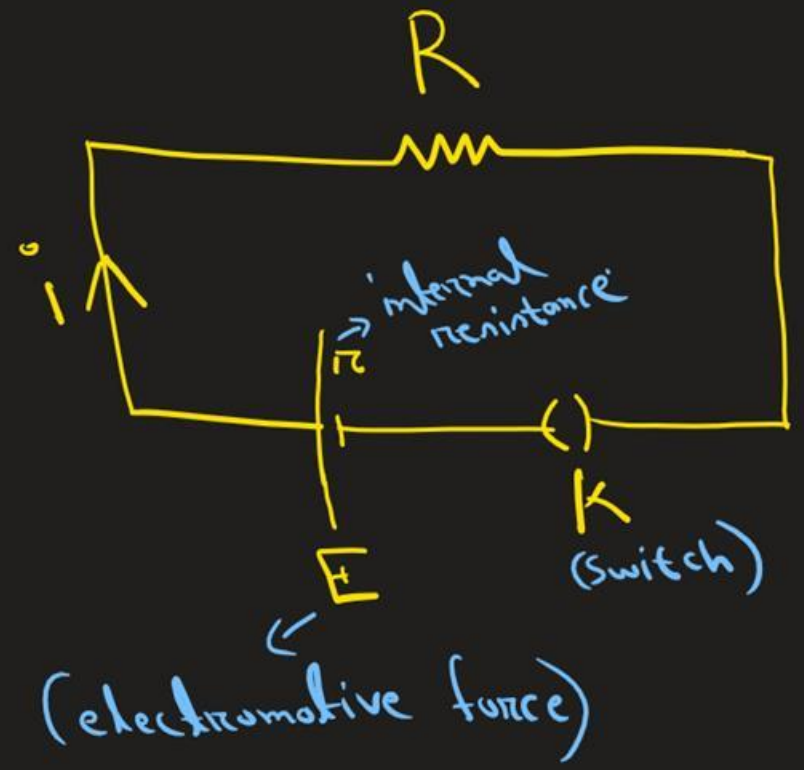
Here, V = Terminal Voltage

Ir = Lost volt

V<E

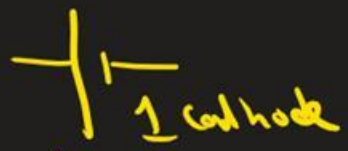
Internal resistance and electromotive force

Wednesday, July 1, 2020 11:56 PM



$E = IR + Ir$ → Lost EMF

Voltage difference (V_{out})



1 cell

Multiple Cells
Battery

$\eta = \frac{O/P}{I/P}$

$= \frac{IR}{E}$

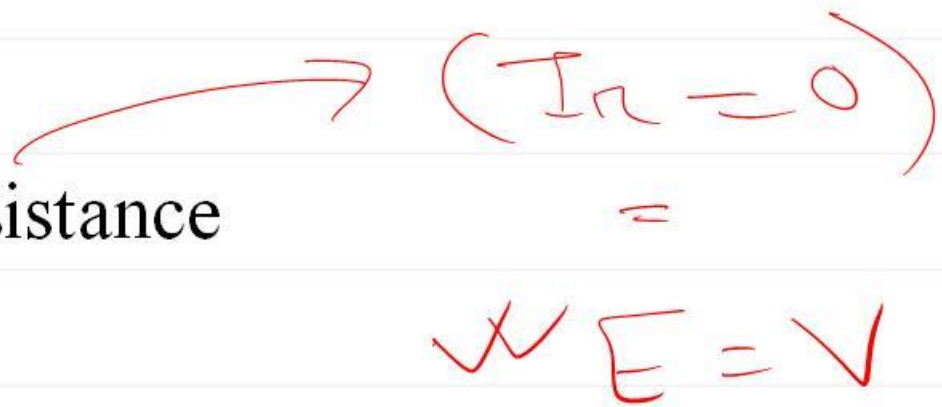
$= \frac{IR}{I(R+r)}$

$\Rightarrow \boxed{\eta = \frac{R}{R+r}}$

POLL QUESTION 02

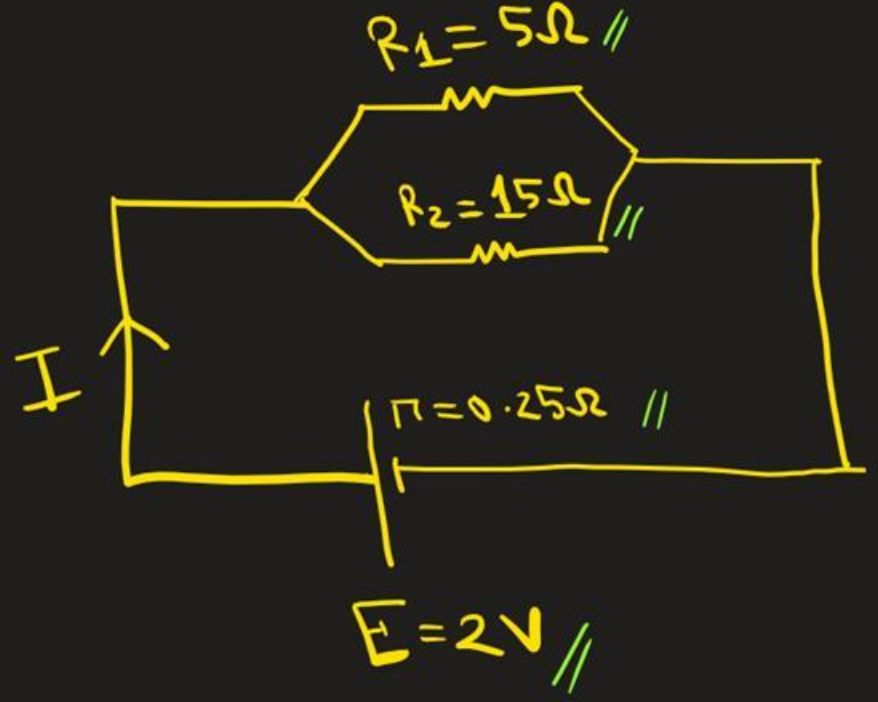
In which condition potential difference will be equal to E.M.F?

(a) Very high current
(b) Current flow zero
(c) Lesser internal resistance
(d) Not possible



Math 1

Thursday, July 2, 2020 3:44 AM



Ques.° $I = ?$

$$I = \frac{V}{R} = \frac{2}{(5 \| 15) + 0.25}$$

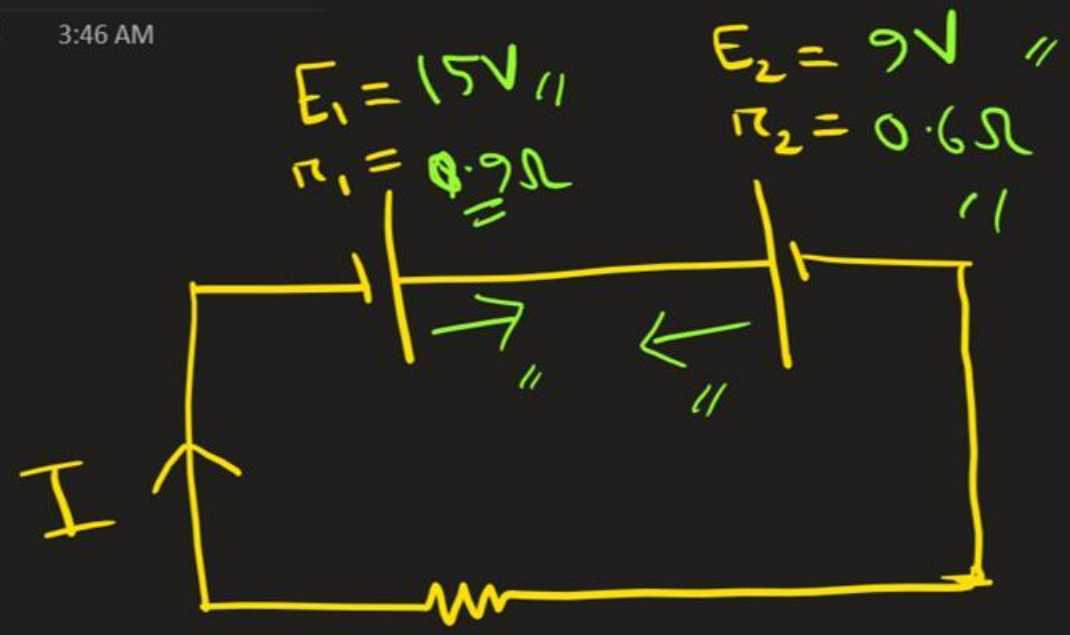
$$= \frac{2}{3.75 + 0.25}$$

$$= \frac{2}{4} = 0.5\,A$$

(Ans)

Math 2

Thursday, July 2, 2020 3:46 AM



$R = 10.5\Omega$

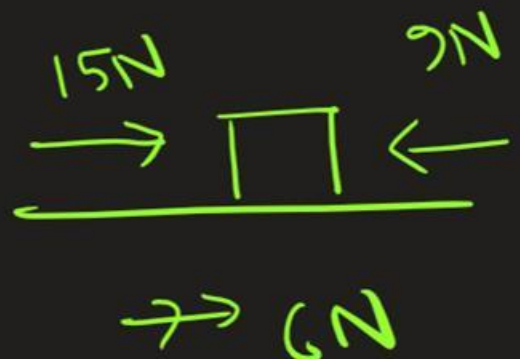
Ques.: $I = ?$

$$I = \frac{V}{R}$$

$$= \frac{15 - 9}{10.5 + 0.9 + 0.6}$$

$$= \frac{6}{12} = 0.5A$$

(Ans)



POLL QUESTION 03

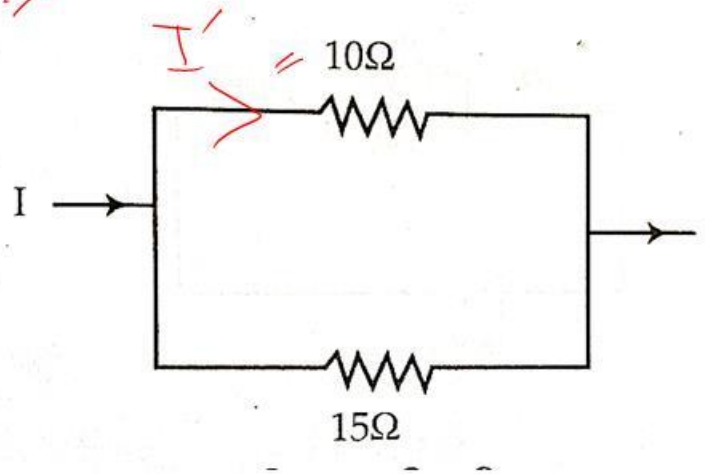
How much current is flowing through 10 ohm ?

(a) 0.6

(b) 0.5

(c) 0.6 I

(d) 0.5 I



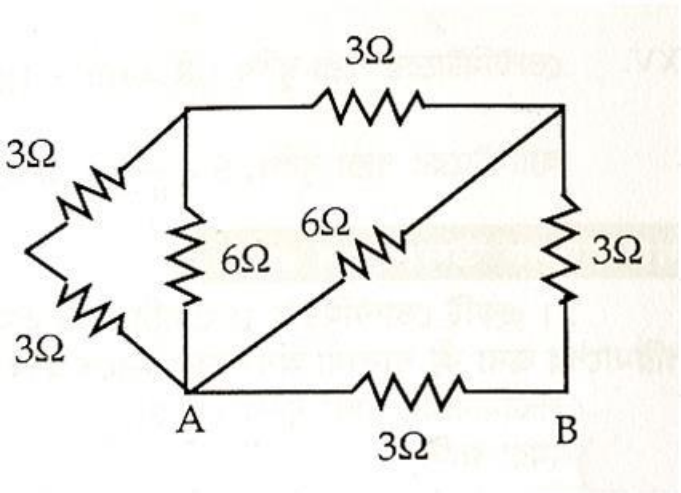
$$I' = I\left(\frac{10^{-1}}{10^{-1}+15^{-1}}\right)$$

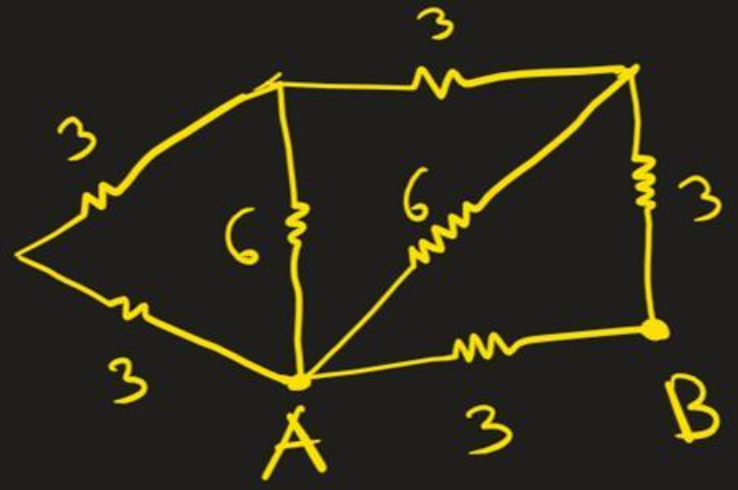
$$= I \times 0.6$$

$$= 0.6I$$

MATH 03

Calculate equivalent resistance Rab





Quen.: $R_{AB} = ?$

Soln:

$$\left\{\left[\left\{\left((3+3)\|6\right)+3\right\}\|6\right]+3\right\}\|3$$

$$= \left[\left\{\left((6\|6)+3\right)\|6\right\}+3\right]\|3$$

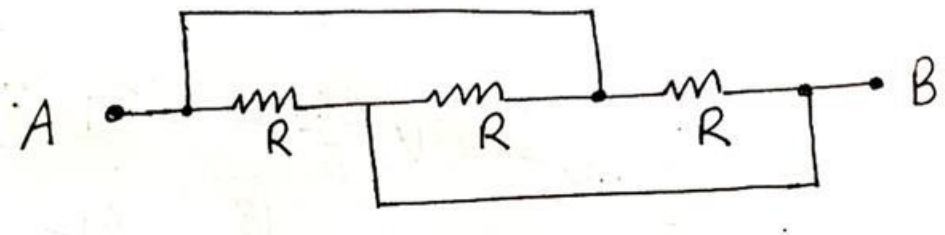
$$= \left\{\left((6\|6)+3\right)\|3\right\}$$

$$= 6\|3 = 2\,\Omega$$

(Ans.)

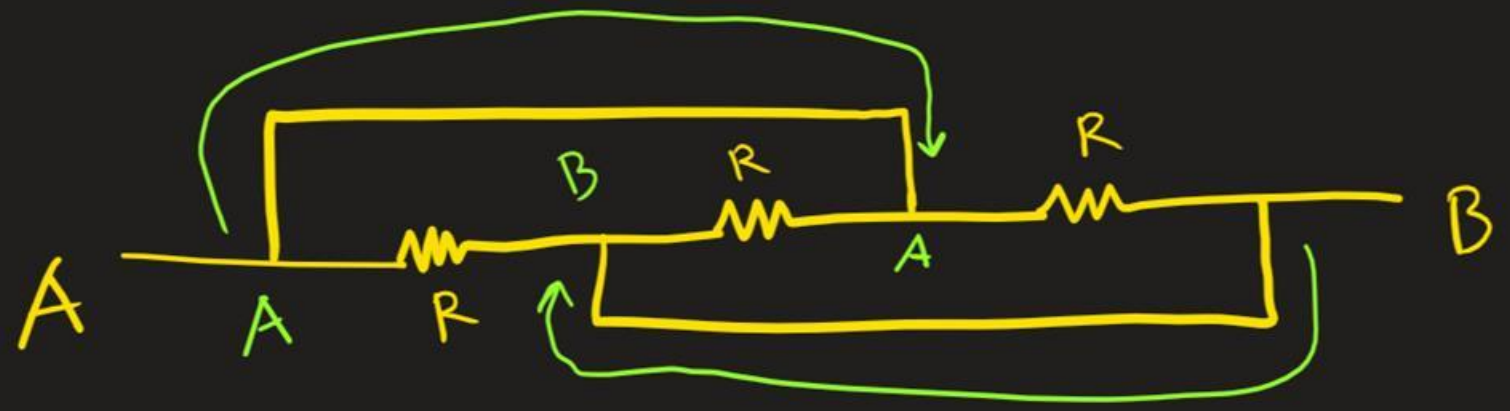
MATH 04

Calculate equivalent resistance



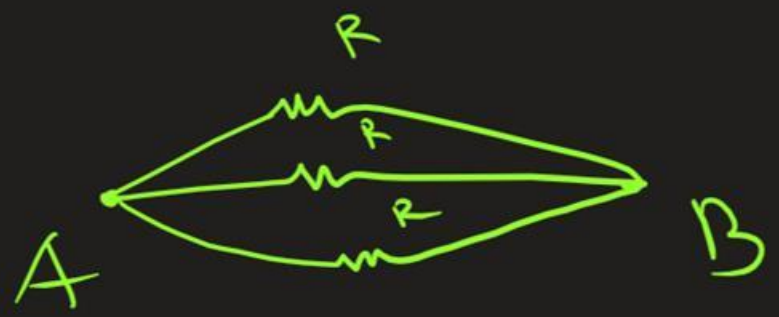
Math 4.1 + point concept + (R/n formula)

Thursday, July 2, 2020 3:49 AM



Quen.: $R_{AB} = ?$

(point concept of Resistance)

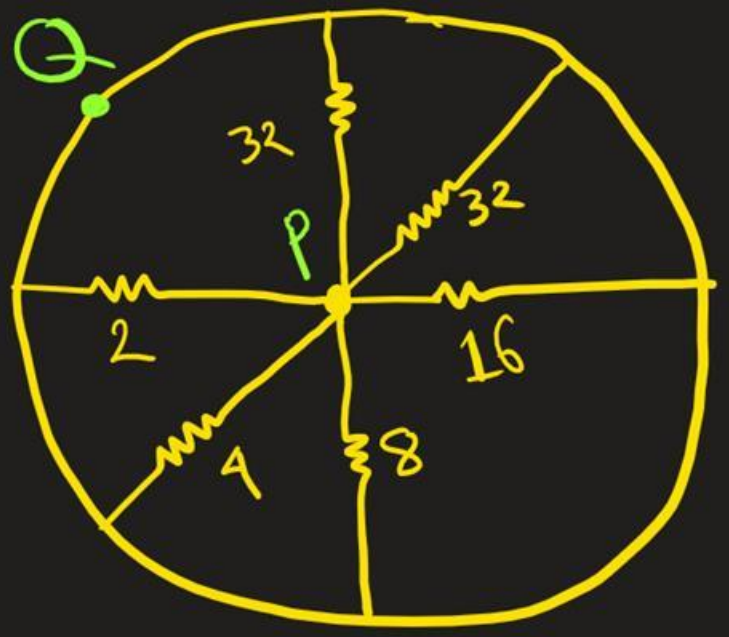


So, $R_{AB} = R/3$

(Ans)

Math 4.2

Thursday, July 2, 2020 3:50 AM



Quen.: $R_{PQ} = ?$

Soln: All the resistors are in parallel connection.

So,

$$\frac{1}{R_{PQ}} = \frac{1}{32} + \frac{1}{32} + \frac{1}{16} + \frac{1}{8} + \frac{1}{4} + \frac{1}{2}$$

$$\Rightarrow R_{PQ} = 1\,\Omega$$

(Ans)

POLL QUESTION 04

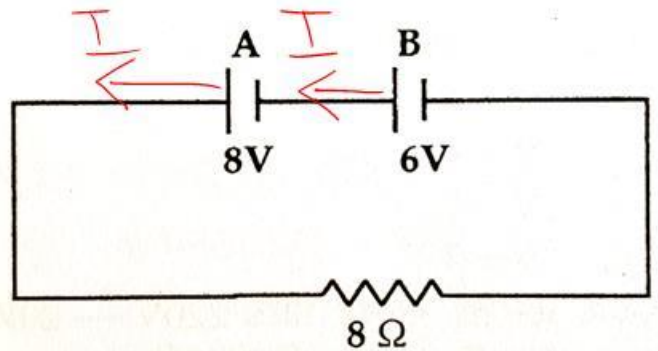
Calculate current flow.

(a) 0.57 amp

(b) 1.75 amp

(c) 0.25 amp

(d) 4 amp

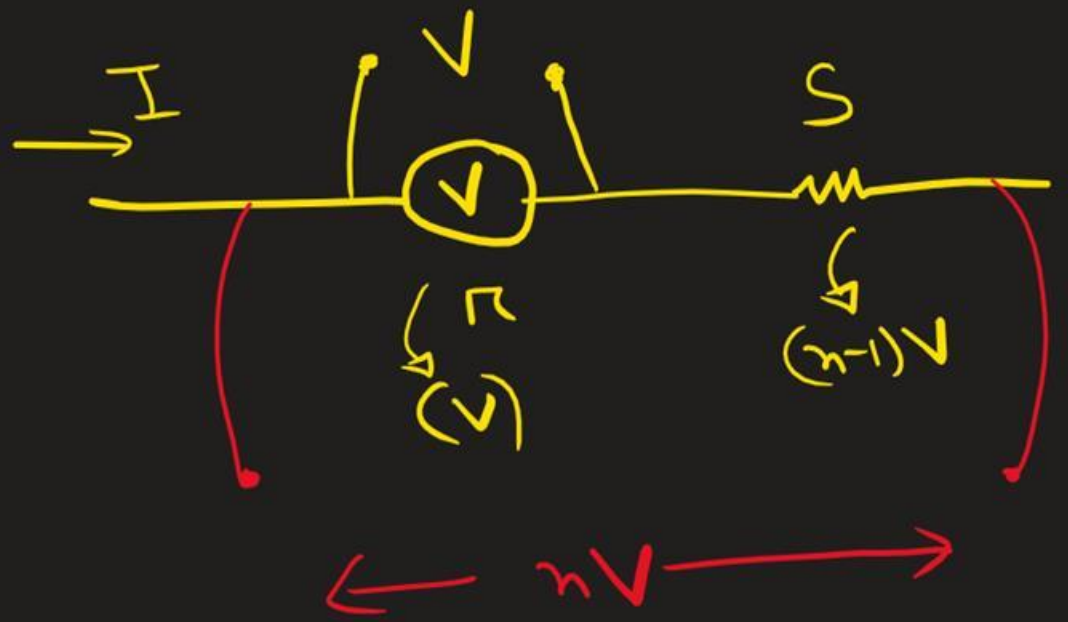


$$I = \frac{V}{R}$$

$$= \frac{8+6}{8} = \frac{14}{8} = \frac{7}{4} = 1.75\,A$$

Increasing the range of voltmeter

Thursday, July 2, 2020 4:01 AM



a shunt of S ohm is required to connect in series with voltmeter to measure voltage n times.

$$V = Ir$$
$$(n-1)V = IS$$

$$\frac{(n-1)V}{V} = \frac{IS}{Ir} \Rightarrow \boxed{S = (n-1)r}$$

MATH 05

A voltmeter of 1000 ohm internal resistance can measure 15 volt. How can it measure 150v ?

A voltmeter of 1000 ohm internal resistance can measure upto 15 volt. What measure should be taken to measure 150 volt by the same voltmeter?

Soln: $r = 1000\Omega$; $V = 15V$; $nV = 150V$

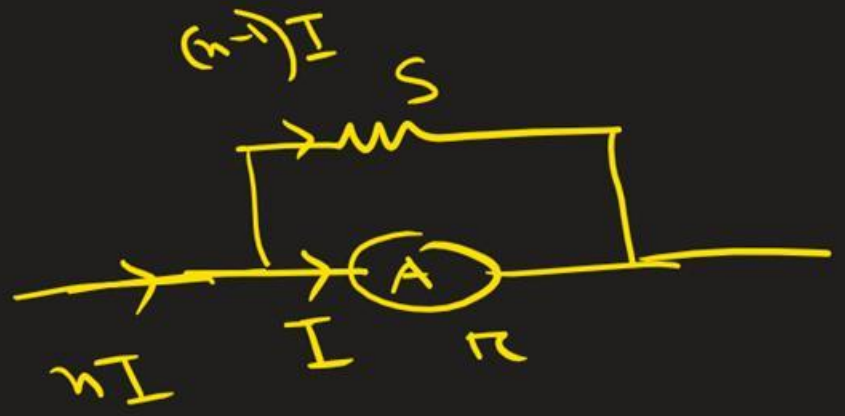
So, $n = 10$

$$S = (n-1)r = (10-1) \times 1000 = \boxed{9000\Omega}$$ → in Series

(Ans)

Increasing the range of ammeter

Thursday, July 2, 2020 4:01 AM



$$V = I_r = (n-1)I \cdot S$$

$$\Rightarrow I'r = (n-1)I'S$$

$$\Rightarrow \boxed{S = \frac{r}{n-1}}$$

← in parallel to increase the range of Ammeter by n times

MATH 06

An ammeter of 2 ohm internal resistance can measure upto 0.2 amp current. How can it measure 2 amp current?

An ammeter of 2Ω internal resistance can measure upto 0.2 Amp, what measure should be taken to measure 2 Amp by the same Ammeter?

Soln: $R = 2\Omega$; $I = 0.2A$; $nI = 2A$

So, $n = 10$

$$S = \frac{R}{n-1} = \frac{2}{10-1}$$

$$= \boxed{\frac{2}{9}\Omega} \text{ (in parallel)}$$

(Ans)

Combination of cells

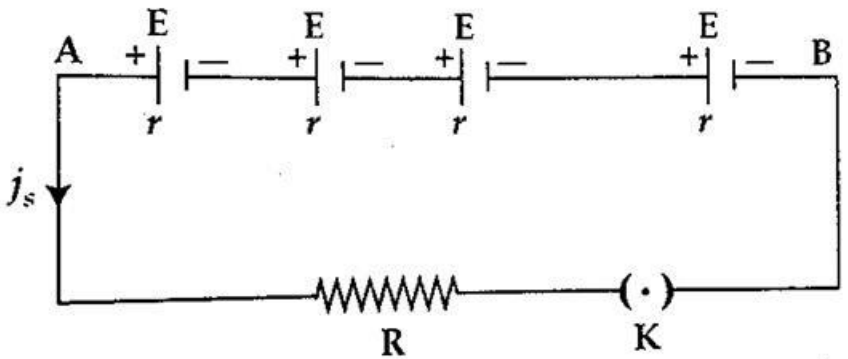
There are 3 types of combination. These are-

(a) Series combination

(b) Parallel combination

(c) Mix combination

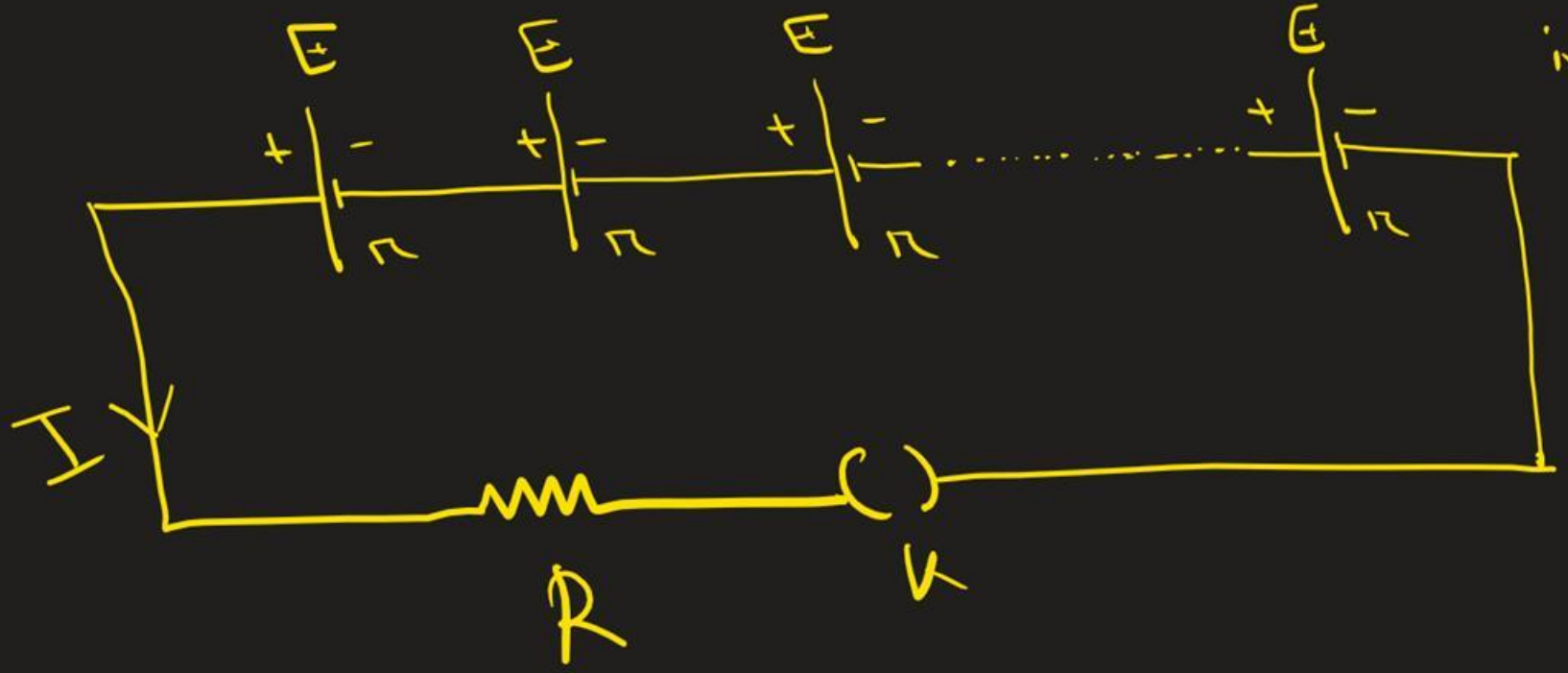
Series combination



Series combination

Thursday, July 2, 2020 4:04 AM

(n no. of cells are in Series connection)



$$I = \frac{nE}{R + nr} \quad ; \quad \text{when, } R >> r, \quad R + nr \approx R$$

$$\text{So, } I \approx \frac{nE}{R}$$

[So, we should use Series combination when $R >> r$]

if 1 cell, $I = E/R$ → n times current

POLL QUESTION 06

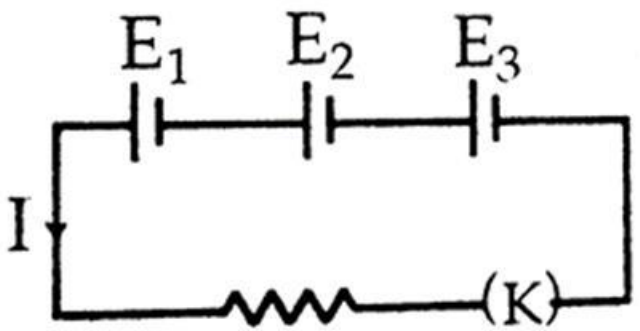
if $E=E_1=E_2=E_3$ and resistance is R, calculate I.

(a) $\frac{3E}{3R+r}$

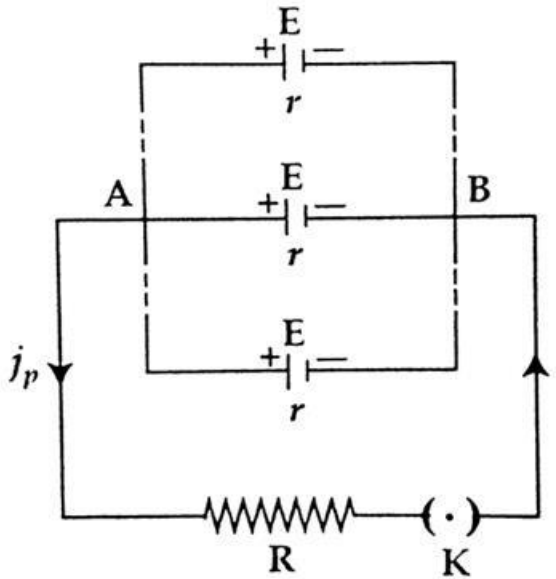
(b) $\frac{E}{3R+r}$

(c) $\frac{3E}{R+3r}$

(d) $\frac{3E}{3R+3r}$



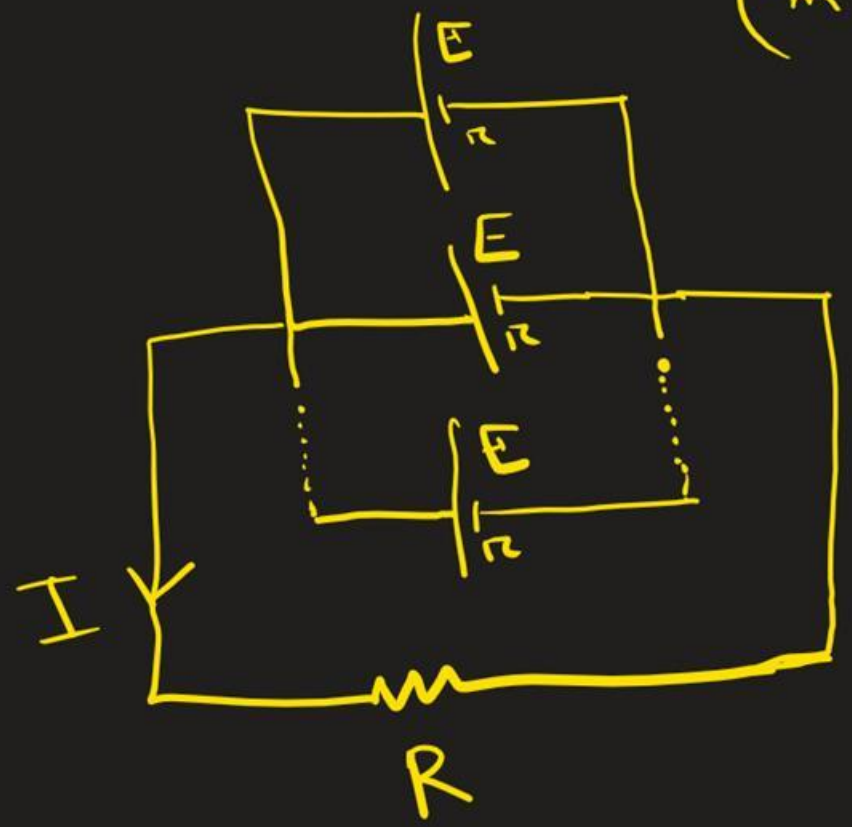
Parallel Combination



Parallel combination

Thursday, July 2, 2020 4:06 AM

(m no. of cells are in parallel (connection)



$$I = \frac{E}{R + r/m} = \frac{mE}{mR + r}$$

when, $R \ll r$, $mR + r \approx r$

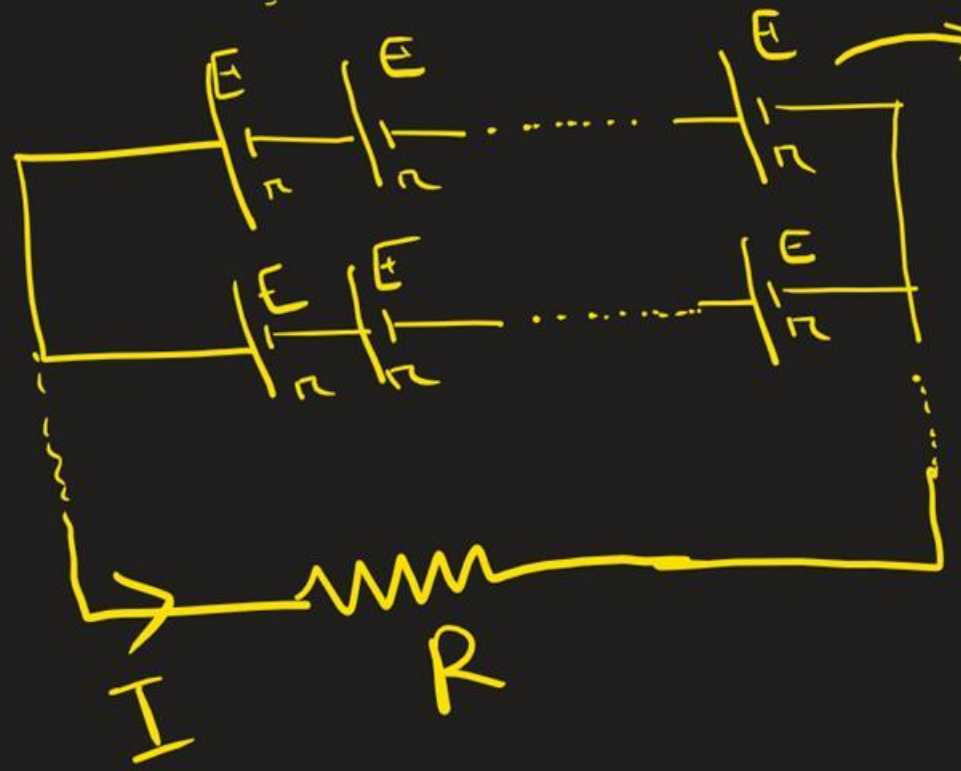
So, $I \approx \frac{mE}{r}$

if one cell, $I = E/r$. So, m times current

So, use parallel combinatn, only when, $R \ll r$

Mixed combination

Thursday, July 2, 2020 4:09 AM



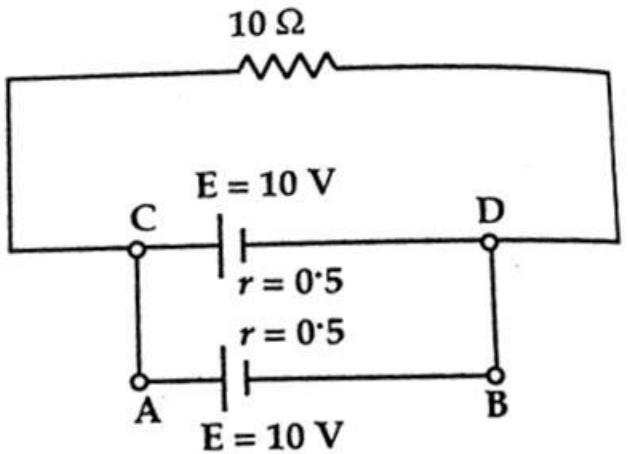
[in each line, n no. of cells are in Series connection]

[m no. of lines, each of which contains n no. of cells in Series]]

$$I = \frac{nE}{R + \frac{nr}{m}} = \frac{mnE}{mR + nr}$$

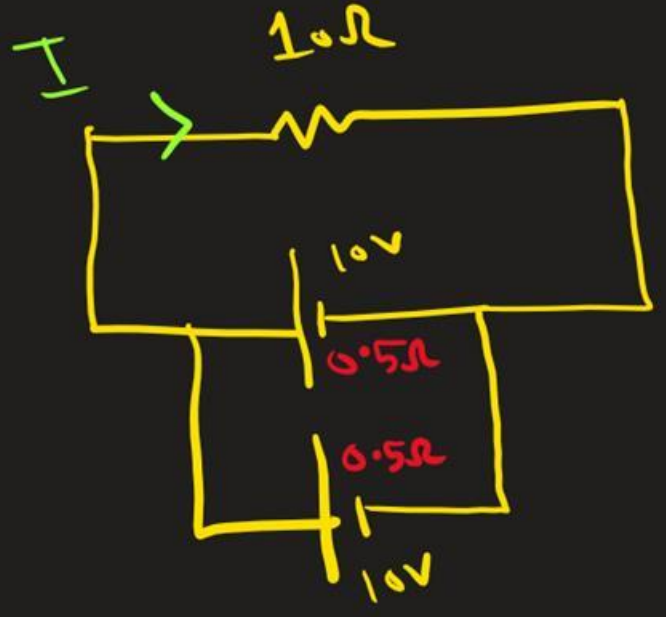
Mix Combination

Calculate power dissipated in 10 ohm resistor.



Mix comb math

Thursday, July 2, 2020 4:12 AM



Soln: $I = \dfrac{10}{10 + \dfrac{0.5}{2}} = 0.9756\,A$

$H = I^2 R t$ if nothing Specified ↓

$= (0.9756)^2 \times 10 \times (1)$

$= 9.506$ J/second

(Ans)

Quen.: How much heat will be produced in 1 sec resistor?

MATH 07

30 electric cells of 5 ohm internal resistance and 10 v emf are equally distributed in 5 branches. 30 ohm resistor is added with them in parallal. Calculate current flow through 30 ohm resistor.

30 electric cells each having 10V EMF and 5Ω internal resistance are equally distributed to 5 branches. 30Ω of resistance is connected in parallel to them. What will be the current flowing through 30Ω resistor?

Soln: $r = 5\Omega$; $E = 10V$; $n = 5$; $mn = 30$; $R = 30\Omega$

$m = 6$

now, $I = \dfrac{nE}{R + \frac{nr}{m}} = \dfrac{mnE}{mR + nr} = \dfrac{5 \times 6 \times 10}{(5 \times 30) + (6 \times 5)} = 1.67\,A$ (Am)

লেগে থাকো সৎভাবে,
স্বপ্ন জয় তোমারই হবে

উদ্ভাস-উন্মেষ শিক্ষা পরিবার

Thank You