Counselling - 833 (G)

23 July 2k25

micro $\rightarrow 10^{-6}$

kilo $\rightarrow 10^{3}$

G - Giga $\rightarrow 10^{9}$

M - Mega $\rightarrow 10^{6}$

k - kilo $\rightarrow 10^{3}$

m — ~~micro~~ mili $\rightarrow 10^{-3}$

μ – micro – 10^{-6}

n – nano – 10^{-9}

◉ চার্জের প্রবাহ হচ্ছে current.

current & charge relation:

$$i = \frac{dQ}{dt} \text{ A}$$

$$e^- = -1.6 \times 10^{-19} \text{ C}.$$

Formula:

$$\int \sin(mx) = -\frac{\cos(mx)}{m} + c$$

$\cos(mx)$

e^{mx}

Ex-1.2: The total charge entering a terminal is given by $q = 5t \sin 4\pi t$ mc. Calculate the current at $t = 0.5$ s.

For Trigonometric function:
- Calculator degree mood এ থাকলে $\pi = 180$
- Radian mood এ থাকলে $\pi = 3.1416$

Soln: Current $i = \frac{dQ}{dt}$

$$= \frac{d}{dt} 5t \sin 4\pi t$$

$$= 5t \frac{d}{dt} \sin 4\pi t + \sin 4\pi t \frac{d}{dt} 5t$$

$$= 5t \cdot 4\pi \cos 4\pi t + \sin 4\pi t \cdot 5$$

$$= (20\pi t \cos 4\pi t + 5 \sin 4t) \text{ mA}$$

At $t = 0.5$,

$i = 31.42\ mA$. (Ans:)

Ex-02: If $q = (10 - 10e^{-2t})\ mC$, find the current at $t = 1.0\ s$

Solⁿ: current $i = \frac{dq}{dt} = \frac{d}{dt}(10 - 10e^{-2t})$

$= -10e^{-2t}(-2)$

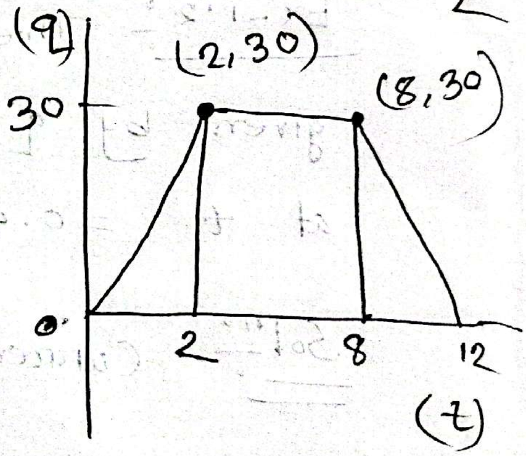
$= +20e^{-2t}$

$= 2.707\ mA$ (Ans:)

\# ঢাল $= \frac{y_2 - y_1}{x_2 - x_1}$; For equation: $\frac{x - x_1}{x_1 - x_2} = \frac{y - y_1}{y_1 - y_2}$

\# $\frac{x - x_1}{y - y_1} = \frac{x_2 - x_1}{y_2 - y_1}$

$\Rightarrow \frac{t - 0}{q - 0} = \frac{2}{30}$ (15)



At $t = 2$; $\frac{x - 0}{0 - 2} = \frac{y - 0}{0 - 30}$

$\Rightarrow -30x = -2y$

$\Rightarrow q = 15t$

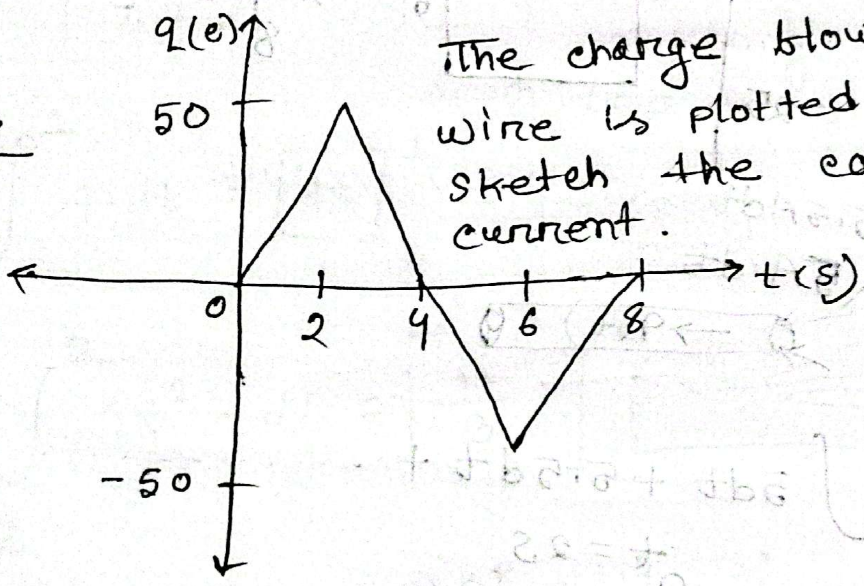
$$q(t) = \begin{cases} 15t \text{ mC}, & 0\text{ms} \le t \le 2\text{ms} \\ 30 \text{ mC}, & 2\text{ms} \le t \le 8\text{ms} \\ -7.5t + 90, & 8\text{ms} \le t \le 12\text{ms} \end{cases}$$ Staircase expression

$i(t) = \frac{d}{dt} q(t)$; $t = 1\text{ mS}$

$= \frac{d}{dt} 15(t) = 15$

Practice-02:

The charge flowing in a wire is plotted in fig. 1.24 sketch the corresponding current.



(2.) $$q(t) = \begin{cases} 25t \text{ C}, & 0 \le t \le 2\text{S} \\ -25t + 100\text{C}, & 2 \le t \le 6\text{s} \\ 25t - 200\text{C}, & 8 \le t \le 8\text{s} \end{cases}$$ Staircase expression

$i(t) = \frac{d}{dt} Q(t)$

$= 25\text{ A}$ $\quad 0 \le t \le 2$

$i(t) = \frac{d}{dt}(-25t + 100)$

$= -25\text{ A}$; $\quad 2 \le t \le 6$

Another way:

$i = \frac{q_2 - q_1}{t_2 - t_1} = \frac{50 - 0}{2 - 0}$

$= 25\text{A}$

similar বাকিগুলো

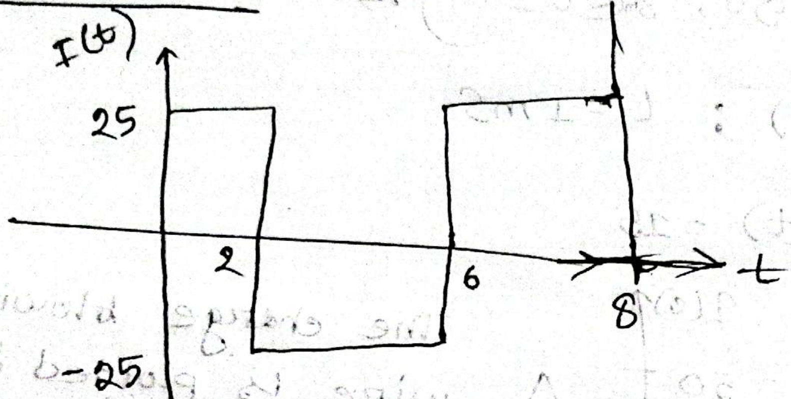
$i(t) = \frac{d}{dt}(25t - 200)$

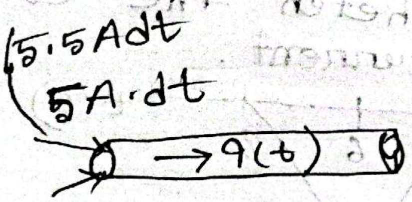
$= 25 \qquad 6 \le t \le 8$

$t = 8S$

$i = \frac{0-0}{10-8} = 0A$

Diagram :-





$\int 5dt + 5.5dt + \cdots$

$$q_t = \int_{t=1s}^{t=2S} i(t) \cdot dt$$

Q.4 Determine the total charge entering a terminal between $t=1s$ and $t = 2s$ if the current passing the terminal is $i = (3t - t)A$

Soln:

$$Q = \int_1^2 i\, dt = \int_1^2 (3t^2 - t)A = \left[\frac{3t^3}{3} - \frac{t^2}{2}\right]_1^2$$

$$= (8 - 2) - \left(1 - \frac{1}{2}\right) = 4 - \frac{1}{2} = \frac{8-1}{2} = \frac{7}{2}C$$

(Ans)

Qn: The current flowing through an element is

$$i = \begin{cases} 4A ; & 0 < t < 1 \\ 4t^2 A ; & t > 1 \end{cases}$$

Calculate the charge entering the element from $t = 0$ to $t = 2S$.

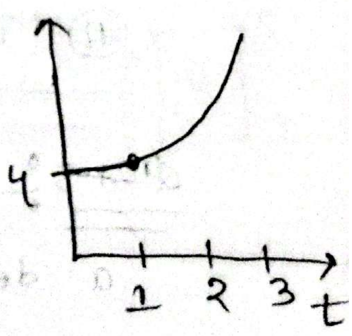
Soln:

$$Q = \int_0^1 4 \cdot dt = [4t]_0^1 = 4C$$

$$= \int_1^2 4t^2 \cdot dt = \left[\frac{4t^3}{3}\right]_1^2$$

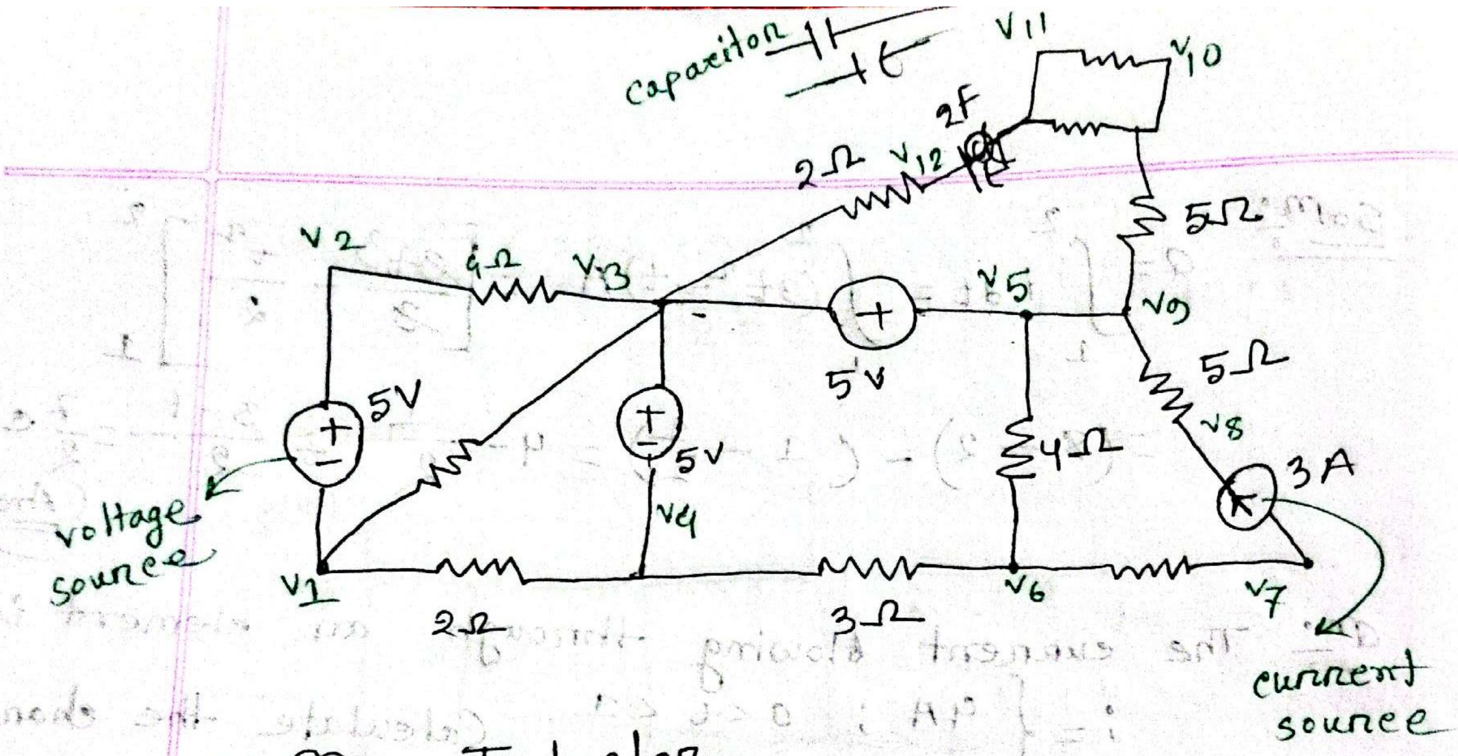
$$= \frac{4\times 8}{3} - \frac{4}{3}$$

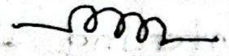
$$= \frac{28}{3}$$

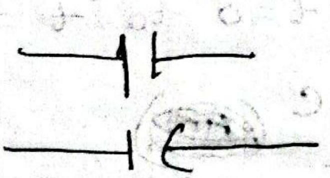


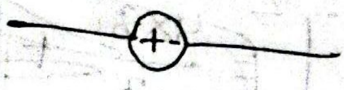
$\therefore$ Total $Q = \frac{28}{3} + 4$

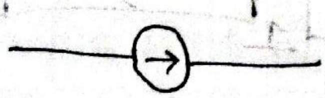
$= 13.33\,C$ (Ans)



 Inductor.

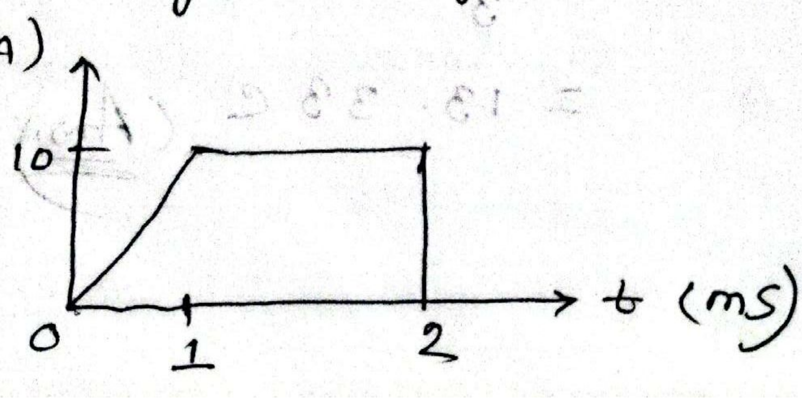
 capacitor

 voltage source

 current source

Math Problem Practice:

Qn-1.8: The current flowing past a point in a device is shown in fig:1.25 Calculate the total charge through the point.



Sol^n: From above diagram,

$$\frac{t-0}{0-1} = \frac{i-0}{0-10}$$

$$\Rightarrow i = 10t$$

$$i(t) = \begin{cases} 10t & ; \ 0 < t < 1 \\ 10\times10^{-3} & ; \ 1 < t < 2 \end{cases}$$

$$q(t) = \int i(t)\,dt$$

For $0 < t < 1$:

$$q(t) = \int i(t)\cdot dt = \int_0^1 10t \cdot dt = \left[10\frac{t^2}{2}\right]_0^1$$

$$= 5\times10^{-6}\ c$$

$$= 5\mu c$$

For $1 < t < 2$:

$$q(t) = \int i(t)\,dt = \int_1^2 (10\times10^{-3})\,dt = 10\times10^{-3}\left[t\right]_1^2$$

$$= 10\times10^{-3}(2\times10^{-3} - 1\times10^{-3})$$

$$= (10\times10^{-3})\times(1\times10^{-3})$$

$$= 10\times10^{-6}$$

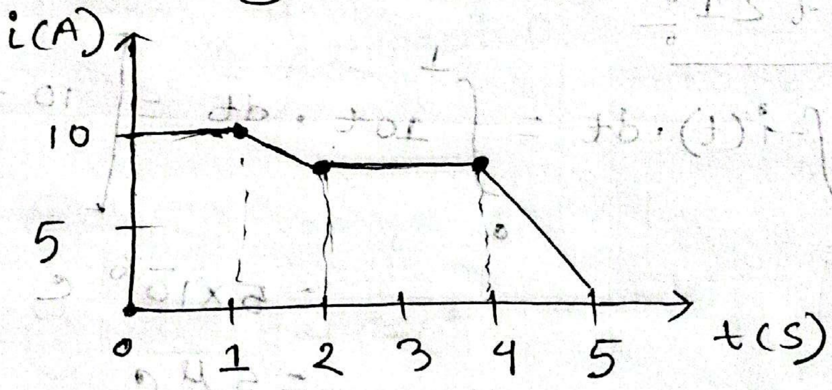
$$= 10\mu c$$

Therefore total charge through the point,

$$q = 5\mu C + 10\mu C$$
$$= 15\mu C \text{ (Ans:)}$$

Q 1.9: The current through an element is shown in fig: 1.28. Determine the total charge that passed through the element at:

a) $t = 1s$ (b) $t = 3s$ (c) $t = 5s$.



$$\frac{y - 10}{10 - 5} = \frac{x - 1}{1 - 2}$$

$$\Rightarrow (y - 10)(-1) = \frac{(x-1)}{5}$$

$$\Rightarrow -y + 10 = 5x - 5$$

$$i = 15 - 5t \quad \Rightarrow 5x + y = 15$$

Soln: $\frac{\cancel{y=0}}{16}$ $i(t) = 10 \; ; \; 0 < t < 1$

Electrical Power and Energy:

Power:
power is the time rate of expending or absorbing energy. measured in watts (W)

$$p = \frac{dw}{dt} = \frac{dw}{dq} \cdot \frac{dq}{dt} = vi$$

$$\boxed{p = vi}$$

Energy deliver/work done between t_0 and t

$$w = \int_{t_0}^{t} p\,dt = \int_{t_0}^{t} vi\,dt$$

Sign Convention for power:

- If current is entering through the positive terminal of a component, we give the equation a positive sign.
- A positive power indicates power absorbed by the component.
- If current is entering though the negative terminal of a component, we give equation a negative sign.
- A negetive power indicates power supplied by the component.

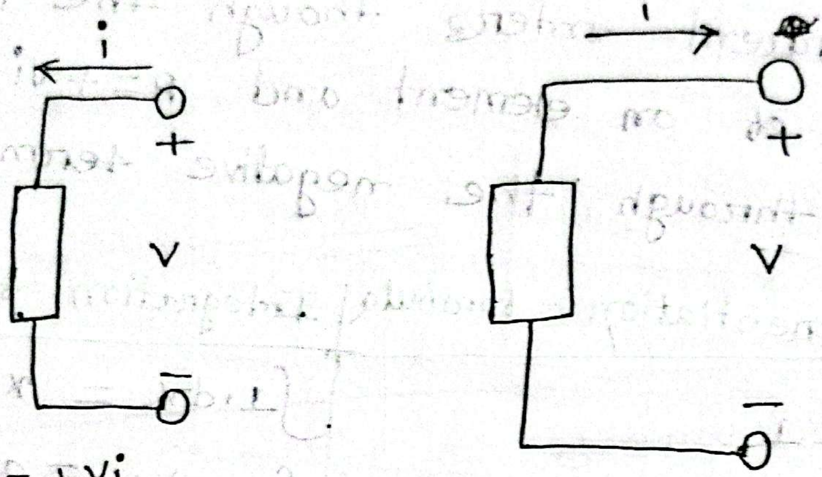
For example:—

$P = +6W$ means 6W power is being absorbed.

$P = -6W$ means 6W power is being supplied.

• In an electric circuit,

total power supplied = total power absorbed.



$P = +vi$

(a). (b)

Reference polaric for power using the passive sign coversion: (a) absorbing power. (b) Supplying power.

⊞ Law of conservation of Energy in Circuits/সার্কিট

শক্তির সংরক্ষণ সূত্র: In fact, the law of conservation of energy must be obeyed in any electric circuit. For this reason, the algebraic sum of power in a circuit, at any instant of time must be zero.

অর্থাৎ, আসলে শক্তির নিত্যতা সূত্র যেকোনো বৈদ্যুতিক বর্তনীতে মানতে হবে। এই কারনে একটি বর্তনীতে যেকোনো মুহূর্তে ক্ষমতার বীজগানিতিক যোগফল শূন্য হতে হবে।

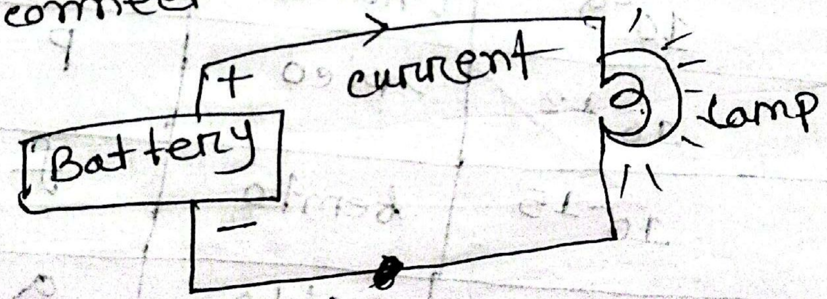
(#) Passive sign convention is satisfied when the current enters though the positive terminal of an element and $p = +vi$. If current enters through the negative terminal, $p = -vi$.

(#) Differentiation formula	Integration formula
$\frac{d}{dx}(x) = 1$	$\int 1 \cdot dx = x + c$
$\frac{d}{dx}(ax) = a$	$\int a \cdot dx = ax + c$
$\frac{d}{dx}(x^n) = nx^{n-1}$	$\int x^n \cdot dx = \frac{x^{n+1}}{n+1} + c$
$\frac{d}{dx}(\cos x) = -\sin x$	$\int \sin x \, dx = -\cos x + c$
$\frac{d}{dx}(\sin x) = \cos x$	$\int \cos x \, dx = \sin x + c$
$\frac{d}{dx}(\tan x) = \sec^2 x$	$\int \sec^2 x \, dx = \tan x + c$
$\frac{d}{dx}(\cot x) = -\operatorname{cosec}^2 x$	$\int \operatorname{cosec}^2 x \, dx = -\cot x + c$
$\frac{d}{dx}(\sec x) = \sec x \cdot \tan x$	$\int \sec x (\tan x) dx = \sec x + c$
$\frac{d}{dx}(\operatorname{cosec} x) = -\operatorname{cosec} x \cdot \cot x$	$\int \operatorname{cosec} x (\cot x) dx = -\cot x + c$
$\frac{d}{dx} \ln x = \frac{1}{x}$	$\int \frac{1}{x} \cdot dx = \ln \lvert x \rvert + c$

~~int~~ Differentiation	Integration
$\frac{d}{dx}(e^x) = e^x$	$\int e^x \cdot dx = e^x + c$
$\frac{d}{dx}(a^x) = (\ln a) \cdot a^x$	$\int a^x \cdot dx = \frac{a^x}{\ln a} + c$
$\frac{d}{dx}(\sin^{-1}x) = \frac{1}{\sqrt{1-x^2}}$	$\int \frac{1}{\sqrt{1-x^2}} \cdot dx = \sin^{-1}x + c$
$\frac{d}{dx}(\tan^{-1}x) = \frac{1}{1+x^2}$	$\int \frac{1}{1+x^2} \cdot dx = \tan^{-1}x + c$
$\frac{d}{dx}(\sec^{-1}x) = \frac{1}{\lvert x\rvert\sqrt{x^2-1}}$	$\int \frac{1}{\lvert x\rvert\sqrt{x^2-1}} dx = \sec^{-1}x + c$

(ii) Electric Circuit:- An electric circuit is an interconnection of electrical elements অর্থাৎ electie circuit হলো যেখানে বিভিন্ন ধরনের electrical elements থাকে এবং তার বিভিন্ন ধরনের circuit দ্বারা connect থাকে।

Example:-



(iii) The S.I Prefix:-

Multiplier	prefix	symbol
10^{18}	exa	E
10^{15}	peta	P
10^{12}	tera	T
10^{9}	Giga	G
10^{6}	✓mega	M
10^{3}	✓kilo	k
10^{2}	hecto	h
10	deka	da
10^{-1}	deci	d
10^{-2}	✓centi	c
10^{-3}	✓mili	m
10^{-6}	✓micro	μ
10^{-9}	✓nano	n
10^{-12}	✓pico	p
10^{-15}	femto	f
10^{-18}	atto	a

1000 m
= 1 km
= 10^3 m

[1 এর শূন থাকে যত হবে 10 এর power তত]

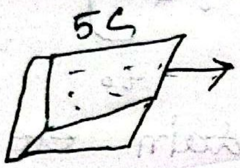
Electrical Change: # Atomic partical এ ছোটে থাকে (electrons(e^-)).

. electrons এ যেই charge গুলো lose করে connect থাকে তারা একটু বাইরে থেকে energy পেলেই free হয়ে যায় তারপর তারা travel করতে থাকে আর তখনই আমরা current পাই।

$1e^- = 1.6\times10^{-19}$ C

charge → q/ Q
→ unit C/ coulombs.

1.6×10^{-19} C $= 1e^-$



→ how e^-? ⇒ $5\text{ C} = \dfrac{5}{1.6\times10^{-19}}\, e^-$

$= 6.24\times10^{18}$.

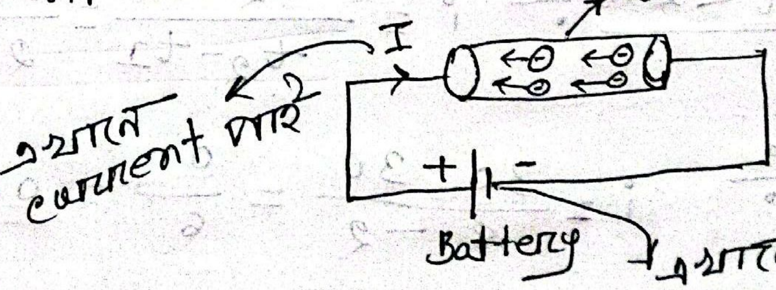
1 coulomb charge এ electron থাকে 6.24×10^{18}.

Total charge কখনো change হয় না। তারা বিভিন্ন দিকে travell করতে পারে।

Current হলো charge এর flow. চার্জ freely move or flow করতে পারে।

⊙ বাইরে থেকে energy (Battary (Like this) না দিলে চার্জ আসলে move করে না। কারন তাদের ঐ energy থাকে না travell করতে।

চার্জই cylinder এর ভিতরেই travell করবে যদি I না দিই।



এখানে potential differen ee তৈরি হয়।

Here we use integration without using limit.

(a) $i(t) = 3A$, $q(0) = 1C$

(b) $i(t) = (2t+5)\,mA$, $q(0) = 0$

(c) $i(t) = 20\cos(10t + \pi/6)\,\mu A$, $q(0) = 2\mu C$

Soln: (a) $q(t) = \int i\,dt = \int 3\,dt = 3t + C_1$

$q(0) = 1C$; $1C = C_1$

$\therefore q(t) = 3t + 1C$.

(b) $i(t) = (2t+5)\,mA$.

$Q(t) = \int (2t+5)\cdot dt = t^2 + 5t + C$

$C = 0$; when $Q(0) = 0$

$\therefore Q(t) = t^2 + 5t$

(c) $q(t) = \int i\,dt = \int 20\cos(10t + \pi/6)\,dt$

$\Rightarrow q(t) = 20\,\dfrac{\sin(10t + \pi/6)}{10} + C_1$

$\Rightarrow q(t) = 2\sin(10t + \pi/6) + C_1$

$q(0) = 2\mu C$;

$2\sin\pi/6 + C_1 = 2$

$\Rightarrow C_1 = 1\mu C$

$\therefore q(t) = 2\sin(10t + \pi/6) + 1\mu C$ Ans

CamScanner

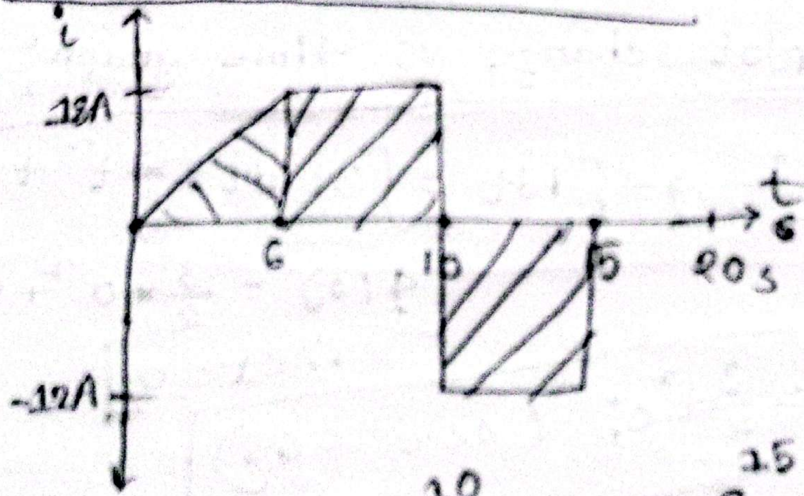
Problem - 1.12:- If the current following through an element is given by

$$i(t) = \begin{cases} 3t\ A, & 0 \leq t < 6S \\ 18A, & 6 \leq t < 10S \\ -12A, & 10 \leq t < 15S \\ 0, & t \geq 15S \end{cases}$$

Determine the total charge till 15S. plot the charge vs time graph from 0S < t < 20S

Soln:-

current vs time graph:-



$$q_{total} = \int_0^6 3t\ dt + \int_6^{10} 18\ dt + \int_{10}^{15} -12\,dt$$

$$= 3\left[\frac{t^2}{2}\right]_0^6 + 18\left[t\right]_6^{10} + (-12) \times \left[t\right]_{10}^{15}$$

$$= 3\left(\frac{36}{2} - 0\right) + 18(10-6) - 12 \times (15-10)$$

$$= 3 \times 18 + 18 \times 4 - 12 \times 5 = 66\ C$$ (Ans.)

আর যদি equation না দিয়ে graph দেওয়া থাকে তাইলে এই shortcut use করবো :-

$0 < t < 6S$: $q = \frac{1}{2} \times 6 \times 18 = 3 \times 18$

$6S < t < 10S$: $q = 4 \times 8$

$10S < t < 15S$: $q = 5 \times (-12)$

Total $q = 3\times18 + 18\times4 - 12\times5 = 66C$ (Ans:)

(iii) For plot charge vs time graph:-

$0 < t \leq 6S$: $q = \int i\,dt = \int 3t\,dt = \frac{3}{2}t^2 + c_1$

$\left[q(0) = \frac{3}{2}\times 0^2 + c_1 = 0 \quad \therefore c_1 = 0\right]$

$$\boxed{q(t) = \frac{3}{2}t^2 C; \quad (0 < t \leq 6S)}$$

$6 < t \leq 10S$:

$q = \int 18\,dt = 18t + c_2$ $\quad \left[q(6) = 18\times6 + c_2 = \frac{3}{2}6^2 \quad \therefore c_2 = -54C\right]$

$$\boxed{q = 18t - 54\,C}$$

$10 < t \leq 15S$:

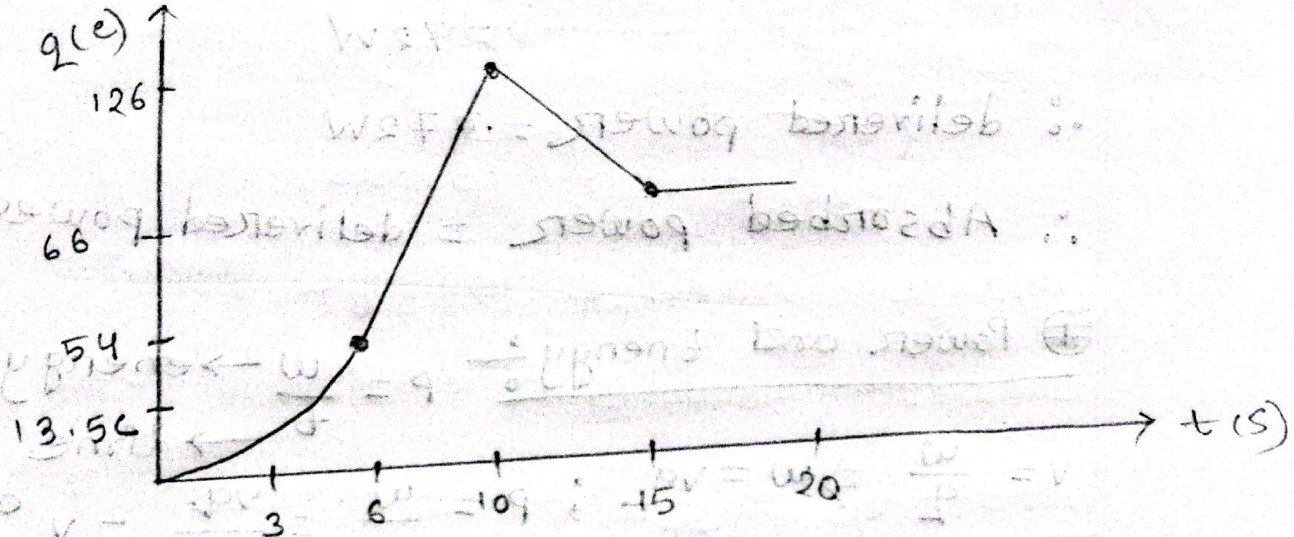
$q = \int -12\,dt = -12t + c_3$

$\left[q(10) = -12\times10 + c_3 = 18\times10 - 54 \quad \therefore c_3 = 246C\right]$

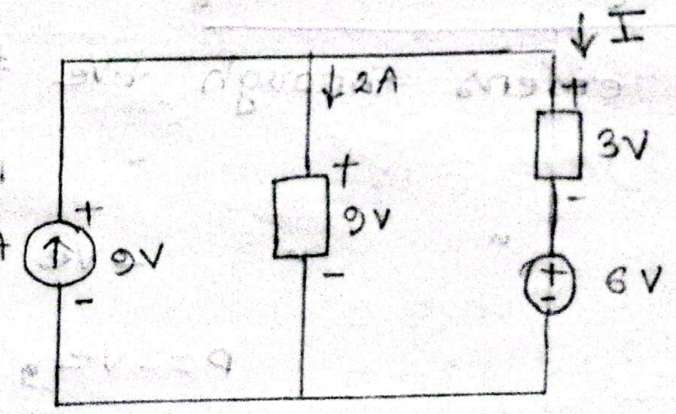
$\boxed{q = -12t + 246\,C}$

$t \geq 15$ s: $q = \int 0\,dt = 0 + C_4 = C_4$ $\left[q(15) = C_4 = -12\times15+246 = 66\,C \right]$

$\boxed{\therefore q = 66\,C}$



Qn: Calculate power for each of the elements in the circuit below: show that power absorbed is equal to power delivered. Here, $I = 6$ A.



Soln: Here, ~~Absorbed power~~ =

$P_{9AS} = 8\times9 = -72$W

$P_{3VA} = 3 \times 2 = 18W$

$P_{3VA} = 3 \times 6 = 18W$

$P_{6VA} = 6 \times 6 = 36W$

$\therefore$ Absorbed power $= (18+18+36)$ W

$= 72W$

$\therefore$ delivered power $= 72W$

$\therefore$ Absorbed power = delivered powed (Proof)

(ii) Power and Energy :-

$P = \frac{w}{t}$ $w \rightarrow$ energy, $t \rightarrow$ time

$V = \frac{w}{q} \Rightarrow w = vq$; $P = \frac{w}{t} = \frac{vq}{t} = V\frac{dq}{dt} = VI$

power → delivered

power → absorption/consume

passive sign convention :-

- Power enters through +ve terminal → $P = +ve$, consume
- power " " -ve terminal → $P = -ve$, delivered.

Ex :- Find the power delivered to an element at $t = 3ms$ if the current