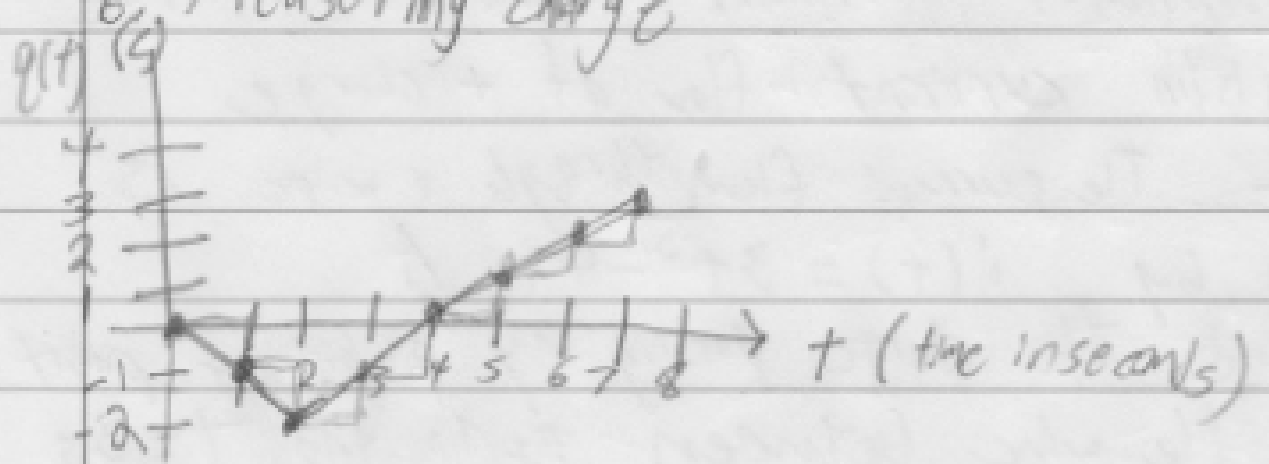
Basics

Electrical charge

1. Atom
   a.) electron - negative
   b.) proton - positive
2. Symbol: q or Q
3. Unit of measure - Coulomb (C)
   a.) 1 electron = -1.602×10^{-19} C
   b.) 1 proton = $+1.602 \times 10^{-19}$ C

   about 6.242×10^{18} electrons / C
4. Stationary charge (static electricity)
5. Moving charge - current
   a) requires an expenditure of energy
6. Measuring charge



   a.) measure the charge passing a point

   b.) positive direction to the right
   c.) + charge to the right adds to the total
   d.) + charge to the left subtracts from the total
   e.) Record values at one second intervals
7. $\frac{\Delta q}{\Delta t}$ $\lim_{\Delta t \to 0} \frac{\Delta q}{\Delta t} = \frac{dq}{dt} = i(t)$ or current

   symbol $i(t)$, constant is I

8. Measure - Ampere (Amp)

$i(t) = \frac{dq}{dt}$ or ~~Coul/sec~~ C/s

$dq = i(t)\,dt$

$\int_{q_0}^{q} dq = \int_{t_0}^{t} i(t)\,dt \qquad q(t) - q(t_0) = \int_{t_0}^{t} i(t)\,dt$

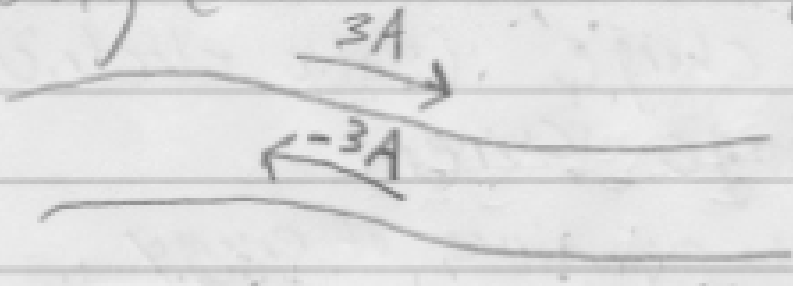
$q = \int i(t)\,dt$

9. $q(t) = \int_{t_0}^{t} i(t)\,dt + q(t_0)$

Let $t_0 = -\infty$, $q(t_0) = 0$

$q(t) = \int_{-\infty}^{t} i(t)\,dt$

10. Representing current flow in a wire



11. Conventional current - flow of - charge

Franklin current - flow of + charge

Example - The current flow through a wire is given by $i(t) = 3t^2 - 4t$ A

find the charge passing any arbitrary point of the wire between $t = 1$s and $t = 3$s

$\int_1^3 3t^2 - 4t\,dt$

$t^3 - 2t^2 \Big]_1^3$

$(27 - 18) - (1 - 2)$

$9 - (-1) = 10$ C

Example - The total charge exiting a terminal is given by $q(t) = 5t + \sin(4\pi t)$ mC

Calculate the current at $t = 0.5$ seconds

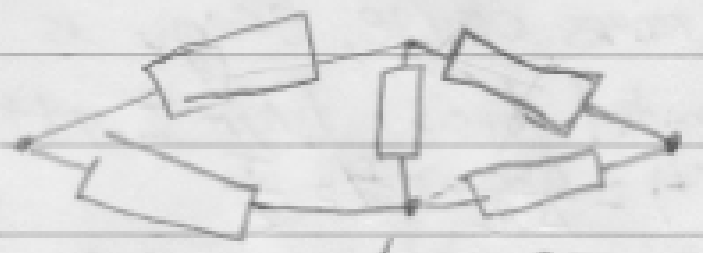
$q'(t) = 20\pi t \cos(4\pi t) + 5\sin(4\pi t)$

$q'(.5) = 10\pi(1) + 5(0) = 10\pi$ mA

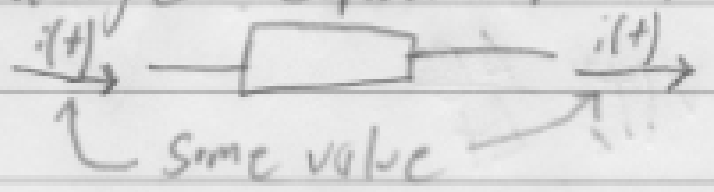
12. Ideal Circuit element - in its simplest form, a component having two terminals by which it's connected to other circuit elements.

Two terminal element

13. Electrical Network (Electrical circuit) - Inner-connection of circuit elements.

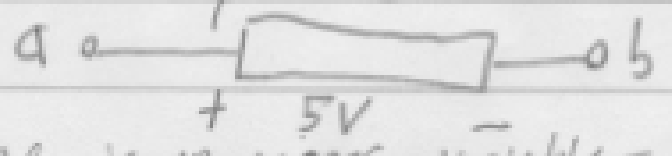


14. Charge CANNOT accumulate



The same value that enters, exits

15. voltage (potential difference)
   1. Causes current to flow
   2. Analogous to work
   3. Exists between two points
      a. not at a point
      b. measured with respect to a reference
   4. Symbol v(t) / constant V
   5. UNIT of measure - volt
      a.) 1 VOLT = $\frac{1\ J}{1\ C}$ = $\frac{1\ Joule}{1\ Coulomb}$
   6. Polarity convention



Voltage is an across variable - current is a through variable