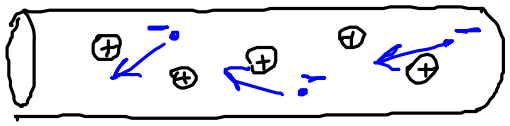
Charge of an electron

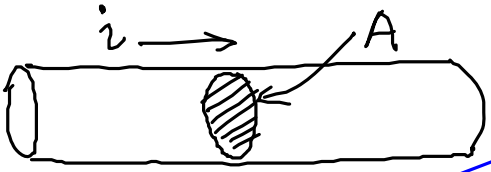
$$e = -1.602 \times 10^{-19}\ C$$

coulomb

Electrical Current



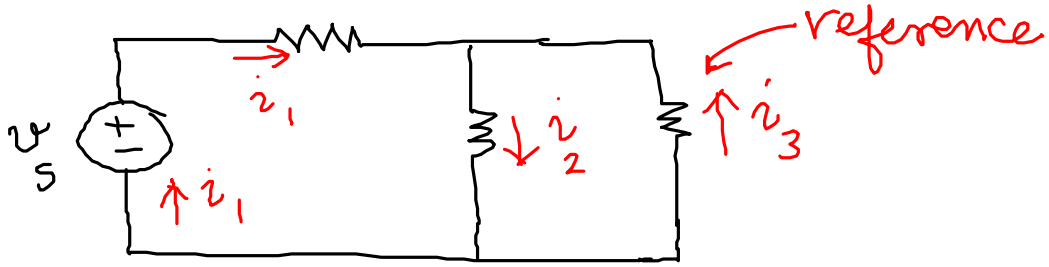
$i \rightarrow$ electrical current

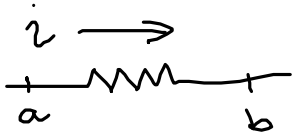


$$i = \frac{dq}{dt}\ \left(\frac{C}{s}\right)$$

charge

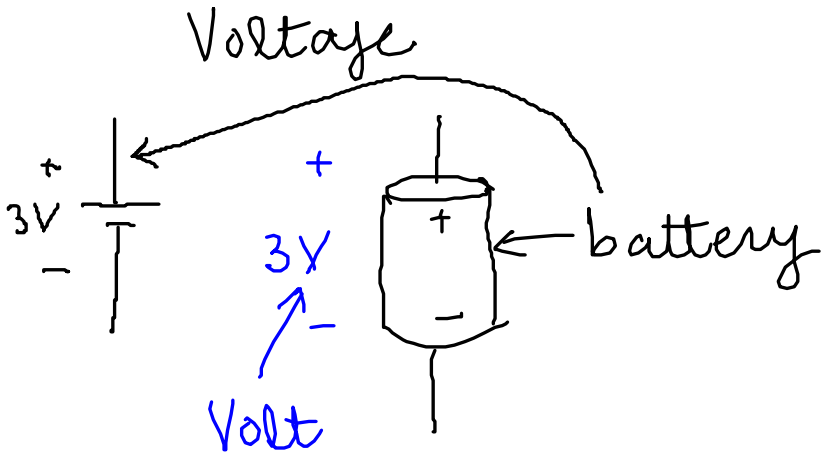
A (ampere or amp)

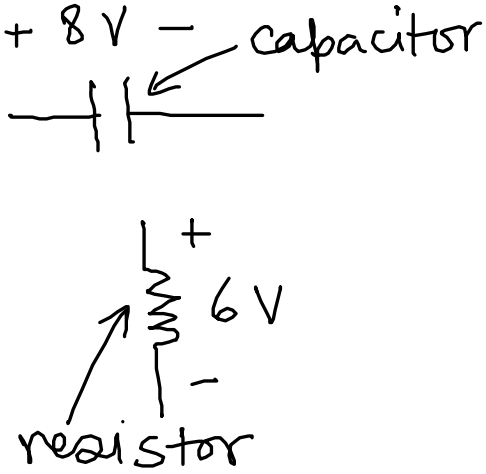




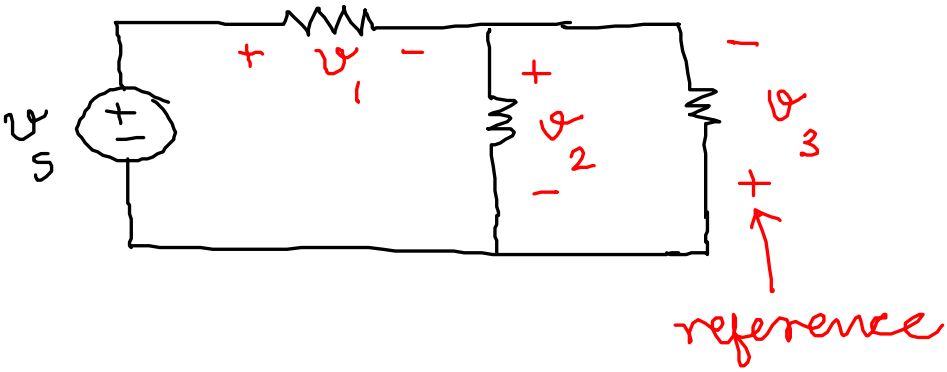
if $i = 3$ A then current flow a → b

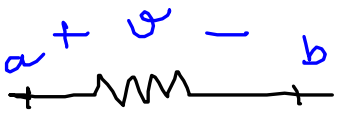
if $i = -4$ A then current flow b → a





1 volt = 1 $\frac{\text{Joule (J)}}{\text{coulomb (C)}}$ ← unit of work / ← unit of charge

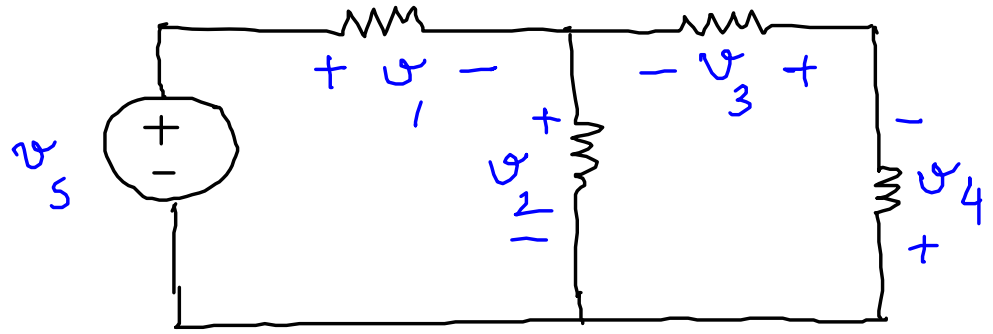




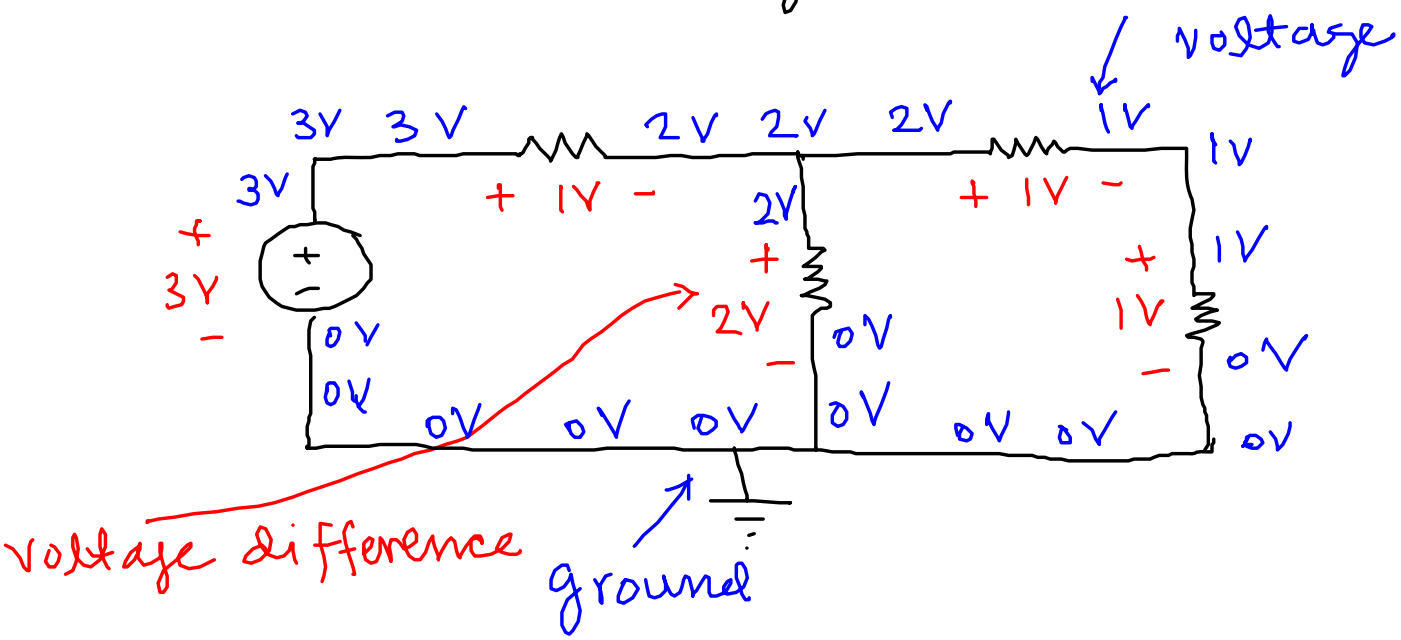
if $v = 3V$ then a is at a higher potential than b

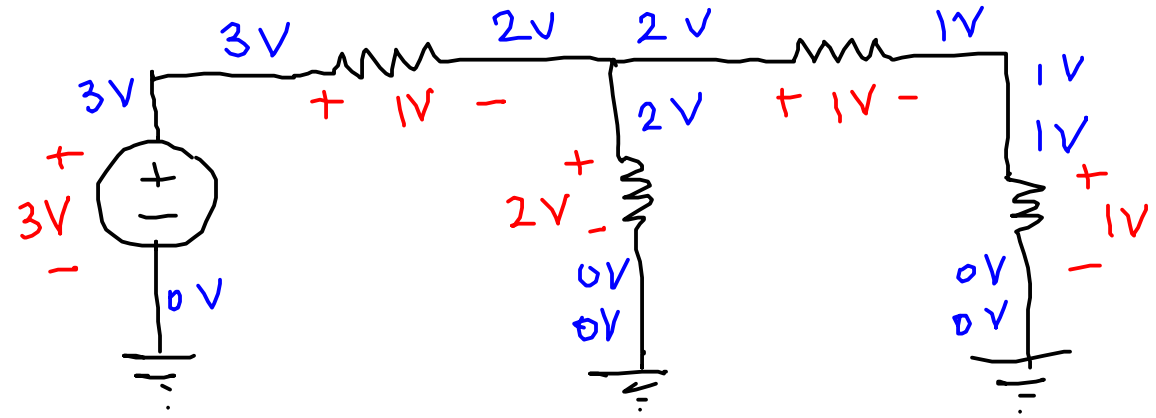
if $v = -4V$ then b is at a higher potential than a

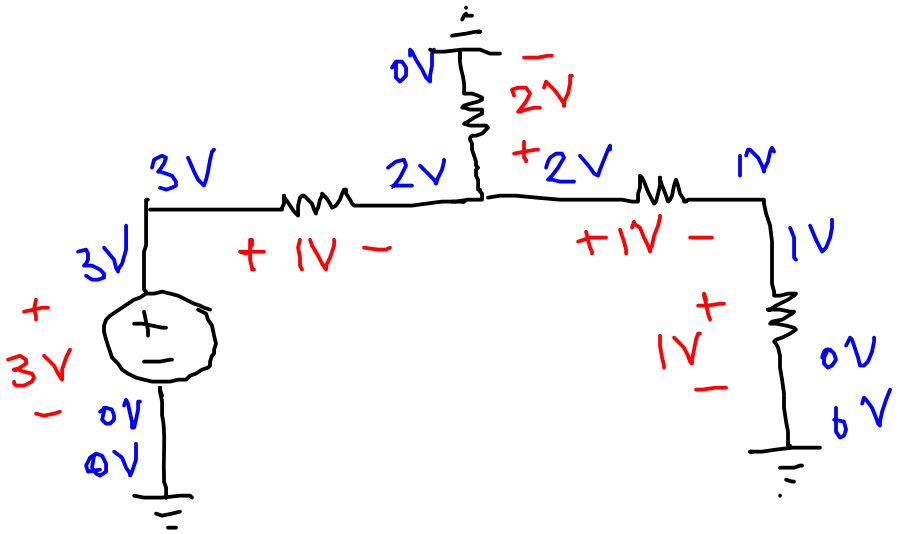
We talk in terms of voltage differences (potential difference) Voltage is a relative concept

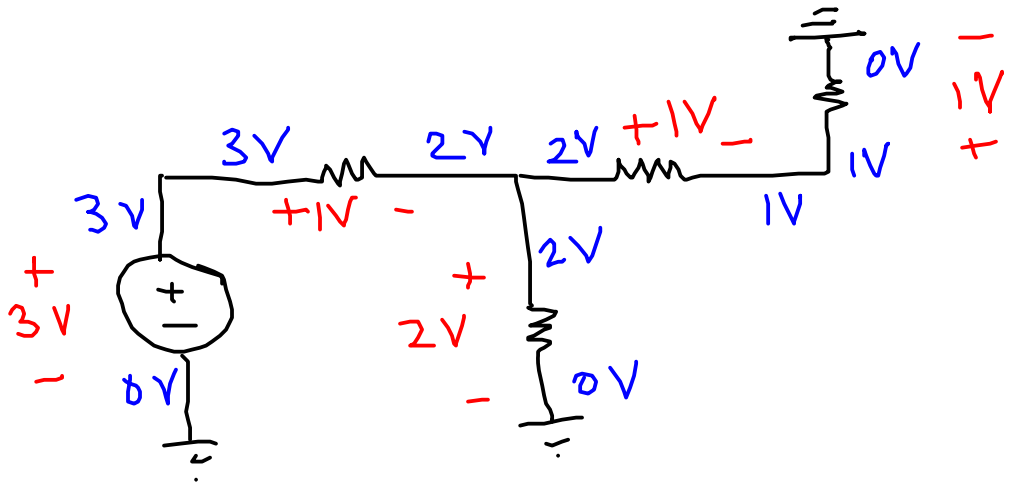


"Absolute" Voltages

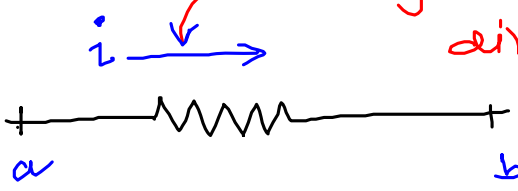



3V
2V
2V
1V
3V
+ 1V −
2V
+ 1V −
1V
1V
+
1V
−
+
3V
−
0V
+
2V
−
0V
0V
0V
0V


0V
2V
3V
2V
+2V
1V
3V
+ 1V −
+1V −
1V
+
3V
−
+
1V
−
0V
0V
0V
0V


0V
1V
+
3V
2V
2V
+1V −
1V
3V
+1V −
1V
2V
+
3V
−
+
2V
−
0V
0V

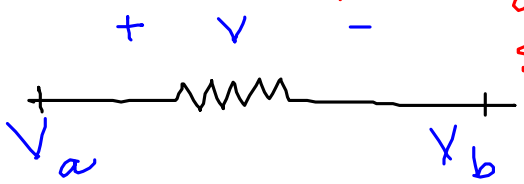
Reference directions revisited



just a reference direction — does not tell which direction the current is flowing

$i > 0$ then current flow $a \to b$

$i < 0$ then current flow $b \to a$

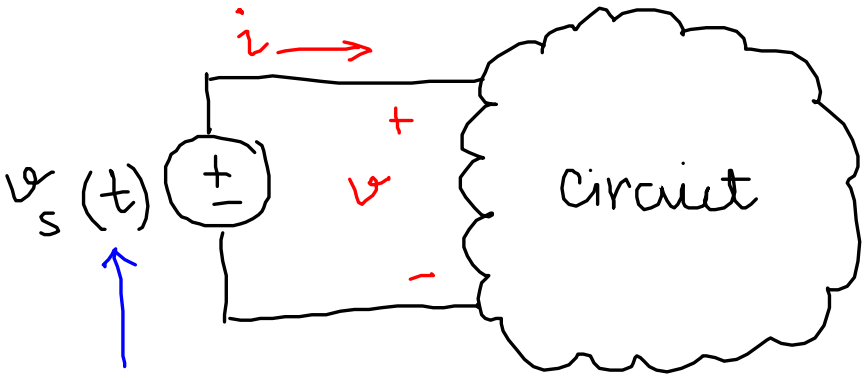


just a reference does not tell which side is at a higher potential

if $v > 0$ then $V_a > V_b$

if $v < 0$ then $V_b > V_a$

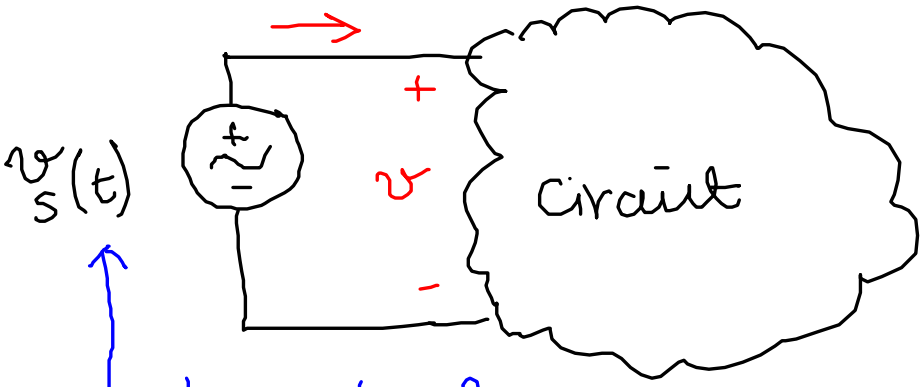
Ideal (Independent) Voltage Source



time varying (AC)

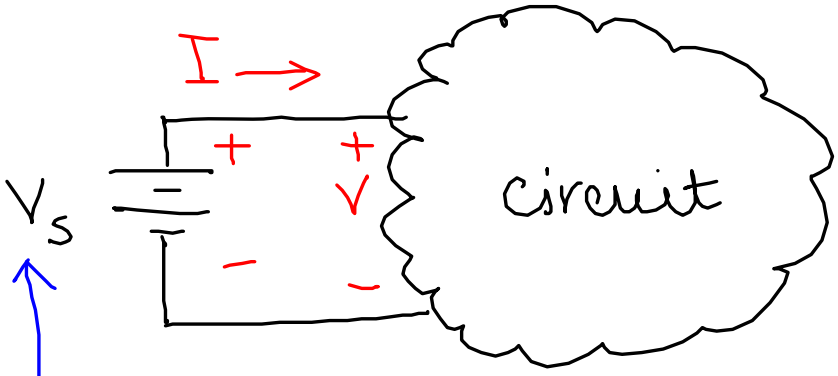
$v = v_s$ independent of i

i is determined by the circuit



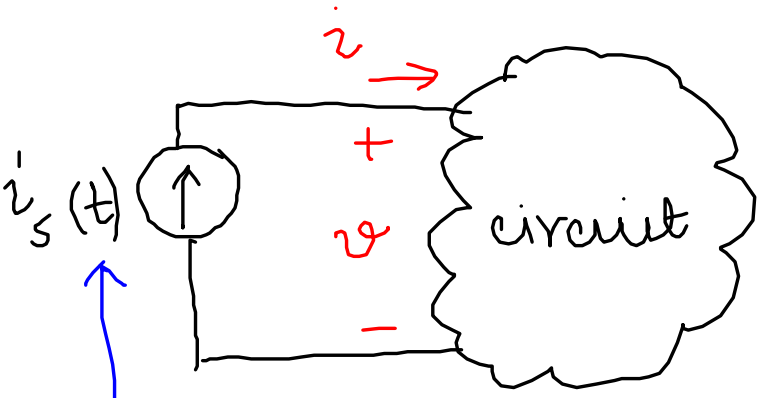
sinusoidal

$v_s(t) = V\cos(\omega t + \phi)$ or $V\sin(\omega t + \phi)$



DC voltge soure (no time variation)

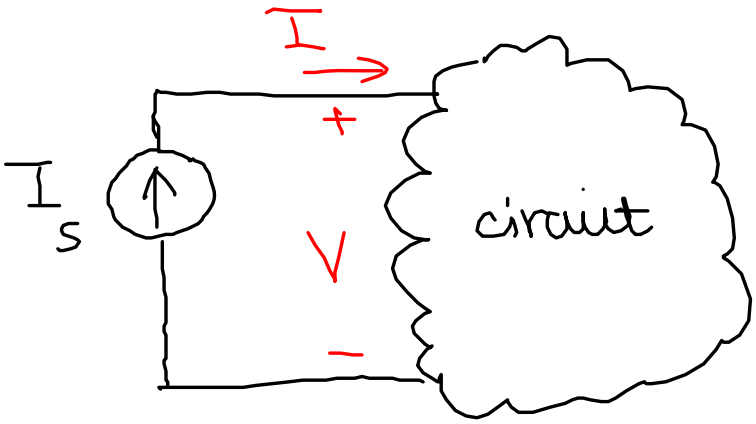
Ideal (Independent) current source



$i = i_s(t)$ independent of v.

v is determined by the rest of the circuit

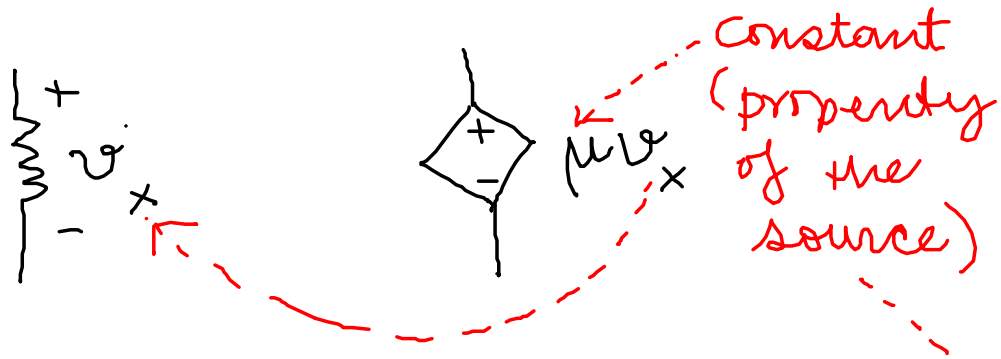
general case might be time varying



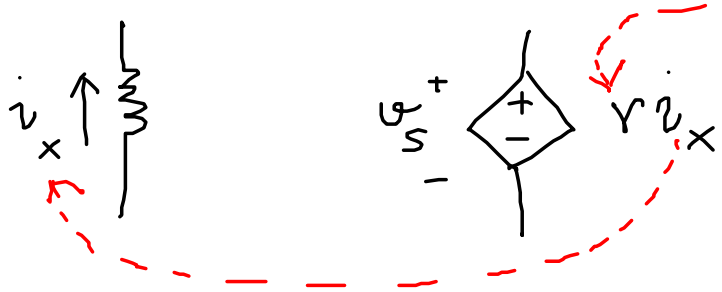
$I = I_s$

Dependent (Controlled) Sources

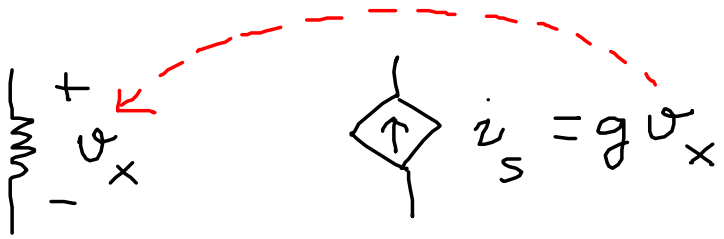
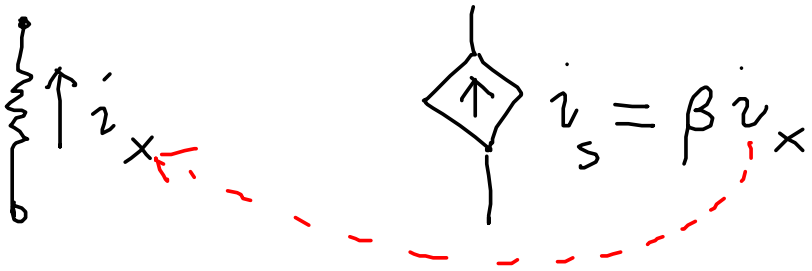
VCVS (Voltage controlled voltage source)



CCVS (Current controlled voltage source)



VCCR (Voltage controlled current source)



CCCS (Current Controlled Current Source)