DC circuits

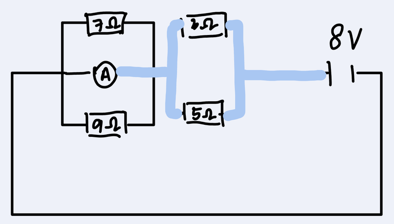
Electricity

chemical potential E
→ Electric E

static E	current of electricity			power	
Q	I	V	R	P	E
charge	current	voltage	resistance	power	electricity
C	(A)	(V)	(Ω)	(W)	(J)

Symbols

dry cell — voltmeter — resistor
battery — Ammeter — closed switch
wire — bulb — switch open



$I = \frac{V}{R_{eff}}$

$= \frac{8}{\left(\frac{1}{3}+\frac{1}{5}\right)^{-1}} = 4.27A$

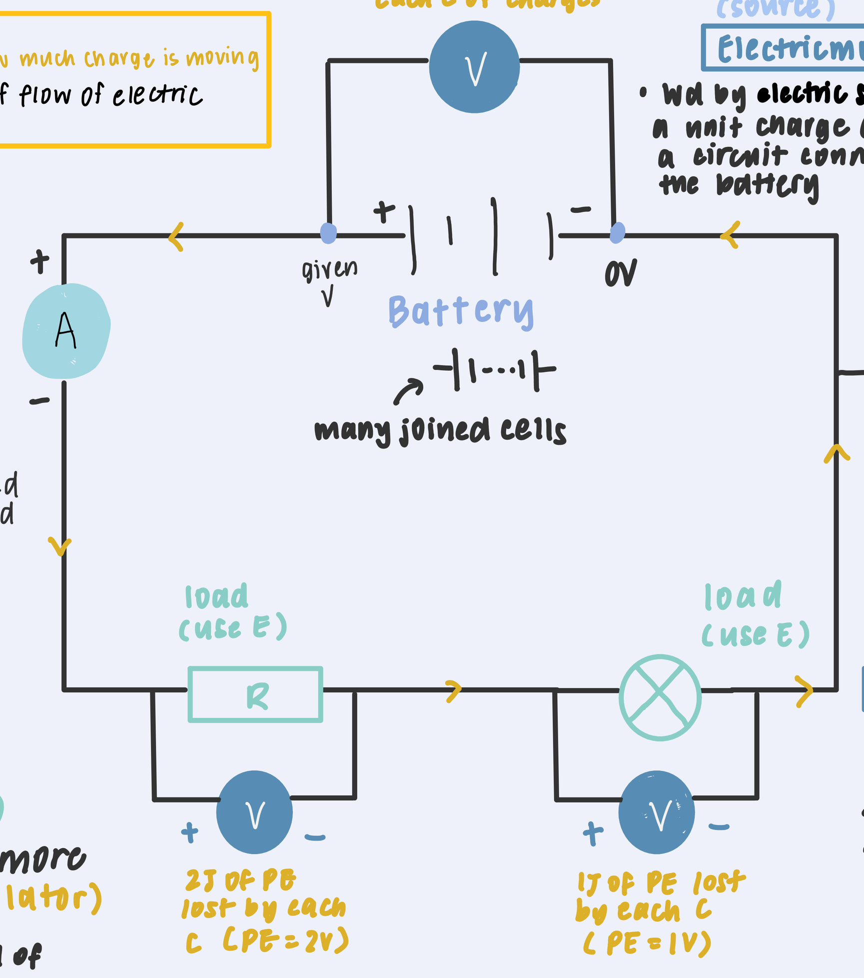
Parts of a circuit

(-) current = flow in opp direction

produces heating

Current: rate of flow of electric charge (e⁻) — how much charge is moving

3J of PE given to each C of charges



Ammeter

measure of electric current

— C of charge flowing through every part of the circuit in 1s

0 resistance

(C) charged moved

$I = \frac{Q}{t}$

current (A)

(current)
Brightness depends on power
$P = VI = \frac{V^2}{R} = I^2R$
highest voltage : highest current

DONT DRAW AT CORNER EG.

Voltmeter

has ∞ resistance so current does not flow through

(1JC⁻¹ energy given to e⁻ by battery)

type of PD (JC⁻¹)

(source)

Electromotive force

- wd by electric source in driving a unit charge (C) through a circuit connected to the battery

$V = \frac{W}{Q}$ → J, → C

EMF / PD (V)

resistance

Copper wire

e⁻ exists in wire due to delocalized electrons

charges moving produce "friction" which heat up...

bulb: another wire

chemical → heat, → light

Potential difference (V = JC⁻¹)

- wd to drive a unit charge through the component
- between 2 points
- can be used for bulbs

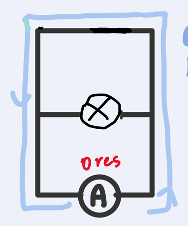
Potential

- At a single point in a circuit

Pd across open switch = EMF

pd of closed switch = 0

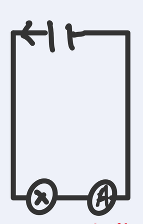
- can't take Pd of a battery / source as it only refers to a component and not the entire circuit.



ammeter in parallel is a closed switch

short circuit

current too small



voltmeter in series is an open switch (current won't flow)

Resistance (Ω)

- any metal but copper but not more reactive than copper (not insulator)
  - ↳ slows e⁻ to ensure optimum speed of current → too much current
- dependent on material properties and physical dimensions

1) length (long > short)
2) cross sec area (thin > thick)
3) material
4) temperature (temp ↑ res ↑)
   - particles move quicker
   - harder for (-) to pass through

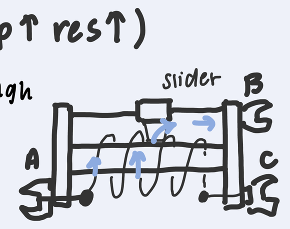
$R = \frac{V}{I}$ → potential difference, → current

$R = \frac{\rho L}{A}$ → resistivity, → length, → area

(variable resistors)

Rheostats

- used to vary current

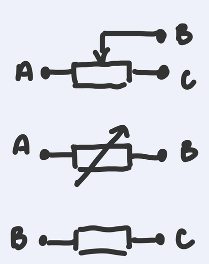


- vary bulb strength

slide control

$R = \frac{\rho L}{A}$

A — C x becomes a fixed resistor (can't vary length)



Input transducers

- R changes with physical changes

thermistor — resistance

T ↑ R ↓

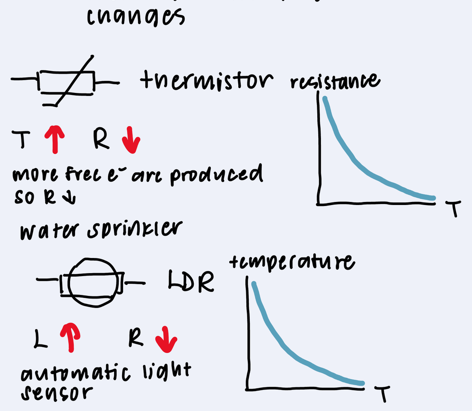
more free e⁻ are produced so R ↓

water sprinkler

LDR — temperature

L ↑ R ↓

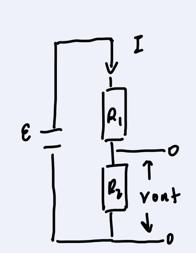
automatic light sensor



can be used with vr and pd

connected to voltmeter

$V_1 = \left(\frac{R_1}{R_1+R_2}\right) emf$



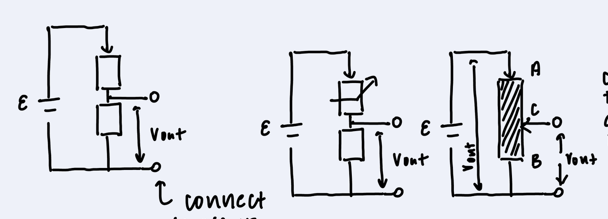
During day
Light ↑ R ↓

During night
Light ↓ R ↑
Vout → turn on light

$V_{out} = \left(\frac{R_2}{R_1+R_2}\right) \times V_E$

Potential Divider circuits

line of resistors connected in series used to provide a fraction of the voltage source to another part of the circuit



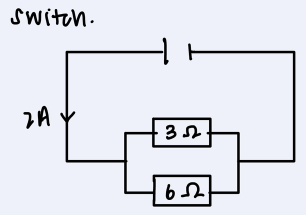
↑ connect to other parts (won't show in qn)

c can adjust the resistance across AB for both sides

potentiometer

variable resistor that is connected to 3 terminals

whenever V↑ will turn on switch.



V = RI

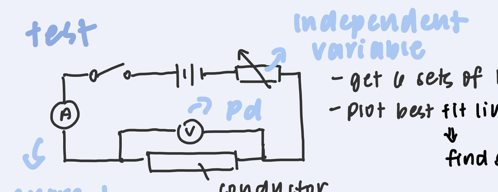
3(2-a) = 6a

Find the current flowing through

OHM'S LAW

current passing through a metallic conductor is directly proportional to the potential difference across it

test



- get 6 sets of values
- plot best fit line
  ↓
  find slope

OBEY

ohmic conductor

- constant res when temp is constant

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

pass (0,0) in theory

- only resistors

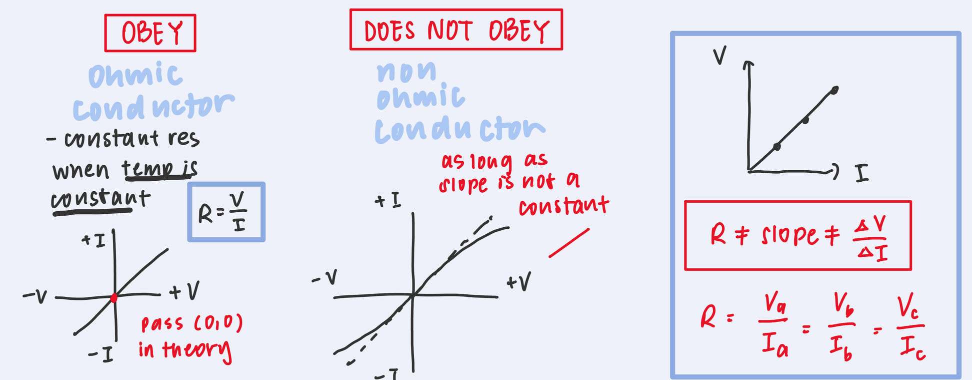
- NEVER ALLOWED TO LEAVE SWITCH ON
  ↳ fixed resistor

Open : carry exp
close : take reading

DOES NOT OBEY

non ohmic conductor

as long as slope is not a constant



$R \neq \text{slope} \neq \frac{\Delta V}{\Delta I}$

$R = \frac{V_a}{I_a} = \frac{V_b}{I_b} = \frac{V_c}{I_c}$

↱ Job done by appliance

Electrical power

$P = \frac{W}{t} = \frac{E}{t}$ rate at which E is transformed / changed

$P = VI = I^2R = \frac{V^2}{R}$

Power rating

for bulb, directly proportional to brightness

240V 2000W
give me 240V, I'll work at 2000W and give a brightness of

when optimal PD is used, bulb will dissipate E at the rate of __ W and shine at "normal brightness"

$P = \frac{E}{t}$ (W, W/s, s)

$P = \frac{E}{t}$ (kW, kW/h, h)

E bill in kWh
kilowatt / hr

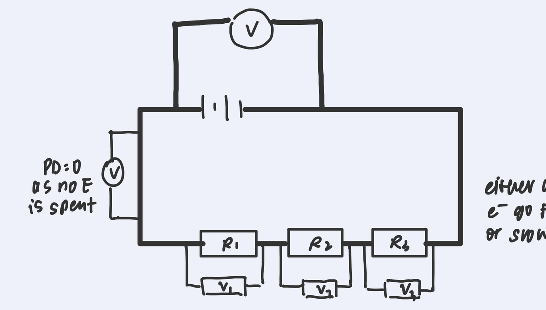
Types of circuits

Ohm's Law
V = RI
} can use many times → use it correctly

from battery

short circuit, path of no resistance

Series circuits



Characteristics

1) Only 1 path for current to flow
2) Components are connected 1 after another

▲ Current in a series circuit is always the same

① $R_{eff} = R_1 + R_2 + R_3$

② $I_1 = I_2 = I_3$ → does not matter where ammeter is placed

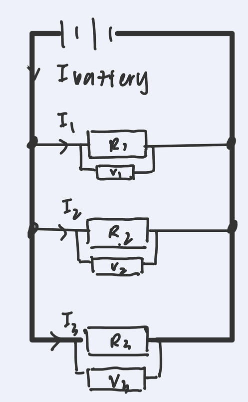
1 path only → current (amt of charge per s is unchanged)

③ $V_1 + V_2 + V_3 = EMF$ shared

same current but dif res so can't be the same

split in proportion of resistivity

parallel circuits



→ can argue that bulb is in parallel with power supply, as $P = \frac{V^2}{R}$ → it has the highest power dissipated

assuming bulbs have same R

Replace 3 guys with 1 guy

1) Components connected in multiple loops
2) several paths which electric current can flow through

derived from $I = \frac{V}{R}$ and ③

① $R_{eff} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1}$ → $R_{eff} < R_{min}$

② $I_{battery} = I_1 + I_2 + I_3$ Sum of current of each branch is equal to current in main path (current splits)

③ $V_1 = V_2 = V_3 = EMF$ — $V = \frac{W}{Q}$ how much per charge

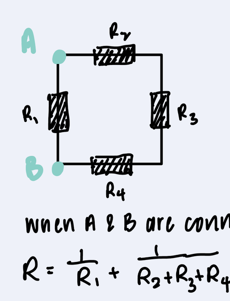
All spent

more resistors: run out of E faster

Pd across whole circuit is equal to the pd across each resistor

↳ $I = \frac{V}{R}$

V is constant
larger res → less current
smaller res → more current
the current "splits" depending on the resistance



when A & B are connected,

$R = \frac{1}{R_1} + \frac{1}{R_2+R_3+R_4}$

V : Energy / unit charge

$R_{eff} : \frac{1}{R_1+R_2+R_3} + \frac{1}{R_4}$

Strategies

Always redraw complex systems