8. a) How much energy is used lighting a 60. W bulb for 4.5 hours? Answer in joules and kilowatt-hours.

$E = P \cdot t$ $\quad 60.\,W = 60.\,\frac{J}{s} \cdot 4.5\,hr \times \frac{3600\,s}{hr} = \boxed{9.7 \times 10^5\,J}$ ↓

$(0.060\,Kw)(4.5\,hr) = \boxed{0.27\,Kwhr}$ → energy

9. A DC power charger is marked as "5.0 V 3.5 VA."

a) What quantity is being measured as 3.5 VA? VA = voltamps

measure of power = 3.5 W

$VI = P$

$\left[\frac{J}{C}\right]\left[\frac{C}{s}\right] = \left[\frac{J}{s}\right]$

Watt

b) How much current does the charger use?

$I = \frac{P}{V} = \frac{3.5\,W}{5.0\,V} = 0.70\,A$

10. A resistor is marked as 270 Ω (R) with a power rating of 0.50 W (P).

a) What is the maximum current this resistor can safely handle?

$P = I^2R \quad I = \sqrt{P/R} = \sqrt{\frac{0.50\,W}{270\,\Omega}} = 0.043\,A$

b) What will happen if there is more current than this maximum amount in the resistor?

$I >> R$ = short circuit

melting, smoking, heating, fire!

11. A cell-phone battery is marked as "90 mA h 12 V 1.08 Wh".

a) What quantity is being measured as 90 mAh? mA · h

measure of charge

$\left[\frac{C}{s}\right] \cdot [s] = C$ (charge)

Capacity:

A quantity to measure the ability of a cell to release charge.

A battery whose capacity is 90 mA h means that before it "dies" and needs recharging you can run it:

at 90 mA for 1 hour or

at 45 mA for 2 hours or

at 9 mA for 10 hours, etc.

90 mA → $90 \times 10^{-3}\,C/s$ × 1 h = $0.090\,\frac{C}{s} \times 3600\,s = 324\,C = 90\,mAh$

$E = qV$

b) Determine how much energy is stored in the battery.

$E = 324\,C \times 12\,V = \boxed{3,888\,J\,(energy)}$

$3888\,J \times \frac{1\,Kwhr}{3.6 \times 10^6\,J} = \boxed{1.08 \times 10^{-3}\,Kwhr}$

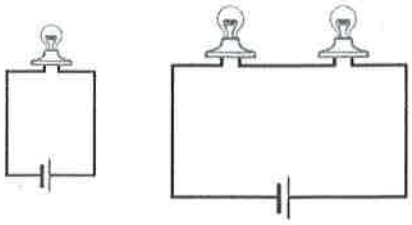
12. A cell has a capacity of 1400 mA h. Calculate the number of hours for which it can supply 1.8 mA.

$\frac{1400\,mAh}{1.8\,mA} = \boxed{777.78\,hrs}$

Series and Parallel Circuits

↑ ↓ same

Combining Light Bulbs in Series



1. Build a circuit with one light bulb and observe its brightness. The brightness of a bulb is a measure of . . power

2. Add a second bulb in series. Observe or infer what happens to the:

	PREDICTION	RESULT
Power of an individual bulb		↓
Total power of the circuit		↓
Resistance of an individual bulb		same
Total resistance of the circuit		↑
Total potential difference across the circuit		same
Potential difference across an individual bulb		↓
Total current in the circuit		↓
Current through an individual bulb		↓

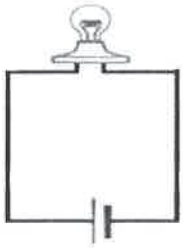
3. Unscrew one light bulb from its base (but leave the base in the circuit). What happens to the other light bulb? Why?

Bulb goes out because the circuit is broken.

4. Assume each light bulb has a constant resistance of 10 Ω. Analyze each circuit.

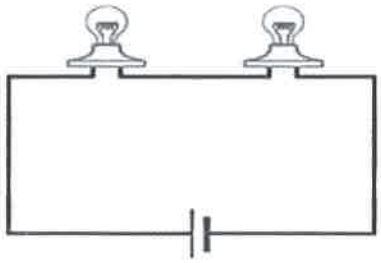
P = IV

V = IR



3 V

R	10Ω
V	3V
I	0.3A
P	0.9W



3 V

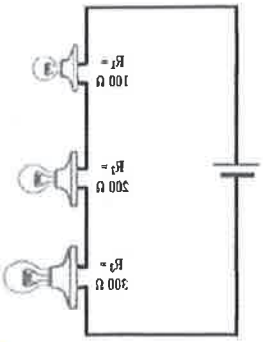
T = total

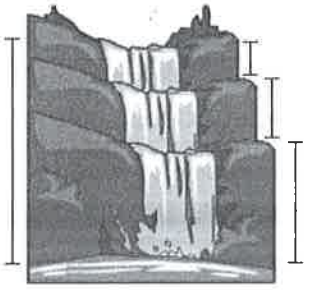
$I_T = \frac{V_T}{R_T}$

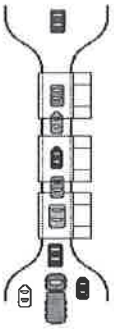
$I_T = \frac{3V}{20\Omega}$

	Bulb #1	Bulb #2	Circuit Total
R	10Ω	10Ω	20Ω
V	1.5V	1.5V	3V
I	0.15A	0.15A	0.15A
P	.225W	.225W	0.45W

Analyzing Series Circuits







Three Resistors Hazed in Series

SAME

1. **Current:** Current is the same at all points in a series circuit. Current is the same through each resistor.

$I_T = I_1 = I_2 = I_3$

NOTE: Current is the same if the circuit is the same

2. **Voltage:** The increase in potential provided by the battery is equal to the sum of the potential drops across each resistor.

SUM

$V_T = V_1 + V_2 + V_3$

NOTE: conservation of energy

Kirchhoff's Second Law (Voltage Law, Loop Rule):

Gustav Robert Kirchhoff (1824-1887)

3. **Resistance:** The total resistance of the circuit is the sum of the individual resistances.

Equivalent resistance –

NOTE:

4. **Power:** The total power used in the circuit is the sum of the power used by the individual resistors.

NOTE:

Series relationships

5. In a series circuit, which resistor, if any, will . . .

   a) have the greatest potential difference across it?

   b) have the most current running through it?

   c) dissipate the most power?

   d) shine brightest (if it is a light bulb)?