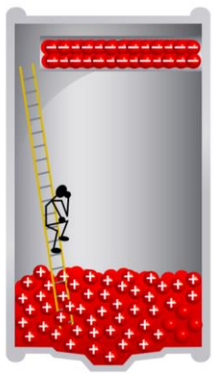
Science 9 – Voltage (Current Electricity Notes 3)

Energy is Required to do Work

- In science, energy is measured in **"Joules" (J)**
  - Your phone battery holds ~ _____ of energy!!!
  - Fun fact: a food "Calorie" is equal to 4184 J, so an egg holds _____ of energy!
- Energy is required to do work (e.g. lighting up a bulb, heating up a stove).
- Energy sources provide electrons with energy to do _____ (e.g. lighting up a bulb, heating up a stove).

Understanding Potential Energy



Voltage Gain

- Batteries give electrons a certain amount of _____, also known as _____ (V).
- E.g. an AA or AAA battery has a potential energy difference of 1.5 V between its two terminals, so we call it a 1.5 V battery.

Voltage Drop

- When electrons go through a _____ (e.g. resistor, light bulb), they _____ _____. Some loads may use more energy than others.
- On its journey around the circuit, an electron must use _____ before it returns to the positive terminal of the battery.

Measuring Changes in Potential Energy

The voltage difference between two points on a circuit can be measured using a voltmeter.

- Voltmeter symbol in circuit diagrams: ☐
- A voltmeter is always connected across the device, in _____.

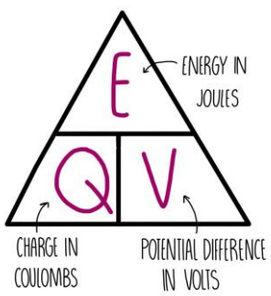
Add a voltmeter to this circuit diagram to show how you would measure the voltage of the battery.

Voltage Calculations

- Voltage is measured in volts (V).
- The voltage of a battery is the amount of Energy (J) carried by 1 Coulomb of electrons in a circuit.

$$V = \frac{E}{Q}$$

V = voltage in Volts (V)
E = energy in Joules (J)
Q = charge in Coulombs (C)

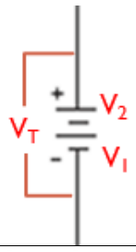


Example 1)
A light bulb is powered by 3 AA batteries. How much energy is delivered to the bulb if 20 C of charge is used?

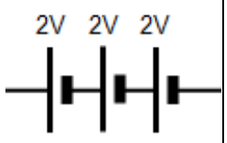
Example 2)
A car battery is 12 V and sends out 28 kJ of energy. How much electric charge does the battery hold?

Series and Parallel Combinations of Cells

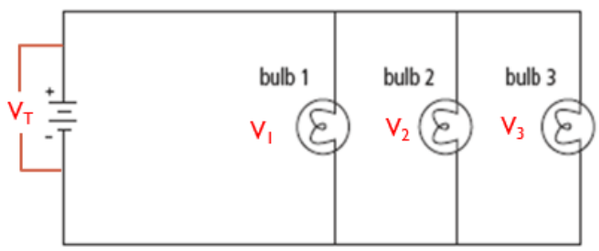
- When cells are connected in **series**, we can find the total amount of voltage by just adding them together.
- $V_T = V_1 + V_2 + \ldots$



Example: Calculate the total voltage of this battery made of three, 2-volt cells connected in series. Draw the voltmeter set-up that could measure this total voltage change.



- When cells are combined in **parallel**, the voltage does not increase but the amount of charge (current) does.
- Advantages: greater current or longer battery life
- $V_T = V_1 = V_2 = V_3$



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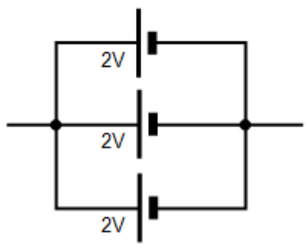
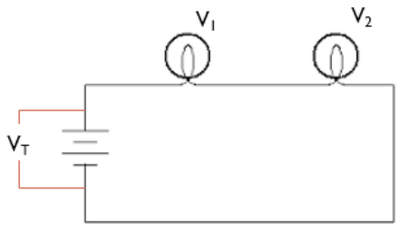


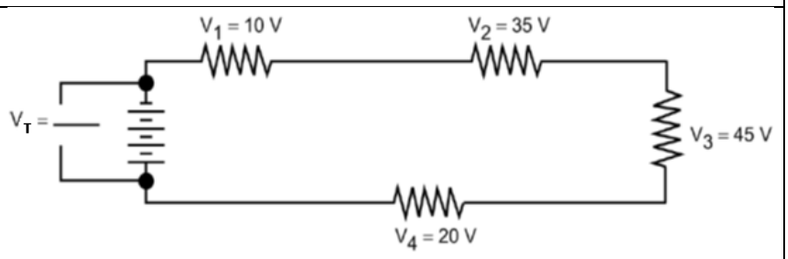
Loads Connected in Series

- Rule: The total voltage gained from the battery is equal to the total voltage drop from all the loads combined.
- $V_T =$ _____



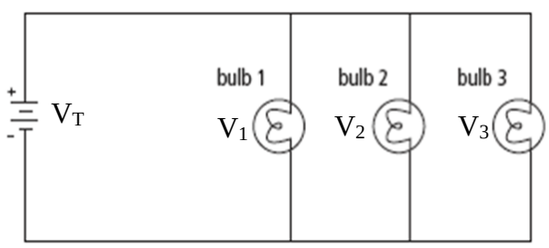
Example:

What is V_T?



Loads Connected in Parallel

- When electrons go through devices in parallel, they split at junction points.
- Each load in parallel will receive the same amount of energy/Voltage.
- $V_T =$ _____



Example: If V_1=10V, Calculate V_T, V_2 and V_3.