Charge and Current

- an electron is a charged subatomic particle
- the coulomb (C) is a measure of electric charge with

$$\frac{-1.6 \times 10^{-19} C}{electron} \quad (notation) \quad = \quad \frac{-1.6 \text{ e} - 19 \ C}{electron}$$

- Electric current is the flow of electric charge in time (C/s)

$$I = \Delta Q / \Delta t$$

- The ampere is the unit of electric current

$$1\ A = 1\ C/s$$

Image is public domain.

Q2 Answers:
A. 0.00000016 A
B. 0.160 A
C. 1 A
D. 1e-9 A
E. 160e-12 A

L1Q1: What is the charge of 1 billion electrons?
L1Q2: A "typical" electronics circuit might have 1 billion electrons pass a cross section of a wire every nanosecond, what is the electric current in amps?

Voltage and Energy

- **Energy** is **the ability to do work**, measured in joules (J), BTUs, calories, kWh, mAh, etc.
- **Voltage** is **the work done per unit charge** (eg. J/C) against a static electric field to move charge between two points
- Also, 1 volt ($1\ V$) is the electric potential difference between two points that will impart $1\ J$ of energy per coulomb ($1\ C$) of charge that passes through it.

$$\Delta E = \Delta Q \times V$$

L1Q3: A certain battery imparts 480 pJ to every 1 billion electrons. What is its voltage?
L1Q4: What is the charge moved through 400 V (EV battery) to provide 800 kJ of energy?
L1Q5: What is the average current if the energy in Q4 is provided in five seconds?

Energy and Power

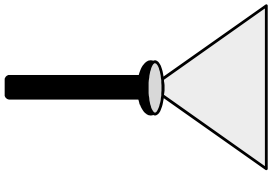
Power is **the rate at which energy is transferred.**

Also, power is (rate of charge flow)·(potential difference)

And power is current·*voltage*

$$P = \frac{\Delta E}{\Delta t} = \frac{\Delta Q}{\Delta t}\, V = I\, V$$

L1Q6: A flashlight bulb dissipates $6\ W$ at $2\ A$. What is the supplied voltage?



L1 Learning Objectives

a. (L1a) Compute relationships between charge, time, and current.
b. (L1b) Compute relationships between charge, voltage, and energy.
c. (L1c) Compute relationships between power, current, and voltage.

$$I = \frac{\Delta Q}{\Delta t} \qquad V = \frac{\Delta \mathrm{E}}{\Delta Q}$$

$$\Delta E = \Delta Q \times V$$

$$P = \frac{\Delta E}{\Delta t} = \frac{\Delta Q}{\Delta t}\, V = I\, V$$