Phys 112 2019

Lecture 11

Tues: Discussion / quiz

Supp Ex 42, 43, 44

Ch 22 Questions ×

Problems 1, 2, 11, 48

Weds: Remember Prelabs

Exam wrap: Q3

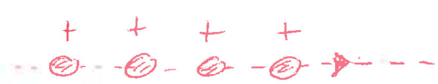
Currents

We have so far considered situations where multiple fixed charged particles act on a single mobile charged particle. But we will eventually have to consider the electromagnetic effects of moving source charges, or currents. Qualitatively

> Current ≈ collection of moving charged particles

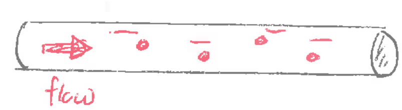
Some examples:

1) beam of charged particles



2) single moving charged particle

3) charged particles flowing through a wire



Demo PhET ✱ DC Circuits

- connect
- remove "Show Current"
- close switch
- show current.

We will describe the operation of such circuits in terms of currents and potential differences and we will need to quantify both.

The scheme for quantifying current is: (Current ~ rate at which charge flows)

* Observe charges flowing through an imaginary window

* Suppose that the magnitude of the charge that flows in time Δt is Δq.

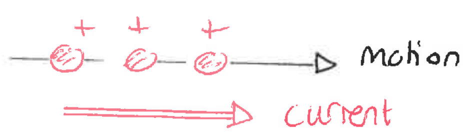
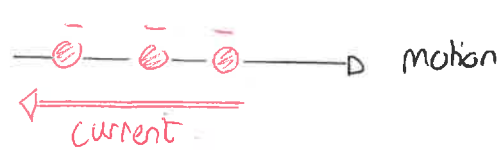
* The magnitude of the current is:

$$I = \frac{\Delta q}{\Delta t}$$

Units: Amperes $A = C/s$

Quiz 1 40% – 90%

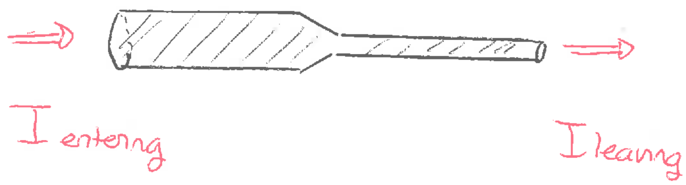
We also need to describe the direction of currents. The definition is

Positive charge carriers	Negative charge carriers.
Direction of current = direction of motion	Direction of current = opposite to direction of motion
	

Quiz 2

Charge conservation + currents

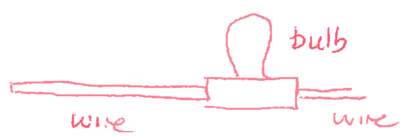
We will consider the steady-state behavior of circuits, and ignore the typically brief period during which the current becomes established. In such circuits the charge cannot accumulate or disappear at any location. In the illustration a wire has different diameters at the ends. If



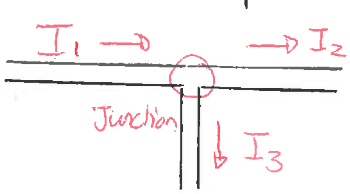
$I_{leaving} \neq I_{entering}$

then it means that the amount of charge leaving every second is not equal to that entering. Then charge would accumulate or disappear in the circuit. This does not occur in steady state circuits. This is similar to water flowing through pipes. Different flow rates would imply that mass accumulates / disappears

Warm Up 1



This can be applied to situations involving a junction. At junctions currents can split and recombine. In the illustration

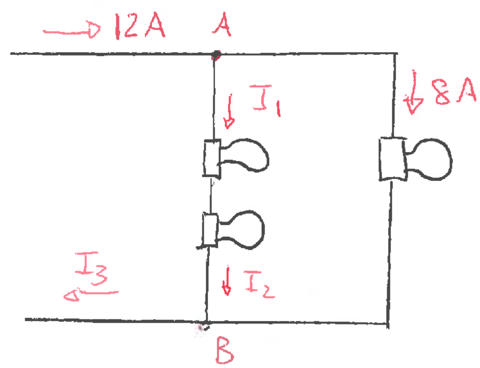


$$\underbrace{I_1}_{\text{total entering}} = \underbrace{I_2 + I_3}_{\text{total leaving}}$$

Example: Consider the illustrated circuit

Determine the currents

I_1, I_2, I_3



Answer: At junction A

$I_{entering} = I_{leaving}$

$12A = I_1 + 8A$

$\Rightarrow$ $I_1 = 4A$

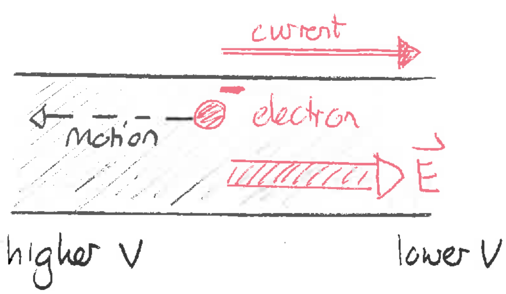
Then $I_1 = I_2$ since there is no split between these. So $I_2 = 4A$

At junction B, $I_{entering} = I_{leaving}$

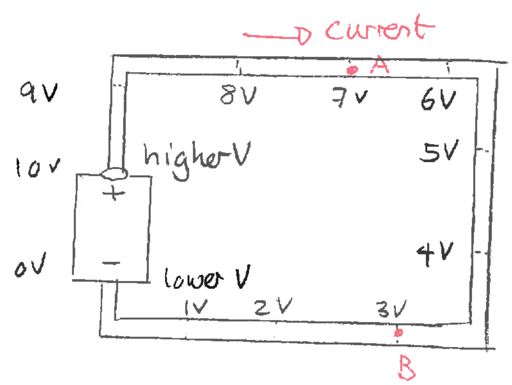
$\Rightarrow$ $I_2 + 8A = I_3$

$\Rightarrow$ $4A + 8A = I_3$ $\Rightarrow$ $I_3 = 12A$ ▣

Energy in circuits



As an electron moves through the wires of a circuit, it will collide or interact with the material. This will slow the electron. In order to sustain the current, the electron must be reaccelerated by an electric field. The electric field is accompanied by a difference in electric potential, V. This is usually provided by the battery.



The electric potential difference between two locations in a circuit has the same meaning in circuits as it does in electrostatics.

So the energy needed to moved charge q through electric potential difference ΔV is

$$\Delta U_{elec} = q \Delta V$$

In the example consider +5 C of charge moving from A to B. This requires energy

$$\Delta U_{elec} = q \Delta V = +5C\,(7V - 3V) = 20J$$

Warm Up 2

Quiz 3