Chapter 1:
Systems of Linear Equations

Sec. 1.4: An Application to Network Flow
Sec. 1.5: An Application to Electrical Networks
Sec. 1.6: An Application to Chemical Reactions

Applications of Systems of Linear Equations

There are many many different applications of systems of linear equations…

Sec. 1.4: An Application to Network Flow

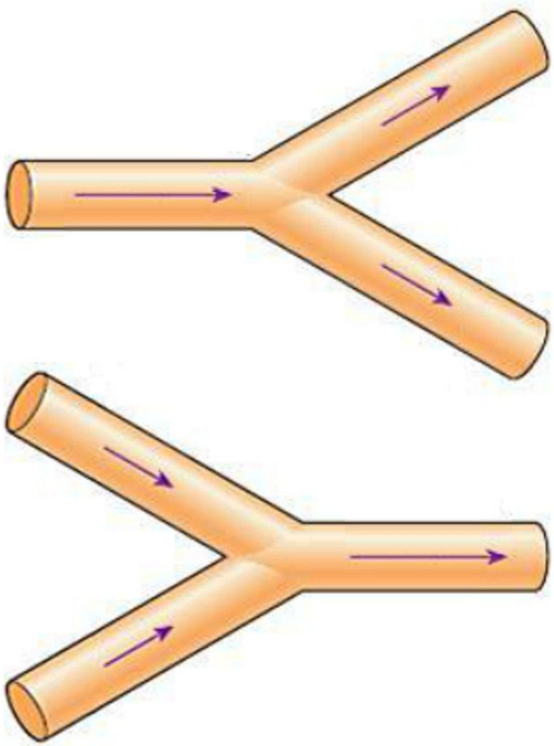
Think water flowing through a pipe

or

Car traffic

or

Electric current



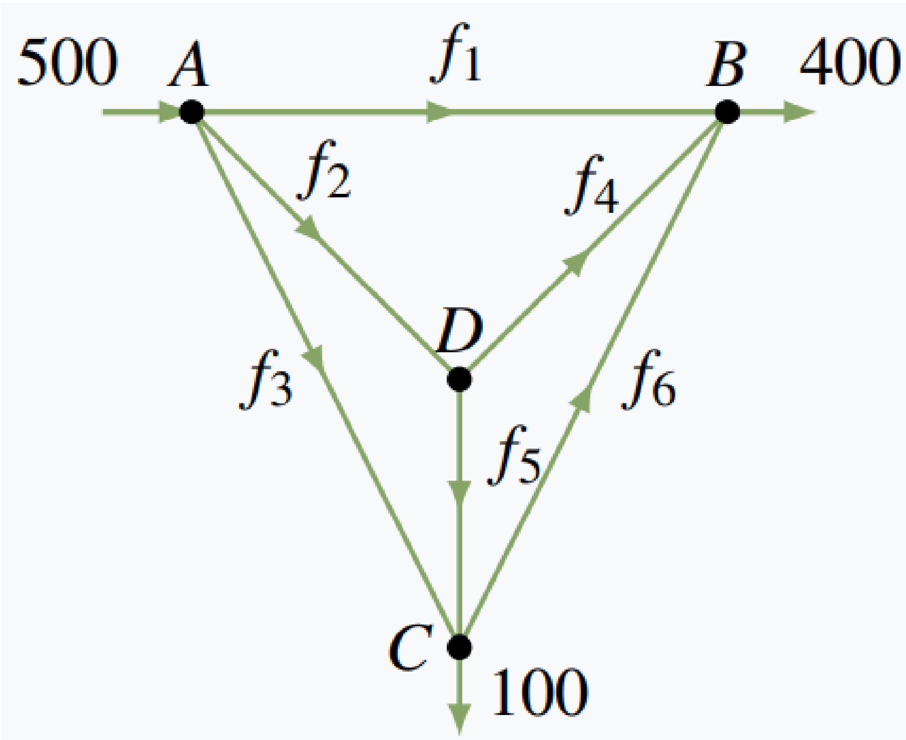
Flow Rate Into a Junction

=

Flow Rate Out of Junction

Sec. 1.4: An Application to Network Flow

Ex 1: Find the possible flows in the following network of pipes…



Sec. 1.5: An Application to Electrical Networks

In an electric circuit…

- There are a bunch of conducting wires connected together to form a closed loop
  (for a conductor, think copper wire…)

- A battery causes electrons to flow through the circuit
  (think that the electron flow is like water flowing through a pipe
  the battery causes the push to keep the flow going
  we will pretend it is positive charge that is flowing)

- A circuit will also contain at least one resistor
  (think of the resistor as a device we are trying to run, like a lightbulb)

Sec. 1.5: An Application to Electrical Networks

- Flow of charge is called current
  The units for current is Amps
  1 Amp = 1 C/s
- Charges flow in a circuit because of a potential difference
  Electric potential is measured in Volts
  Positive charge flows from a point of higher electric potential to a point of lower potential
  The potential difference in a piece of conducting wire is negligible
- A resistor has a resistance which measures how hard it is for charge to flow through it
  Charge must flow through the device for the device to function
  Resistance is measured in Ohms Ω

Analyzing Circuits

The ideas you need to analyze circuits …

1)

Law of conservation of current The current is the same at all points in a current-carrying wire.

with no junctions!

Analyzing Circuits

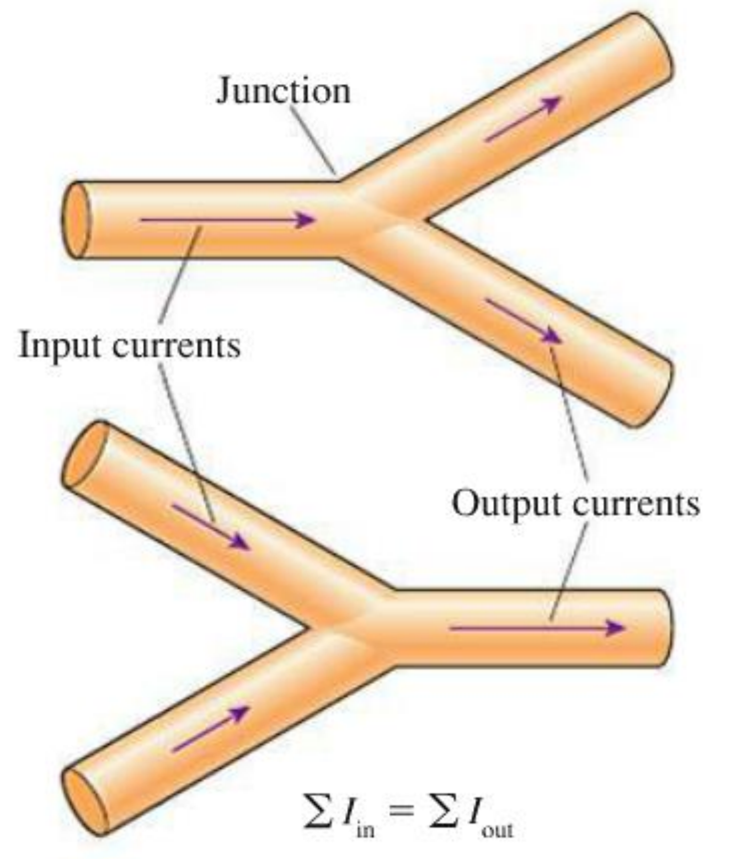
The ideas you need to analyze circuits …

2)

$$\sum I_{\text{in}} = \sum I_{\text{out}}$$

Kirchhoff's junction law

FIGURE 22.11 The sum of the currents into a junction must equal the sum of the currents leaving the junction.



Analyzing Circuits

The ideas you need to analyze circuits …

3) **Ohm's Law**

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

Ohm's law for a conductor of resistance R

or $\Delta V = IR$

Analyzing Circuits

The ideas you need to analyze circuits …

4)

$$\Delta V_{\text{loop}} = \sum_i \Delta V_i = 0$$

Kirchhoff's loop law

Analyzing Circuits

The ideas you need to analyze circuits …

5) If 2 points in a circuit are connected by an ideal wire (a wire with no resistance) then the electric potential is the same at both points (i.e. there is no potential drop between the points)

Analyzing Circuits

The ideas you need to analyze circuits …

6) If in a problem you don’t know what the direction of the current is, pick a direction and if you get a negative answer for the current, then you picked the wrong direction.

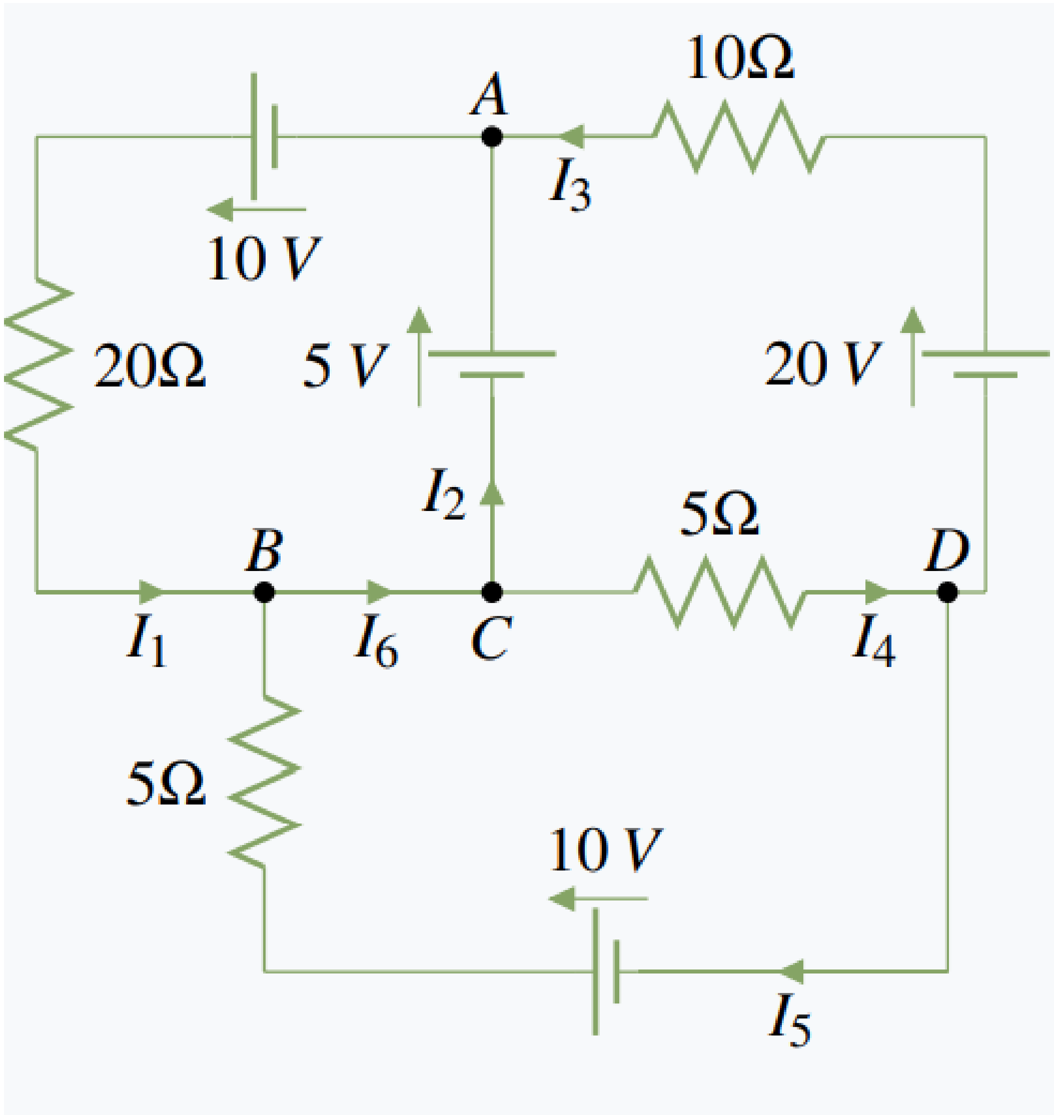
Analyzing Circuits

The ideas you need to analyze circuits …

7) When going across a resistor in the direction of the current, the potential drops (by $\Delta V = IR$)

Sec. 1.5: An Application to Electrical Networks

Ex 2: Find the various currents in the circuit below…



Sec. 1.6: An Application to Chemical Reactions

In a chemical reaction…

- Different types of molecules are brought together
- Bonds are broken
- The atoms are rearranged
- New bonds are created
- Different molecules are created

As in the creation of water from hydrogen and oxygen: $\mathrm{H_2} + \mathrm{O_2} \rightarrow \mathrm{H_2O}$

Sec. 1.6: An Application to Chemical Reactions

Ex 3: Balance the following reaction (called the photosynthesis reaction).

$$CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$$