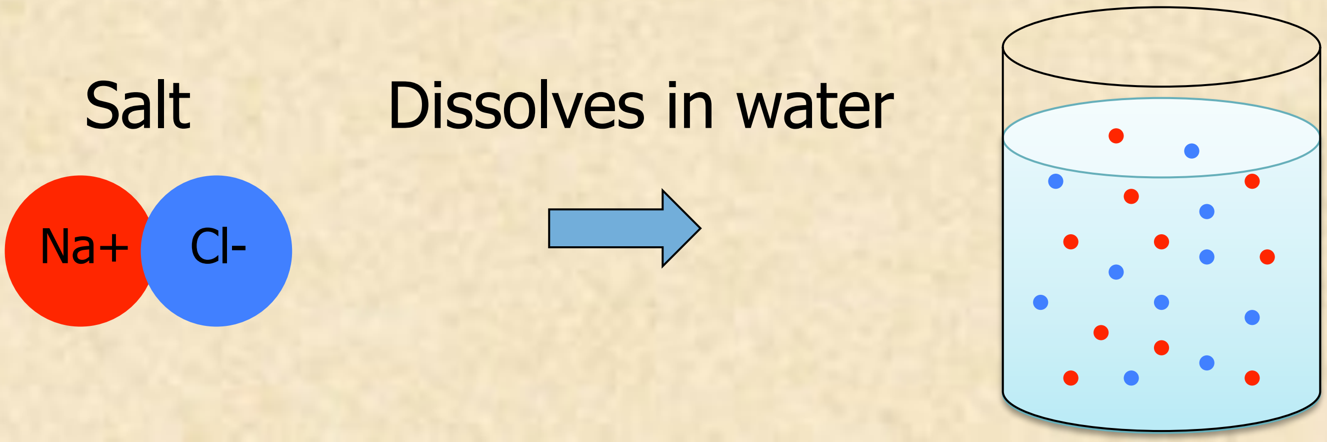
The force of Diffusion

- When sugar dissolves in water, the sugar molecules become equally distributed in the water
- The molecules move from a region of high concentration, to a region of low concentration
- The tendency to move from high to low concentration is called the force of *Diffusion*

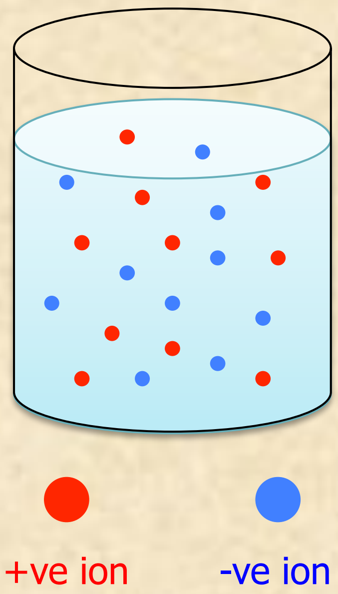
Salty water has charged particles

- When a salt dissolves in water, the molecules break up into separate particles call ions
- Table salt is made up of sodium and chlorine ions
- A sodium ion has the chemical symbol Na+
- A chlorine ion has the chemical symbol Cl-
- The + indicates that a sodium ion has a positive charge
- The - indicates that a sodium ion has a negative charge



The force of Electrostatic Pressure

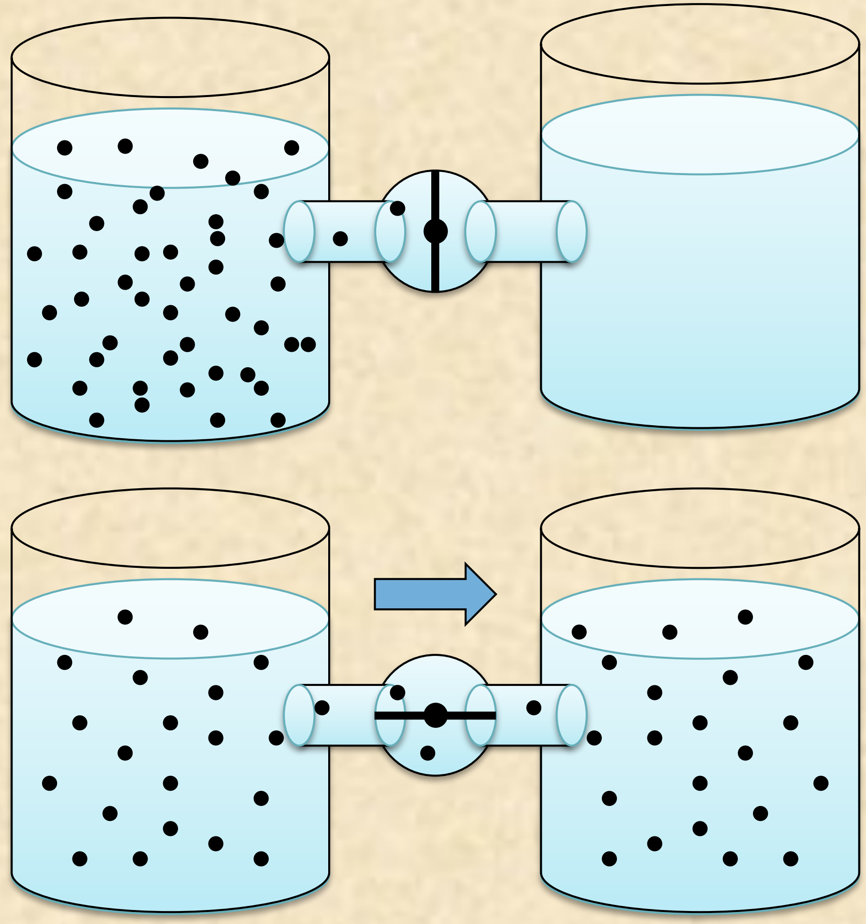
- When a salt dissolves in water, the charge of the ions also affects the concentrations
- Ions with *different charge attract* each other
  - -ve and +ve ions attract
- Ions with the *same charge repel* each other
  - +ve and +ve ions repel
  - -ve and -ve ions repel
- The tendency to be attracted or repelled by the electrical charge is called the force of *Electrostatic Pressure*



Note how the -ve and +ve charged ions are equally distributed because like charged ions repel each other

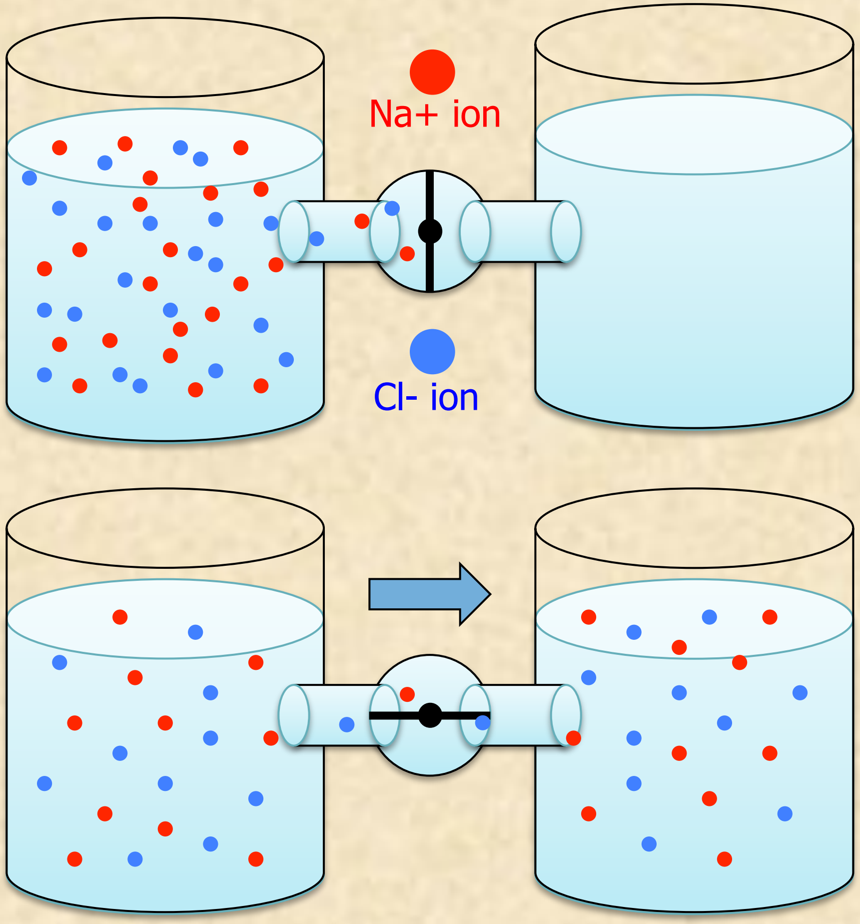
Experiment using the force of Diffusion

- Let's join two containers to do some experiments
- In the top setup, a gate stops the fluids mixing
- In the bottom setup, the gate is opened, allowing the fluids to mix and for molecules to move from the left container to the right
- This occurs from the force of Diffusion



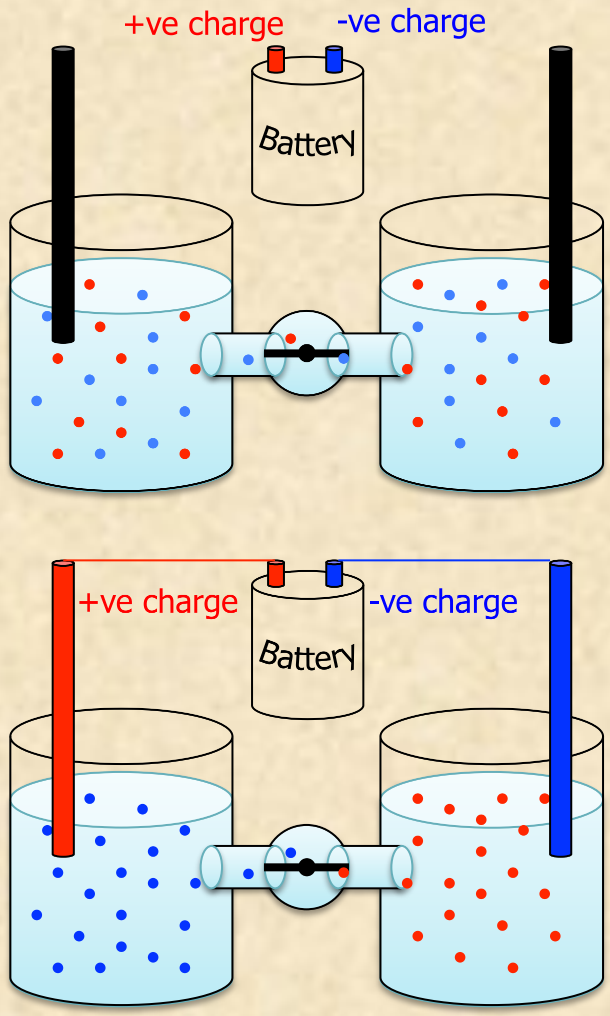
Experiment using the force of Diffusion

- Let's do the same thing with salty water
- Remember common salt dissolves into Na+ ions and Cl- ions
- When the gate is opened, both Na+ ions and Cl- ions move from high concentration on the left to low concentration on the right due to the force of Diffusion



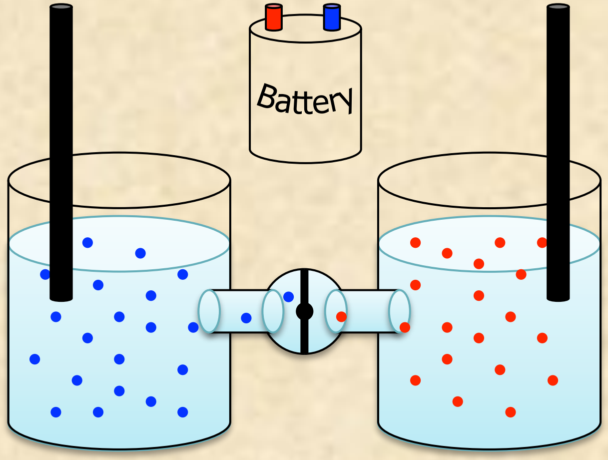
Injecting current

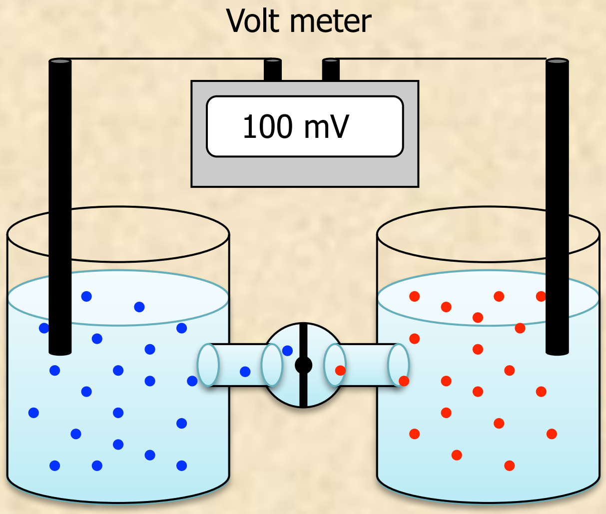
- We can inject current by placing two electrodes in the containers
- Ordinarily, the +ve and –ve ions are equally distributed in each side
- When the +ve and –ve poles of a battery are connected to the electrodes, the ions move
- Na+ ions move to the –ve electrode and Cl- ions move to the +ve electrode
- This results from the force of Electrostatic Pressure



Measuring voltage

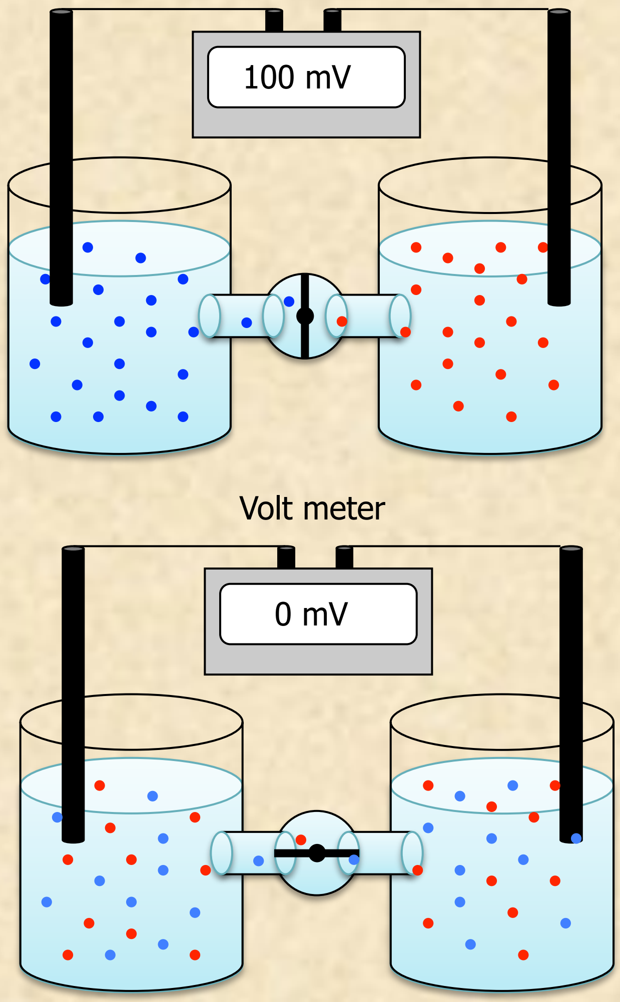
- When we close the gate and remove the electrodes the Na+ ions and Cl- ions are prevented from redistributing due to Diffusion
- This leaves an abundance of -ve ions in the left container and an abundance of +ve ions in the right container
- If we connect the electrodes to a volt meter, we can measure the difference in charge between the containers – the voltage





Voltage change results from ion movement

- When we open the gate the Na+ ions and Cl- ions are able to redistribute between the containers due to Diffusion
- This leaves a balance of +ve ions in both containers and a balance of –ve ions in both containers
- If we measure the difference in charge between the containers while the ions move, the voltage begins to fall
- When the ions redistribute, the voltage difference falls to 0



How is this useful for understanding neurons?

- The inside and outside of a neuron are like two containers
- Normally, the gates between the two are closed
- Outside the neuron there is an abundance of Na+ ions
- Inside the neuron there is an abundance of Cl- ions
- We can measure the voltage difference between the inside and outside using a volt meter and two electrodes
- When we open the gates between the inside and outside of a neuron, the Na+ ions and Cl- ions are able to move due to Diffusion and Electrostatic pressure
- We can measure this change with electrodes and a volt meter
- We can also shift ions by injecting current into a neuron…