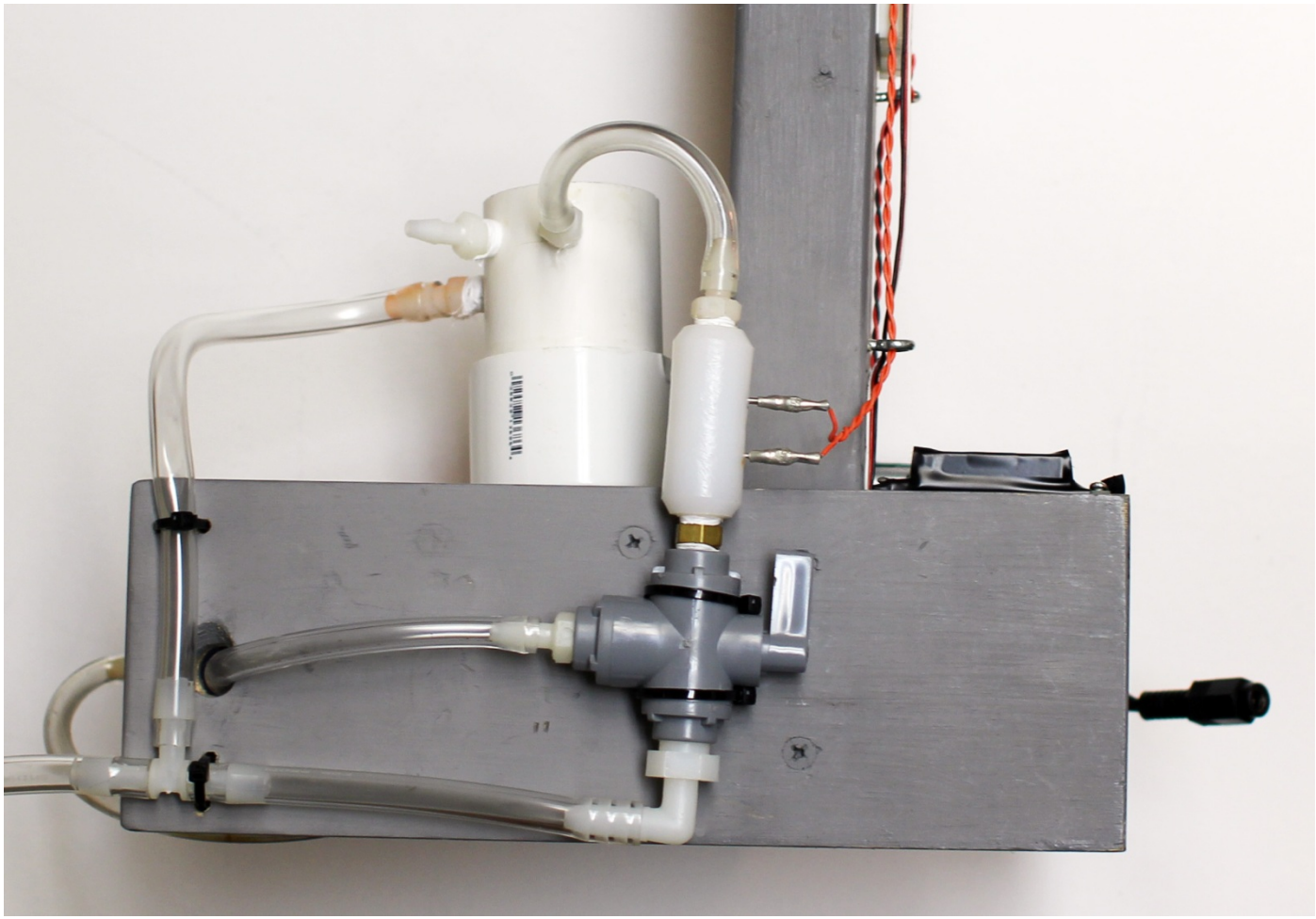
conductivity sensor implementation

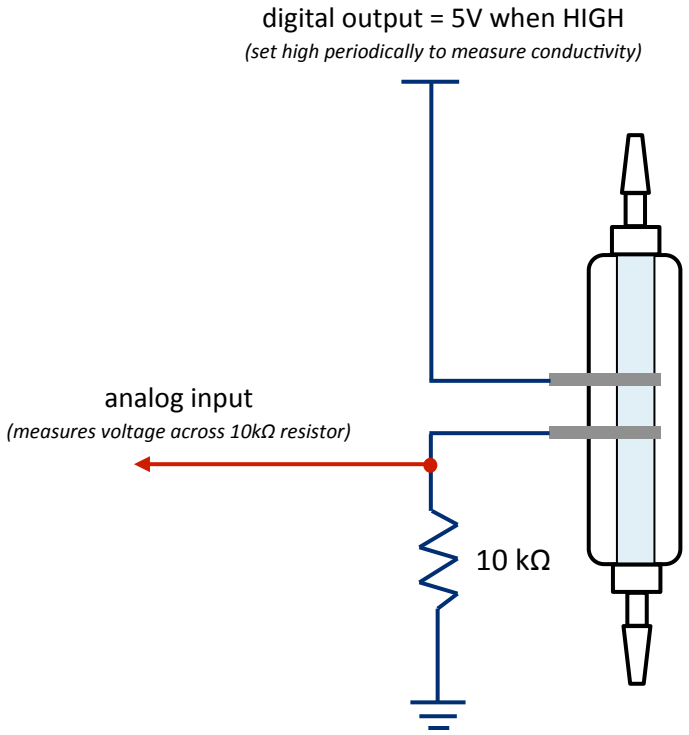


conductivity measurement circuit

- we use the same voltage divider circuit used earlier for the photoresistor circuit

$$\Delta V\downarrow conductivity\ sensor + \Delta V\downarrow 10k\Omega\ resistor = 5\ volts$$

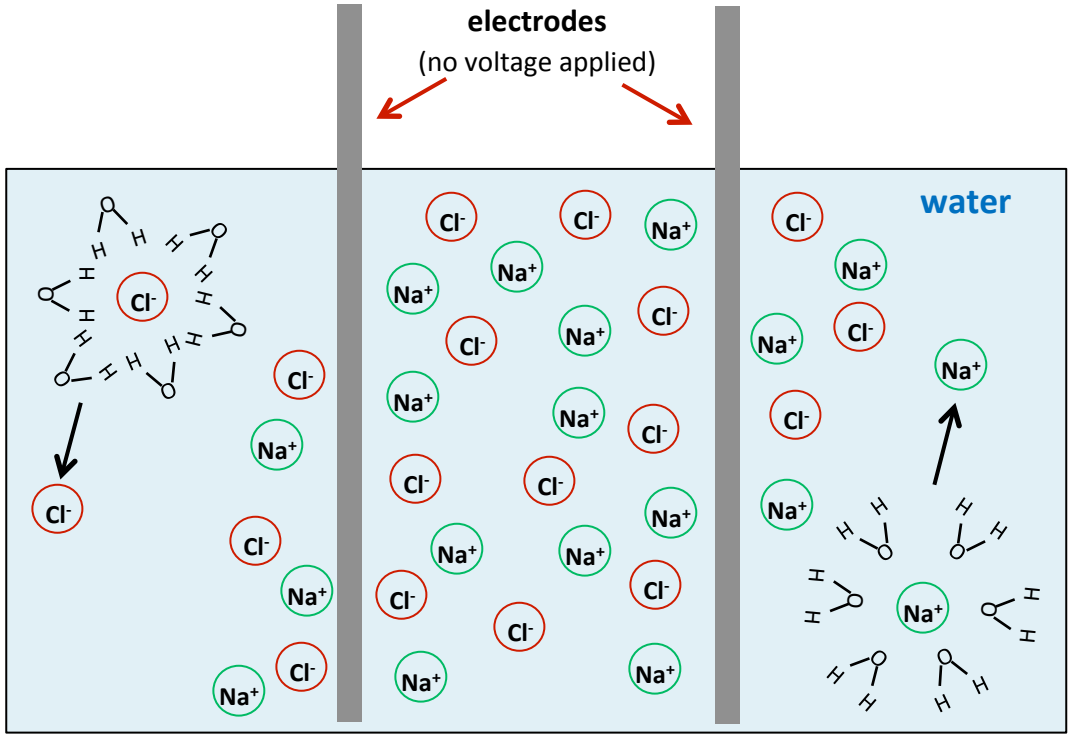
- what happens to the electrical resistance of the water as it becomes more salty?
  it decreases
- if the resistance of the salt water decreases, then what happens to the voltage drop across the conductivity sensor?
  it decreases
- if the voltage drop across the conductivity sensor decreases, then how does this influence the voltage drop across the 10kΩ resistor?
  it increases
- so, increasing the salinity of the water causes the analog input read by the Arduino to (**increase** or **decrease**)?



0 to 1023

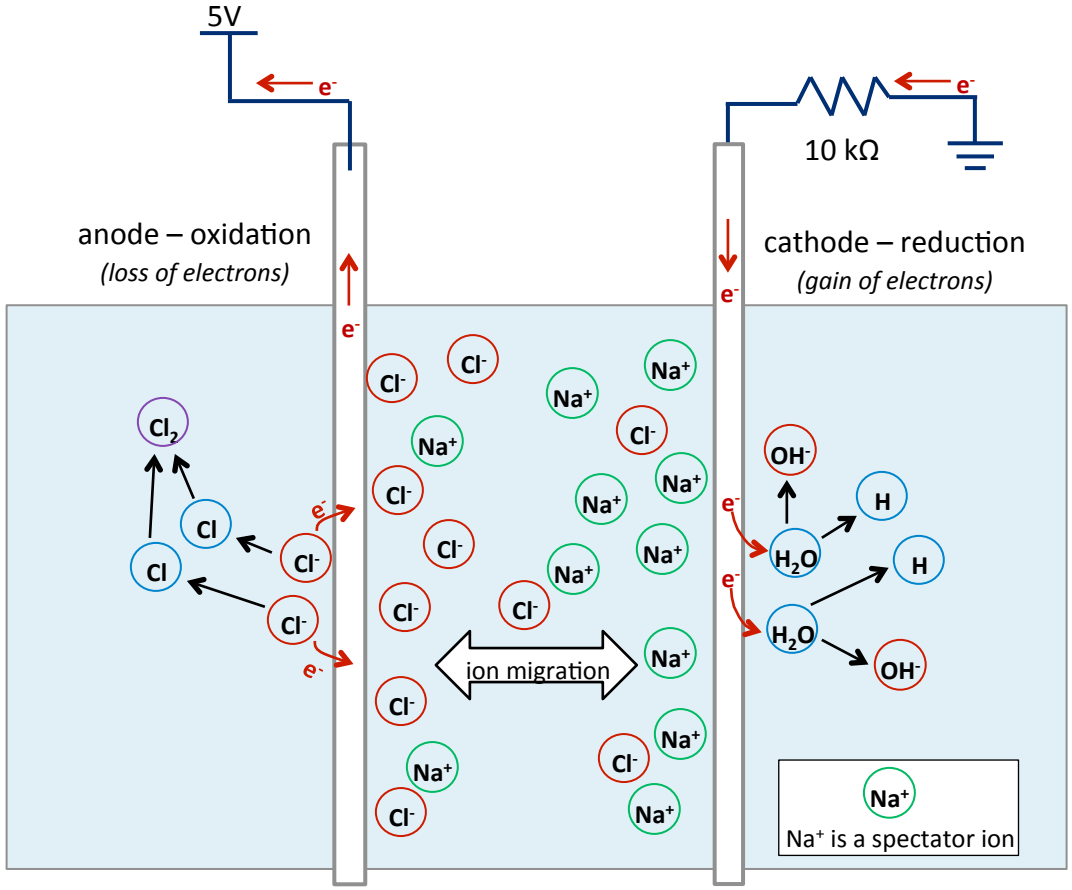
what happens when salt is added to water????

- The ionically bonded NaCl molecules dissociate into Na+ and Cl- ions and become mobile
- they are surrounded by polar water molecules (they are hydrated)



applying voltage to induce electron flow

electrons are really not directly conducting through the water from one electrode to the other (like when electrons move through a copper wire)



reduction occurs at the negatively charged cathode:

$$2\,H{\downarrow}2\,O(l)+2e{\uparrow}- \rightarrow H{\downarrow}2\,(g)+2OH{\uparrow}-$$

oxidation occurs at the positively charged anode:

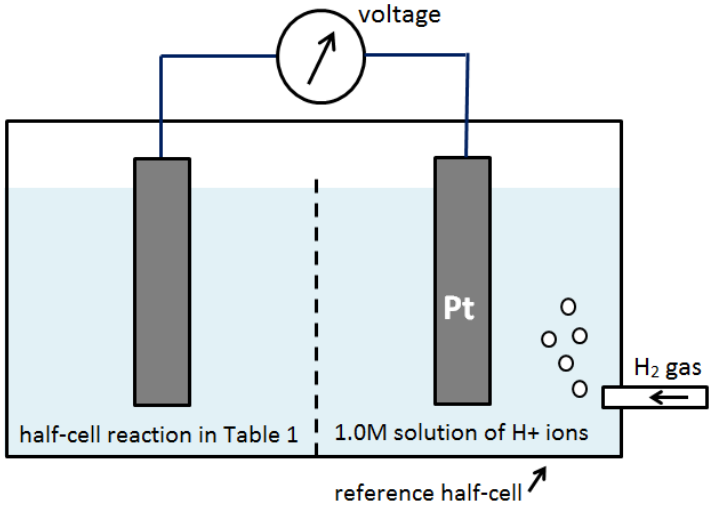
$$2\,Cl{\uparrow}-\,(aq) \rightarrow Cl{\downarrow}2\,(g)+2e{\uparrow}-$$

It seems like an Na+ would accept an electron and be reduced . . . why not???

why is H_2O reduced and not Na^+ ???

	Electrode Reduction Half-Reaction	Voltage Output *(when electrode is coupled with a 1.0M H+ ion solution using a platinum electron)*
increasingly inert	$F_2(g) + 2e^- \rightarrow 2F^-(aq)$	+2.87 V
	$H_2O_2(aq) + 2H^+ + 2e^- \rightarrow 2H_2O(l)$	+1.78 V
	$Au^{3+}(aq) + 3e^- \rightarrow Au(s)$	+1.52 V
	$Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$	+1.36 V
	$O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$	+0.40 V
	$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	+0.34 V
	$2H^+ + 2e^- \rightarrow H_2(g)$	0.00 V
	$Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$	-0.25 V
	$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$	-0.83 V
	$Al^{3+}(aq) + 3e^- \rightarrow Al(s)$	-1.66 V
increasingly active	$Na^+(aq) + e^- \rightarrow Na(s)$	-2.71 V
	$Li^{-1}(aq) + e^- \rightarrow Li(s)$	-3.04 V

reactions further down in the table are less likely to occur



- reactions with positive voltages will occur spontaneously
- you must apply external voltage across the electrodes to make a reaction with a negative potential occur

the net reaction of conductivity system

	Possible Half-Reaction	Reference Voltage
1	$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$	-0.83 V
2	$2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$	-1.36 V *(direction & sign swapped)*
3	$Na^+(aq) + e^- \rightarrow Na(s)$	-2.71 V

the net reaction occurring in the system is . . .

anode	$2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$	-1.36 V
cathode	$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$	-0.83 V
net reaction	$2Cl^-(aq) + 2H_2O(l) \rightarrow Cl_2(g) + H_2(g) + 2OH^-(aq)$	-2.19 V

- we must apply at least 2.19 V to the conductivity circuit to drive the reaction
- applying 5 V is sufficient, and higher voltages will increase the rate of oxidation & reduction reactions

system wiring