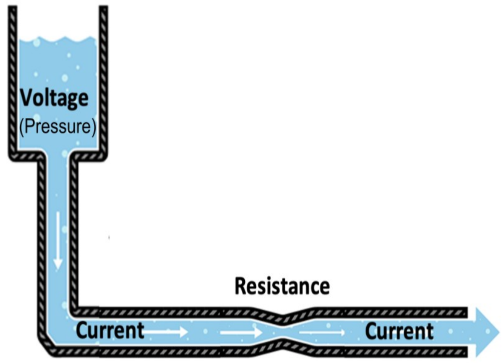
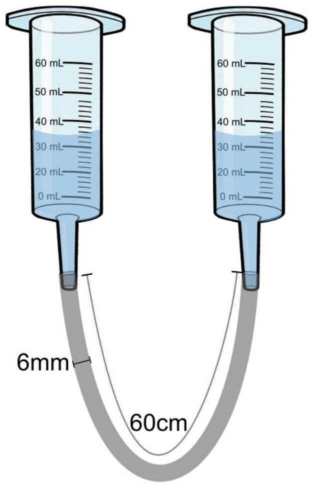
Fluid Flow Through Tubes:
Pressure, Current, and Resistance

- Taller columns of water exert more pressure, pushing the water to move until it is at the same level everywhere
- The rate of flow for water through a tube depends on the pressure pushing it through, the viscosity of the fluid, and the tube's width and length
- We can think about water flow through a tube just like current flowing through a resistor in an electric circuit.



Part 1: Pascals' Law

1. You have a selection of plastic hoses with two different widths (thick and thin). The thicker hose has diameter 6mm. Find a thick tube of length 60cm. Attach each end of the tube to the tip of a syringe.



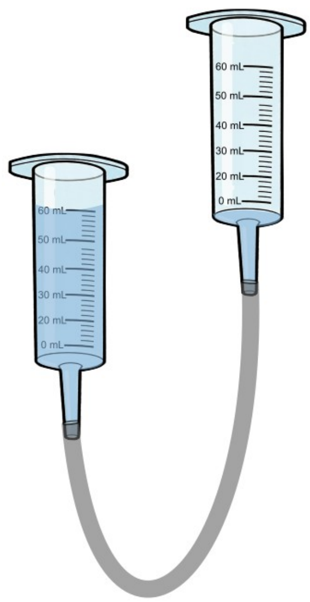
2. Hold both syringes next to each other (same height) with the open end up. Pour 75 mL of water into one of the syringes.

Discuss: What happens to the water level in the other syringe? What is the level in both syringes when the water stops moving?

3. Now hold one syringe higher than the other, so that the 0mL mark on one lines up with the 60mL mark on the other.

When the water stops moving, how does the water in the two syringes compare?
(circle all that are true)

a) Water is at 60mL mark on one and 0mL mark on the other
b) Water is at 30mL mark in both
c) Water is at 60mL mark in both
d) Water is at the same absolute height in both



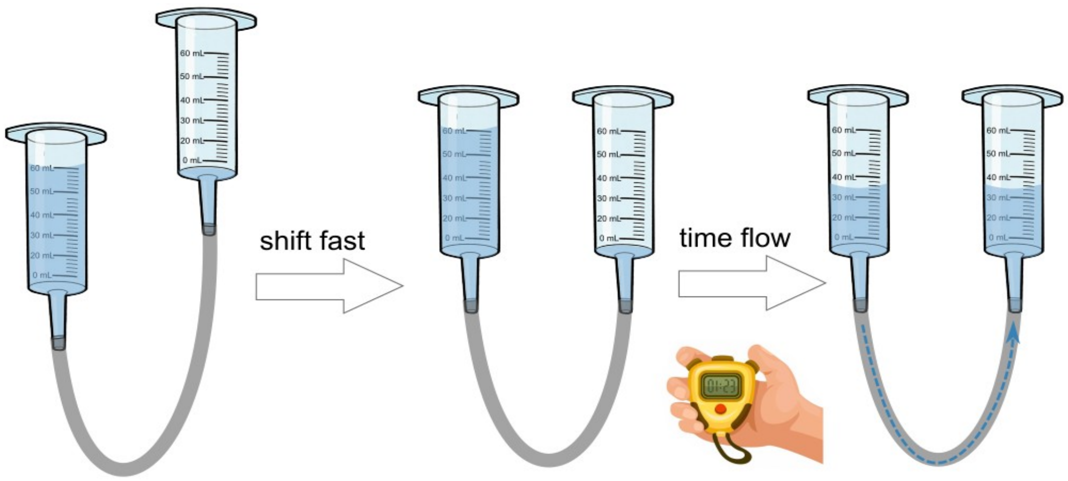
4. Play around with moving the syringes up and down.

Which statement above always holds?

Pascal's Law states "water seeks its own level": it comes to the same height everywhere under an open surface. If one end is higher than the other, the weight of the taller column of water pushes down and makes the water move until the height is equalized.

Part 2: Flow through a Tube as an Analogy for Electric Circuits

1. Start with the 60mL mark of one syringe lined up to the 0mL mark of the other. Have one student start the timer while another quickly brings the syringes to the same level. Time how long it takes for the water level in the fuller syringe to drop down to the 35mL mark.



Do two trials to be sure of your measurements:

Trial	Time to drop from 60mL to 35mL (long thick tube)
1	
2	

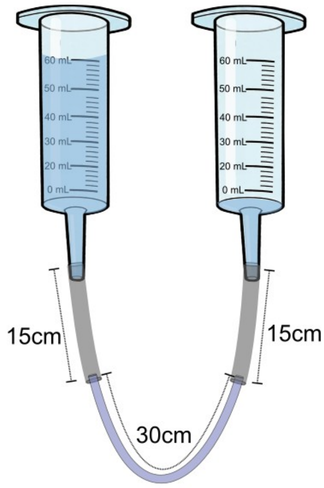
Notice that the syringes store water at different heights. The higher water level in one provides more pressure, forcing the water to flow.

Draw lines to match each part of the fluid flow experiment to the analogous part in an electronic circuit:

water containers (syringes)	electric current
plastic tubing	battery
water	wires

Discuss: What factors do you think affect the rate of flow? What would happen if the water started close to the same height? What would this correspond to in an electric circuit? Hint: what happens with over-used batteries.

2. Remove the tube from the syringes. Now create a new tube with a narrower section (4mm diameter) inserted between two thick sections.



Attach this new linked tube to the syringes and repeat the experiment above.

Trial	Time to drop from 60mL to 35mL (tube with 1 thin section)
1	
2	

How does the flow rate compare in the new tube with a thinner section?

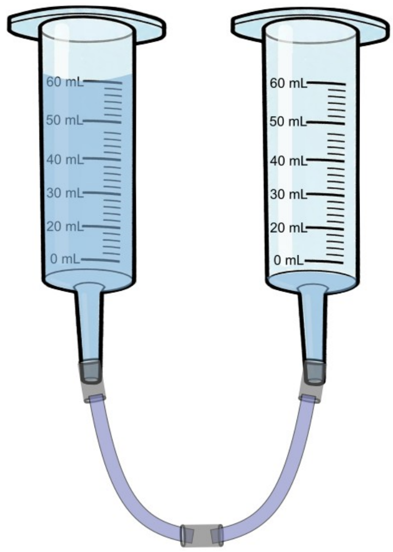
water flows faster   water flows slower   about the same

What part of an electronic circuit does the thinner piece of tube represent?

Battery   wire   resistor   electric current

Part 3: Resistors in Series and in Parallel

1. Make a hose that has 2 narrow “resistors” connected **in series** (one after the other, as shown in the picture).



2. Repeat your measurements of the time for the water level to drop to 35mL

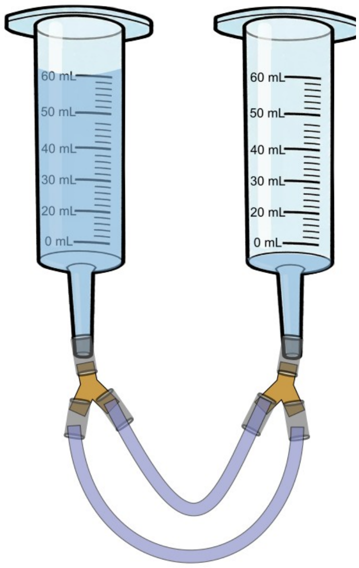
Trial	Time to drop from 60mL to 35mL (2 thin sections in series)
1	
2	

Is the overall flow rate with 2 resistors in series:

higher   or   lower

than the flow rate with just 1 resistor?

3. Now make a hose with 2 narrow resistors connected **in parallel**. Use the small sections of thick tube to attach your narrow tubes to Y-connectors and to the syringe tips. Your system should look like this:



4. Repeat your measurements again

Trial	Time to drop from 60mL to 35mL (2 thin sections in parallel)
1	
2	

Is the overall flow rate with 2 resistors in parallel:

higher or lower

than the flow rate with just 1 resistor?

Discuss:

- Why does the flow rate change so much if you connect the resistors in parallel versus in series?
- What other things could you change in this experiment to alter the flow rate? (eg: what would happen if you used honey instead of water?)