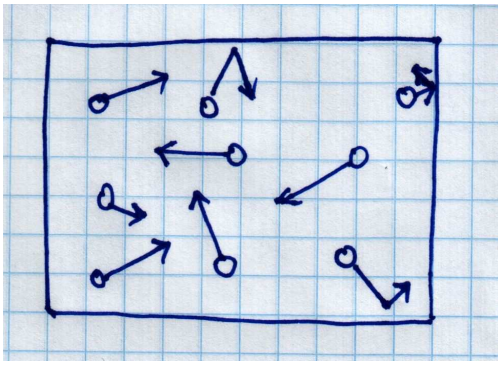
1 Week 1 Day 2: Proportionality relations

1. Chemistry professors (and successful Chem 2070 students) have an approximate picture in their mind of what a gas would look like if we could see the molecules in the gas. I illustrate a possible picture in the figure below. In this picture we represent the roughly 10^{23} molecules in a gas sample by 6-12 molecules. The molecules themselves can be thought of as the pictured balls. The motion each molecule is experiencing is represented by an arrow. The direction the balls are travelling in is represented by the direction of the arrows. The magnitude of the arrows corresponds to the magnitudes of the indiviual molecule's velocities.



   (a) Draw a comparable picture, with n and V the same as before but T significantly smaller. Did p increase, decrease, or stay the same? How does your picture shows this answer?

   (b) Draw two pictures of ideal gases of the type shown above. Assume that in the two pictures you have drawn, that V and T are the same, but n is doubled in one picture with respect to the other picture. Briefly explain how the pictures shown suggest $p \propto n$.

   (c) Draw two pictures of ideal gases of the type shown above. Assume that in the two pictures you have drawn, that n and T are the same, but V is doubled in one picture with respect to the other picture. Briefly explain how the pictures shown suggest $p \propto 1/V$.

   (d) Explain how the above questions suggest $p \propto nT/V$. Written as an equality $p = nRT/V$. Is this expression equivalent to $pV = nRT$?

   (e) Imagine the gas is cooled until it becomes a liquid. Draw a sketch of what the container looks like, showing the 6-12 representative molecules after the sample has liquified.

2. Listed below are pairs of quantities. State whether the two quantities are related by a proportionality relation or not. If they are connected by a proportionality relation, state what type of proportionality relation it is.

   (a) A person's height in feet and the same person's height in inches.

   (b) The amount paid in FICA (social security tax) and the amount you earn.

   (c) Mr. Fantastic's height and Mr. Fantastic's width.

   (d) The dollars spent at the gas pump and the amount of gas pumped.

   (e) The temperature of an ideal gas and the average velocity of the same ideal gas.

(f) A person's height and the same person's age.
(g) The side of a square and the area of the square.
(h) The number of books on a bookshelf and the amount of available shelf space.
(i) The temperature outside and the amount of clothes one wears.
(j) The mass of a piece of iron and the volume of a piece of iron.
(k) The amount you eat and the amount you weigh.
(l) The volume of water drunk and the number of molecules of water drunk.
(m) The distance one travels on a US interstate and the number of hours one drives.
(n) The amount you spend on education and the amount you earn.
(o) The number of heartbeats in one's life and the number of years one lives.

3. State either the name or the value of the proportionality constant for the following pair or quantities. If stating a value, please state all relevant units.

(a) A person's height in feet and the same person's height in inches.
(b) The amount paid in FICA (social security tax) and the amount you earn.
(c) The dollars spent at the gas pump and the amount of gas pumped.
(d) The pressure and volume of an ideal gas, if n and T are held constant.
(e) The temperature of an ideal gas and the average velocity of the same ideal gas.
(f) The diameter of a circle and the circumference of the circle.
(g) The mass of a piece of iron and the volume of a piece of iron.
(h) The number of moles of water drunk and the number of molecules of water drunk.
(i) The translational energy of an ideal gas and the temperature of the gas.
(j) The distance one travels on a US interstate and the number of hours one drives.
(k) The number of heartbeats in one's life and the number of years one lives.

4. Fractions: Without the use of a calculator, answer the following questions. If at all possible, answer the questions without using pencil and paper to figure out the answer. You may express your answer either in scientific notation or regular numerical form.

(a) To one or two significant figures (whichever is easier for you) what is: 1/4, 1/3, 1/10, 1/1000, 1/7, 1/15, 1/49?
(b) To one or two significant figures (whichever is easier for you) what is: 2/3, 4/10, 5/100, 2/7, 3/20, 6/96?
(c) To one or two significant figures (whichever is easier for you) what is: 1/6, 2/9, 13/10, 51/20 1000/11, 147/33?
(d) To one or two significant figures (whichever is easier for you) what is: 7/3, 14/10, 5/100, 5/7, 7/20, 119/96?
(e) To one or two significant figures (whichever is easier for you) what is: 11/6, 21/9, 247/10, 511/20 1000/15, 147/66?
(f) Memorize to three significant figures the decimal values of 1/2, 1/3, 2/3, 1/4, 3/4, 1/5, 2/5, 3/5, 4/5, 1/6, 5/6, 1/8, 3/8, 5/8, and 7/8.