1 Cognitive reasoning in chemistry 2.8

1. *Let's play Jeopardy! Part I:* In this set of Jeopardy questions you will be given sentences from a problem. For each item express what additional thoughts these sentences invoke in your mind. At any point you can play Jeopardy and call out the question which will be asked.

   (a) **One Saturday morning your Junior year**

      i. If $xr = v$, $v = kr$, and ...

      ii. If $xr = v$, $v = kr$, and $rv \neq 0$, ...

      iii. *Jeopardy time:* what is the question you could be asked?

      iv. If $xr = v$, $v = kr$, and $rv \neq 0$, express k as a function of x.

   (b) **A mystery planet**

      i. An explorer visits a new planet. The atmosphere is entirely composed of H_2, and Ar.

      ii. An explorer visits a new planet. The atmosphere is entirely composed of H_2, and Ar. A flask capable of effusion is filled with a sample of this gas.

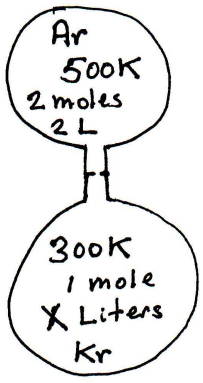
      iii. An explorer visits a new planet. The atmosphere is entirely composed of H_2, and Ar. A flask capable of effusion is filled with a sample of this gas. On a gram basis 90% of the effusing gas is Ar.

      iv. *Jeopardy time:* what is the question you could be asked?

      v. *State the procedure to solve the following problem:* An explorer visits a new planet. The atmosphere is entirely composed of H_2, and Ar. A flask capable of effusion is filled with a sample of this gas. On a gram basis 90% of the effusing gas is Ar. What is the molar ratio of H_2 to Ar on the mystery planet?

   (c) **Two flasks**

      i. Two flasks are connected as shown in the figure below.



      ii. *Jeopardy time:* what is the question you could be asked?

iii. *State the procedure to solve the following problem:* Two flasks are connected as shown in the figure above. A small hole connects them. Initially the rate of flow of gas molecules from the upper flask into the lower flask exactly equals flow from the lower flask to the upper flask. What is the volume of the lower flask?

(d) **Later that Saturday morning**

i. If x^2-y^2=77 ...

ii. If x^2-$y^2 = 77$ and $x + y = 11$

iii. *Jeopardy time:* what might be the question you will be asked?

iv. If x^2-$y^2 = 77$ and $x + y = 11$, what is $x - y$ equal to?

2. *Let's play Jeopardy! Part II:* In this set, we will state the best question we can think of which can be connected to the given data. We will also state the exact procedure by which we could numerically answer the most interesting questions which we have generated.

(a) A 4.0 L sample of O_2 has a pressure of 1.0 atm. A 2.0 L sample of N_2 at the same temperature has a pressure of 2.0 atm. If these two samples are mixed and then compressed in a 2.0 L vessel, with temperature kept constant...

(b) A compound is 85.6% carbon by mass. The rest of the compound is hydrogen. When 10.0 grams of the compound is evaporated at 50.0 ^{o}C, the vapor occupies 6.30 L at 1.00 atm pressure.

(c) The density of a 20.0% by mass ethylene glycol ($C_2H_6O_2$) solution in water is 1.03 g/mL.

(d) Hard water often contains Ca^{2+} and Mg^{2+} cations. One way to soften the water is to add phosphates. The phosphate anion,PO_4^{3-}, combines with the cations to form the insoluble precipitates, $Ca_3(PO_4)_2$ and $Mg_3(PO_4)_2$, removing the cations from solution. You can assume that nitrates are completely soluble and phosphates are completely insoluble. Suppose that a solution is 0.050 M $Ca(NO_3)_2$ and 0.085 M $Mg(NO_3)_2$. You have 1.5 L of this solution.