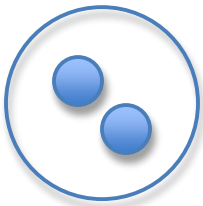
Exam 1 – Free Response Point Breakdown

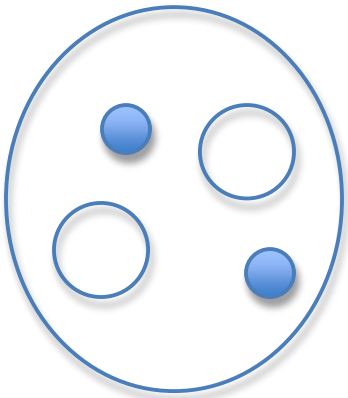
Total of 20 Points

1. Pictures of Balloon with Nitrogen and Argon gas: (Total of 5pts)

- +2 Shows volume increased between final and initial
- +2 Correct relative number of moles of gas (If they chose to represent 2 moles with 5 particles, then second picture needs to have 10 particles, etc.)
- +1 Shows two DIFFERENT types of particles (color, shape, size, anything!)



Before (blue = Nitrogen)



After (white = Argon, blue = Nitrogen)

2. Explanation of gas collisions: (Total of 5pts)

- +2 for choosing the correct gas (Nitrogen)
- +1 for expressing the velocities of the two particles will be different
- BECAUSE +2 the lighter gas to move faster (lower molar mass, less dense, lighter, etc.) The velocities are different due to differences in molar mass. The connection of the two ideas is important.

General example of a 5pt answer:

Nitrogen gas has more collisions because, even though the average kinetic energy of the two gases is the same because the temperature is the same, the velocities are different due to the difference in molar masses of the particles. Nitrogen is a lighter gas, so it will move faster therefore colliding with the sides of the balloon more frequently.

3. Limiting Reagent Problem: (Total of 5pts)

- +1 for balanced equation: $NH_3 + HCl \rightarrow NH_4Cl$
- +2 for calculating moles of each substance correctly <u>or for at least just calculating the number of moles of HCl correctly</u> (it is the LR)
    - Only +1 If they set up calculations correctly, but get wrong numbers

$$\frac{73\text{ g } NH_3}{} \left| \frac{1\text{ mol } NH_3}{17\text{ g } NH_3} \right.$$

= 4.29 moles NH_3 (or within $\pm$ 0.2 mol)

$$\frac{73\text{ g HCl}}{} \left| \frac{1\text{ mol HCl}}{36.4\text{ g HCl}} \right.$$

= 2 moles HCl (or within $\pm$ 0.2 mol)

- +1 for identifying HCl as the Limiting Reagent – they should say it or choose it for their final calculation of NH_4Cl made
- +1 for final correct answer

$$\frac{2\text{ mol HCl}}{} \left| \frac{1\text{ mol } NH_4Cl}{1\text{ mol HCl}} \right| \frac{53.4\text{ g } NH_4Cl}{1\text{ mol } NH_4Cl}$$

= 106.8 g NH_4Cl (or within a $\pm$ 4 g)

4. Volume of Remaining Gas: (Total of 5pts)

- +2 for identifying there were 2.29 moles of NH_3 remaining
- +1 for using PV = nRT in some form or fashion
- +1 for correct use of KELVIN and the correct R – basically correct math and substitution in general with the PV = nRT equation
- +1 for accurate answer <u>using the number of moles they chose to use!</u>

NOTE: A LOT of students will probably use a total of 4.29 moles because they are adding NH_3 and NH_4Cl. This is incorrect. The NH_4Cl is a solid and will not contribute to the final volume of gas. A common answer for volume using the 4.29 moles will be about **105 L**. **This answer will be worth only 4 points.**

Example of a 5pt answer:

(+2 pt) Remaining moles of NH_3: n_{NH3} = 4.29 moles – 2 moles = 2.29 moles

The moles of NH_4Cl made will not contribute to final volume because it is a solid.

(+1 pt) $PV = nRT$

$V = (nRT)/P$

(+1 pt) $V = (2.29\text{ mol})(0.08206\text{ Latmmol}^{-1}\text{K}^{-1})(298\text{K})/(1\text{atm})$

(+1 pt) **V= 56.3 L** (or within a $\pm$ 1.5 L)