Name: _____

Period: 1 2 3 4 5 6

# Chemistry Semester 2 Final Exam Review

***The following will be provided on your test:***

**Solutions/Concentration**

$$\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{liters of solution}}$$

$$\text{molality (m)} = \frac{\text{moles of solute}}{\text{kg of solvent}}$$

$$\text{ppm} = \frac{\text{mass of solute}}{\text{mass of solvent}} \times 10^6$$

$$\text{ppb} = \frac{\text{mass of solute}}{\text{mass of solvent}} \times 10^9$$

$\Delta T_f = m \times k_f \times df$

for water, $k_f = 1.86\ ^\circ\text{C/m}$

$\Delta T_b = m \times k_b \times df$

for water, $k_b = 0.52\ ^\circ\text{C/m}$

**Acids and Bases**

$pH = -\log [H^+]$

$[H^+] = 10^{-pH}$

$pOH = -\log [OH^-]$

$[OH^-] = 10^{-pOH}$

$pH + pOH = 14$

$\text{Molarity} = \frac{\text{moles}}{\text{liters}}$

| Anion Ending | Acid Name |
|---|---|
| *-ide* | *hydro-*(stem)*-ic acid* |
| *-ite* | (stem)*-ous acid* |
| *-ate* | (stem)*-ic acid* |

**Gases**

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

$P_1V_1 = P_2V_2$

$PV = nRT$

R= 0.0821 L*atm/mol*K

K = °C + 273

## Unit 5: Solutions

1. What is the molarity of a solution in which 3.6 moles of iron (III) nitrate are dissolved in 1.8 L of solution?

$M = \frac{3.6\ \text{mol}}{1.8\ \text{L}} = \boxed{2.0\ \text{M}}$

2. What is the molarity of a solution in which 14.7 grams of barium chloride ($BaCl_2$) are dissolved in 5.0 L of solution?

*convert to moles:

$\frac{14.7\ \text{g } BaCl_2}{x\ \text{moles}} = \frac{208.23\ \text{g}}{1\ \text{mol}}$ $\quad x = 0.0706\ \text{mol}$

$M = \frac{0.0706\ \text{mol}}{5.0\ \text{L}} = \boxed{0.014\ \text{M}}$

3. How many moles of magnesium carbonate are needed to prepare 4.50 L of a 0.500 M solution?

$0.500\ \text{M} = \frac{x\ \text{moles}}{4.50\ \text{L}}$ $\quad \boxed{x = 2.25\ \text{mol}}$

4. How many grams of sodium oxide are needed to prepare 1.00 L of a 1.7 M solution?

$1.7\ \text{M} = \frac{x\ \text{moles}}{1.00\ \text{L}}$ $\quad x = 1.7\ \text{moles}$

*convert to grams:

$\frac{x\ \text{grams}}{1.7\ \text{moles}} = \frac{61.98\ \text{g } Na_2O}{1\ \text{mol}}$

$\boxed{x = 105\ \text{g } Na_2O}$

5. What volume of solution should be added to 0.75 moles of copper (I) chloride to prepare a 5.0 M solution?

$5.0\ M = \frac{0.75\ mol}{x\ L} \rightarrow \frac{5x}{5} = \frac{0.75}{5} \rightarrow \boxed{x = 0.15\ L}$

6. Which of the five solutions in problems 1-5 is the most **concentrated**? Why?

#5 CuCl with molarity of 5.0 M; highest molarity

7. Determine the appropriate label/units for the following:
   a. Molarity: M (capital "M")
   b. Molality: m (lowercase "m")
   c. Molar mass: g/mol
   d. Moles: mol

8. A solution of lead (II) sulfate ($PbSO_4$) contains 0.897 g of lead sulfate in 100.0 g of water.
   a. What is this concentration in ppm?

$ppm = \frac{0.897\ g}{100.0\ g} \times 10^6 = 8970\ ppm$

   b. What is this concentration in ppb?

$ppb = \frac{0.897\ g}{100.0\ g} \times 10^9 = 8{,}970{,}000\ ppb$

9. The solubility of KCl is 187 grams/100 grams of water.
   a. What is this concentration in ppm?

$ppm = \frac{187\ g}{100\ g} \times 10^6 = 1{,}870{,}000\ ppm$

   b. What is this concentration in ppb?

$ppb = \frac{187\ g}{100\ g} \times 10^9 = 1{,}870{,}000{,}000\ ppb$

10. Calculate the molality of a solution that contains 8.0 grams of barium sulfate and 5 kg of water.

$\frac{8.0\ g\ BaSO_4}{x\ moles} = \frac{233.43\ g}{1\ mol} \rightarrow x = 0.034\ moles \qquad m = \frac{0.034\ moles}{5\ kg} = \boxed{0.007\ m}$

11. What is the volume of a solution that has a molality of 1.2 m and contains 3.2 grams of sodium chloride?

$\frac{3.2\ g\ NaCl}{x\ moles} = \frac{58.44\ g}{1\ mol} \rightarrow x = 0.055\ moles \qquad 1.2\ m = \frac{0.055\ mol}{x\ L}$

$\boxed{x = 0.046\ L}$

12. Determine the dissociation factor for the following compounds:
   a. $CO_2$ 1 (covalent!)
   b. $Na_2SO_4$ 3 ($SO_4$ is polyatomic)
   c. $Mg(OH)_2$ 3 (OH is polyatomic)
   d. $Ba(C_2H_3O_2)_2$ 3 ($C_2H_3O_2$ is polyatomic)

13. Calculate the molality of a solution that contains 85.2 grams of zinc iodide in 650 grams of water.

$\frac{85.2\ g\ ZnI_2}{x\ moles} = \frac{319.22\ g}{1\ mol} \rightarrow x = 0.267\ moles \qquad m = \frac{0.267\ moles}{0.650\ kg}$

$= \boxed{0.411\ m}$

14. What is the freezing point of a 0.62 m solution of iron (III) nitrate? $Fe(NO_3)_3$

$\Delta T_f = m \times k_f \times df$

$\Delta T_f = (0.62\ m) \times (1.86) \times (4) = 4.6$

$T_f = 0°C - 4.6°C = \boxed{-4.6°C}$

15. What is the boiling point of a solution of 12.5 g of calcium hydroxide dissolved in 4,500 g of water? $Ca(OH)_2$

$\frac{12.5\ g}{x\ moles} = \frac{74.093\ g}{1\ mol}$

$x = 0.169\ mol$

$m = \frac{0.169\ mol}{4.5\ kg} = 0.037\ m$

$\Delta T_b = (0.037\ m)(0.52)(3) = 0.058°C$

$T_b = 100°C + 0.058°C = \boxed{100.058°C}$

16. What is the freezing point of a solution of 65.8 g of copper (II) chloride in 1 kg of water? $CuCl_2$

$\frac{65.8\ g}{x\ moles} = \frac{134.45\ g}{1\ mol}$

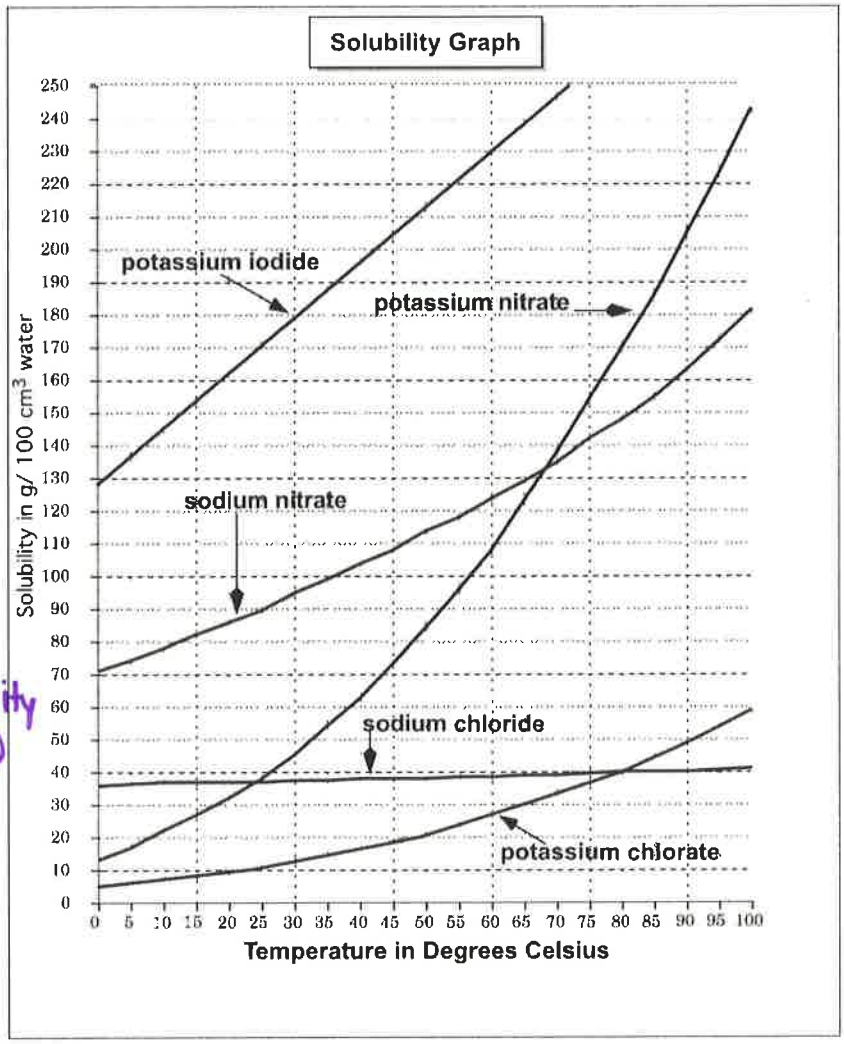
$x = 0.489\ mol$

$m = \frac{0.489\ mol}{1\ kg} = 0.489\ m$

$\Delta T_f = (0.489\ m)(1.86)(3) = 2.73°C$

$T_f = 0°C - 2.73°C = \boxed{-2.73°C}$

**Use the solubility graph below to answer questions 17-21:**




17. Which of the substances is the least soluble in water at 90°C?

sodium chloride

18. What is the solubility of sodium nitrate at 30°C?

95 g/100 g $H_2O$

19. A saturated solution of potassium nitrate is formed from 100 g of water. If the saturated solution is cooled from 80°C to 50°C, how many grams of precipitate are formed?

170 g − 85 g = 85 g

20. At 30°C, 90 g of potassium iodide is dissolved in 100 g of water. Is this solution saturated, unsaturated, or supersaturated?

unsaturated (the solubility at 30°C is 180 g/100 g $H_2O$)

21. At 40°C, how much potassium nitrate can be dissolved in 500 g of water?

solubility at 40°C: 65 g/100 g $H_2O$

$\frac{65\ g}{100\ g\ H_2O} = \frac{x}{500\ g\ H_2O}$

$\boxed{x = 325\ g}$

## Unit 6: Acids and Bases

22. What color results with red litmus paper in acid?

red

23. Milk has a pH of 6.4. Is milk an acid, a base, or neither one?

acid (pH < 7)

24. Name the following compounds and circle whether it is an acid, a base, or neither.

a. $Ca(OH)_2$ calcium hydroxide — acid/(base)/neither

b. HBr hydrobromic acid — (acid)/base/neither

c. $H_3PO_4$ phosphoric acid — (acid)/base/neither

d. $H_3P$ hydrophosphoric acid — (acid)/base/neither

e. $CoCl_2$ cobalt chloride — acid/base/(neither)

f. $Sr(OH)_2$ strontium hydroxide — acid/(base)/neither

g. HF hydrofluoric acid — (acid)/base/neither

h. $ZnSO_4$ zinc sulfate — acid/base/(neither)

i. HOH water — (acid/base/neither) ~both!

25. Write the formulas of the following compounds and circle whether it is an acid, a base, or neither.

a. Carbon dioxide $CO_2$ — acid/base/(neither)

b. Chlorous acid $HClO_2$ — (acid)/base/neither

c. Sodium oxide $Na_2O$ — acid/base/(neither)

d. Sulfuric acid $H_2SO_4$ — (acid)/base/neither

e. Barium hydroxide $Ba(OH)_2$ — acid/(base)/neither

f. Lead (IV) sulfide $PbS_2$ — acid/base/(neither)

g. Sulfurous acid $H_2SO_3$ — (acid)/base/neither

h. Magnesium chloride $MgCl_2$ — acid/base/(neither)

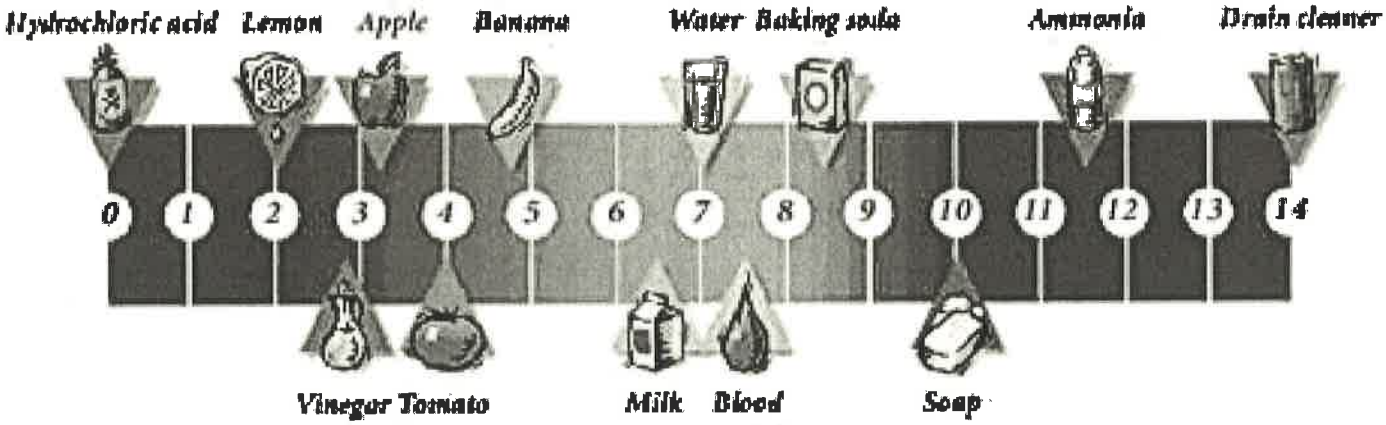
26. What is the definition of an indicator?

chemical/solution that changes color depending on the pH

27. You create an indicator solution using purple cabbage. The original solution color is pale purple. You observe that under acidic conditions, the indicator changes from pale purple to light pink. You also observe that under basic conditions, the indicator solution changes from pale purple to pale green. Complete the table below to reflect these observations:

| | | Indicator solution color in... | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Original Solution Color** | **pH = 1** | **pH = 3** | **pH = 5** | **pH = 7** | **pH = 9** | **pH = 11** | **pH = 13** |
| **Indicator Solution:** purple cabbage | pale purple | pale purple | pale purple | light pink | light pink | pale green | pale green | pale green |

# The pH Scale




28. Order the following from most basic (1) to least basic (4):

highest pH

4 vinegar
1 ammonia
2 water
3 milk

29. As $[H^+]$ increases, what happens to the pH?

pH value decreases

30. Calculate the pH of the following solutions and determine whether the solution is acidic, basic, or neutral:

a. $[H^+] = 5.8 \times 10^{-8}$ acidic/basic/neutral

$pH = -\log(5.8 \times 10^{-8}) = 7.2$

b. $[OH^-] = 1.0 \times 10^{-7}$ acidic/basic/neutral

$pOH = -\log(1.0 \times 10^{-7}) = 7 \quad pH = 14 - 7 = 7$

31. Calculate the $[H^+]$ of the following solutions and determine whether the solution is acidic, basic, or neutral:

a. pH = 2.5 acidic/basic/neutral

$[H^+] = 10^{-2.5} = 0.0032\ M$

b. pOH = 6.8 acidic/basic/neutral

$pH = 14 - 6.8 = 7.2$

$[H^+] = 10^{-7.2} = 6.3 \times 10^{-8}\ M$

32. Calculate the pOH of the following solutions and determine whether the solution is acidic, basic, or neutral:

a. $[H^+] = 3.1 \times 10^{-4}$ acidic/basic/neutral

$pH = -\log(3.1 \times 10^{-4}) = 3.5$ so $pOH = 14 - 3.5 = \boxed{10.5}$

b. $[OH^-] = 9.8 \times 10^{-2}$ acidic/basic/neutral

$pOH = -\log(9.8 \times 10^{-2}) = \boxed{1.0}$ $(pH = 14 - 1 = 13)$

33. Calculate the $[OH^-]$ of the following solutions and determine whether the solution is acidic, basic, or neutral:

a. pH = 11.6 acidic/basic/neutral

$pOH = 14 - 11.6 = 2.4$ $[OH^-] = 10^{-2.4} = \boxed{0.0040\ M}$

b. pOH = 8.7 acidic/basic/neutral

$[OH^-] = 10^{-8.7} = 2.0 \times 10^{-9}\ M$

34. Finish the following neutralization reaction and write the names of all compounds:

$H_2CO_3$ + $Al(OH)_3$ → $Al_2(CO_3)_3$ + $H_2O$

carbonic acid; aluminum hydroxide; aluminum carbonate; water

35. Write the complete balanced neutralization reaction for the reaction of nitric acid and calcium hydroxide.

$2HNO_3 + Ca(OH)_2 \rightarrow Ca(NO_3)_2 + 2H_2O$

36. A 25 mL solution of $H_2CO_3$ is completely neutralized by 15 mL of 1.25 M LiOH. What is the molarity of the $H_2CO_3$ solution?

x1/2

| | | | | |
|---|---|---|---|---|
| Moles | 0.009375 mol | 0.01875 mol | | |
| Molarity (M) | 0.375 M | 1.25 M | | |
| Liters (L) | 0.025 L | 0.015 L | | |

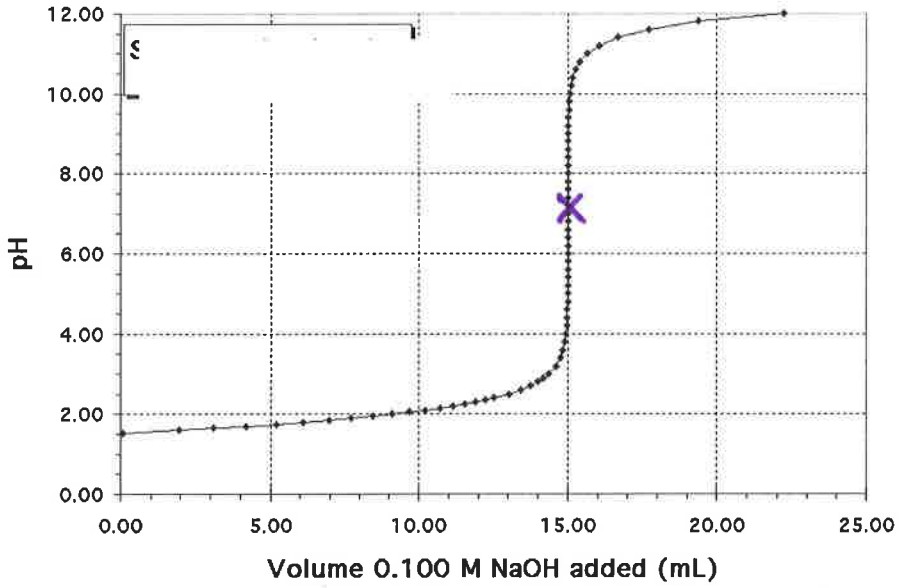
*BALANCE: ___$H_2CO_3$ + 2 LiOH → ___$Li_2CO_3$ + 2 $H_2O$

37. A 65 mL solution of $HNO_3$ is completely neutralized by 19 mL of 1.5 M $Mg(OH)_2$. What is the molarity of the $HNO_3$ solution? x2/1

| | | | | |
|---|---|---|---|---|
| Moles | 0.057 mol | 0.0285 mol | | |
| Molarity (M) | 0.88 M | 1.5 M | | |
| Liters (L) | 0.065 L | 0.019 L | | |

*BALANCE: $\underline{2}\ HNO_3 + \underline{\quad}\ Mg(OH)_2 \rightarrow \underline{\quad}\ Mg(NO_3)_2 + \underline{2}\ H_2O$

38. 50.00 mL of $HNO_3$ was titrated with 0.100 M NaOH and the graph below was created.
    a. On the graph, draw an X at the equivalence point.
    b. How many mL of NaOH were added at the equivalence point? 15.00 mL




    c. What is the molarity of the $HNO_3$?

| | | | | |
|---|---|---|---|---|
| Moles | 0.0015 mol | 0.0015 mol | | |
| Molarity (M) | 0.030 M | 0.100 M | | |
| Liters (L) | 0.050 L | 0.015 L | | |

$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$

balanced!

## Unit 7: Gases

39. What **two** properties of gases does Charles' Law relate?

volume & temp

40. What **two** properties of gases are held constant in Charles' Law?

pressure & # of particles/moles

41. According to Charles' Law, as temperature increases, volume ___increases___.
We call this relationship between temperature and volume a (direct / inverse ) relationship.

42. If I have 21 liters of helium in a balloon at 29°C and increase the temperature of the balloon to 48°C, what will the new volume of the balloon be? **SHOW YOUR WORK AND LABEL ALL YOUR UNITS!**

$\frac{V_1}{T_1} = \frac{V_2}{T_2} \rightarrow \frac{21\ L}{302\ K} = \frac{V_2}{321\ K} \rightarrow \boxed{V_2 = 22.3\ L}$

43. The temperature in a 100 mL container is 140 K. That volume is compressed to 15 mL, what is the new temperature? **SHOW YOUR WORK AND LABEL ALL YOUR UNITS!**

$\frac{V_1}{T_1} = \frac{V_2}{T_2} \rightarrow \frac{100\ mL}{140\ K} = \frac{15\ mL}{T_2} \rightarrow \boxed{T_2 = 21\ K}$

44. What **two** properties of gases does Boyle's Law relate?

pressure & volume

45. What **two** properties of gases are held constant in Boyle's Law?

temp & # of particles/moles

46. According to Boyle's Law, as pressure increases, volume ___decreases___. We call this relationship between pressure and volume a ( direct / inverse ) relationship.

47. 3.8 L of a gas at standard temperature and pressure (1 atm) is compressed to 756 mL. What is the new pressure of the gas? **SHOW YOUR WORK AND LABEL ALL YOUR UNITS!**

$P_1V_1 = P_2V_2 \rightarrow (1\ atm)(3.8\ L) = P_2(0.756\ L)$

$\boxed{P_2 = 5\ atm}$

48. If a gas at 19.0°C occupies 4.8 liters at a pressure of 1.00 atm, what will be its volume at a pressure of 2.50 atm? **SHOW YOUR WORK AND LABEL ALL YOUR UNITS!**

$P_1V_1 = P_2V_2 \rightarrow (1.00\ atm)(4.8\ L) = (2.50\ atm)V_2$

$\boxed{V_2 = 1.92\ L}$

49. What **two** properties of gases does Gay-Lussac's Law relate?

pressure & temp

50. What **two** properties of gases are held constant in Gay-Lussac's Law?

volume & # of particles/moles

51. According to Gay-Lussac's Law, as temperature increases, pressure ___increases___.
We call this relationship between pressure and temperature a/an ( direct / inverse ) relationship.

52. A gas system has an initial temperature of 416 K with the pressure unknown. When the temperature changes to 1390 K the pressure is found to be 11.2 atm. What was the initial pressure in atm? **SHOW YOUR WORK AND LABEL ALL YOUR UNITS!**

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \rightarrow \frac{P_1}{416\,K} = \frac{11.2\,atm}{1390\,K} \rightarrow P_1 = 3.35\,atm$$

53. A gas system has initial pressure and temperature of 5.0 atm and 21.9°C If the pressure changes to 3.74 atm, what will the resultant temperature be in K? **SHOW YOUR WORK AND LABEL ALL YOUR UNITS!**

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \rightarrow \frac{5.0\,atm}{294.9\,K} = \frac{3.74\,atm}{T_2} \rightarrow T_2 = 221\,K$$

54. What 4 properties of gases does the Ideal Gas Law relate?

pressure, volume, temp, number of moles

55. If I have a 50 liter container that holds 45 moles of gas at a temperature of 200°C, what is the pressure inside the container? **SHOW YOUR WORK AND LABEL ALL YOUR UNITS!**

$PV = nRT$

$P(50\,L) = (45\,mol)(0.0821\,L\cdot atm/mol\cdot K)(473\,K)$

$P = 35\,atm$

56. How many moles of gas does it take to occupy 85 liters at a pressure of 0.87 atmospheres and a temperature of 340 K? **SHOW YOUR WORK AND LABEL ALL YOUR UNITS!**

$PV = nRT$

$(0.87\,atm)(85\,L) = n(0.0821\,L\cdot atm/mol\cdot K)(340\,K)$

$n = 2.6\,moles$

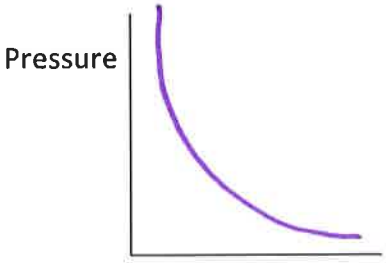
57. I have a balloon that can hold 100 liters of air. If I blow up this balloon with 3 moles of oxygen at a pressure of 1.00 atm, what is the temperature of the balloon? **SHOW YOUR WORK AND LABEL ALL YOUR UNITS!**

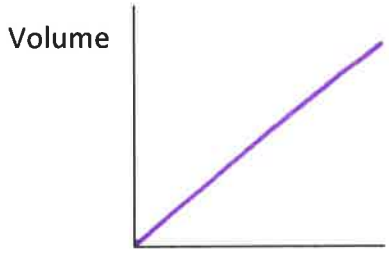
$PV = nRT$

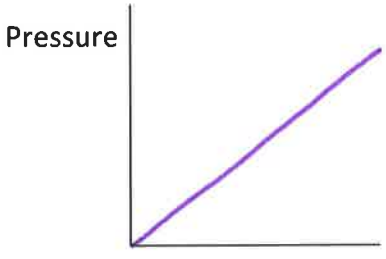
$(1.00\,atm)(100\,L) = (3\,mol)(0.0821\,L\cdot atm/mol\cdot K)T$

$T = 406\,K$

58. Look at the variables on the axes of the graphs below. Draw a line that represents the correct relationship between the variables and identify what variables are being held constant.




*Constants:*
temp.
# of moles

*Constants:*
pressure
# of moles

*Constants:*
volume
# of moles