Problem Set 4 Chem 115 Summer 2014 for Exam 4

Specific heat of ice = 2.09 J/g·ºC Specific heat of water = 4.18 J/g·ºC Specific heat of steam = 2.03 J/g·ºC Heat of fusion of water = 334 J/g Heat of vaporization of water =2260 J/g

R=0.0821 L atm/mol K=62.4 L torr/mol K

1. Explain why it is necessary to add air to a car’s tires during the winter?

The volume decreases when the temperature decreases. Since there is less volume at lower temperature you need to add air to keep the same volume of air in the tires.

1. The pressure of a sample of neon gas is 578 torr. What is the pressure in atmospheres?

$$?atm=578 torr×\frac{1 atm}{760 torr}=0.761 atm$$

1. A sample of nitrogen gas occupies a volume of 362 mL at 15oC. What is the volume of the nitrogen gas if the temperature is increased to 55oC?

$$\frac{V\_{1}}{T\_{1}}=\frac{V\_{2}}{T}\_{2}\rightarrow \rightarrow V\_{2}=V\_{1}\left(\frac{T\_{2}}{T\_{1}}\right)=362 mL\left(\frac{328 K}{288 K}\right)=$$

1. A 3.48 L sample of methane gas contains methane at 2.94 atm pressure and 25.0oC. What is the mass of the gas?

$$PV=nRT\rightarrow \rightarrow n=\frac{PV}{RT}=\frac{\left(2.94 atm\right)\left(3.48 L\right)mol K}{\left(0.0821 L atm\right)\left(298 K\right)}=$$

$$0.418 mol CH\_{4}×\frac{16.04 g CH\_{4}}{1 mol CH\_{4}}=6.71 g CH\_{4}$$

1. The atmosphere of a newly discovered planet is composed of nitrogen (364 mm Hg), methane gas (632 mm Hg), and bromine gas (499 mm Hg). What is the atmospheric pressure on this planet?

Total pressure = 364 mm Hg + 632 mm Hg + 499 mm Hg = 1495 mm Hg

1. Given the reaction 4 NH3(g) + 5 O2(g) 🡪 4 NO(g) + 6 H2O(g). How many L of water will be produced by the reaction of 16.8 L of ammonia (NH3) in excess oxygen at 25oC and 1.14 atm pressure?

$$?L H\_{2}O=16.8 L NH\_{3}×\frac{6 L H\_{2}O}{4 L NH\_{3}}=25.2 L H\_{2}O$$

1. An experiment shows that a 364 mL gas sample has a mass of 0.747 g at a pressure of 0.644 atm and a temperature of 37oC. What is the molar mass of the gas?

$$PV=nRT \rightarrow \rightarrow \frac{V}{n}=\frac{RT}{P}=\frac{\left(0.0821 L atm\right)\left(310 K\right)}{mol K \left(0.644 atm\right)}=\frac{39.5 L}{mol}$$

$$M=\frac{0.747 g}{0.364 L}×\frac{39.5 L}{mol}=81.1 g/mol$$

1. Classify these molecules as polar or nonpolar.

|  |  |  |
| --- | --- | --- |
| CCl4: nonpolar | H2O: polar | CO2: nonpolar |
| H2: nonpolar | HF: polar  | CH3Cl: polar |

1. The four major attractive forces between particles are ionic bonds, dipole-dipole attractions, hydrogen bonds, and dispersion forces.
	1. Classify each compound by its predominant attractive or intermolecular force among atoms or molecules of the same type.

|  |  |
| --- | --- |
| MgF2: ionic | HF: hydrogen bonding |
| HBr: dipole-dipole | N2: London dispersion |

* 1. Based upon the intermolecular forces present, rank the substances according to the expected viscosity for the substance from highest to lowest boiling point.

MgF2 > HF > HBr > N2

1. Classify each process as endothermic or exothermic.

|  |  |  |
| --- | --- | --- |
| Evaporation: endothermic | Freezing: exothermic | Condensation: exothermic |
| Melting: endothermic | Sublimation: endothermic  |  |

1. Place the following substances in order of increasing vapor pressure at a given temperature (It may help to draw the Lewis structure of the molecules) . Explain your order (it may help to list all IMF’s of each molecule).

nitrogen trifluoride ammonia sulfur trioxide

NF3 NH3 SO3



London-dispersion London-dispersion London-dispersion

Dipole-dipole dipole-dipole

 Hydrogen bonding

So, in order of increasing vapor pressure: NH3 < NF3 < SO3

1. Explain why ethyl alcohol (C2H5OH) has a higher boiling point (78.40 C) than methyl alcohol (CH3OH; 64.70 C).

Both molecules contain one O-H bond, which means that they do the same amount of hydrogen bonding. However, ethyl alcohol is a larger molecule, which means that Van der Waals forces are stronger in it, giving it a slightly higher boiling point.

1. Rank the following by from lowest to highest anticipated boiling point: C2H4, CH4, Ne, H3COCH3. Explain Answer

The highest is clearly H3COCH3, as it’s the only polar molecule. The three lowest all experience Van der Waals forces, meaning that the biggest one will have the highest boiling point.

 Overall, the ranking is Ne (-246.10 C) < CH4 (-161.50 C) < C2H2 (-103.70 C) < H3COCH3 (-23.70 C).

1. How much energy is needed to heat a 35.5g sample of ice at -17.5ºC to liquid water at 77.3ºC?

q-17.5→0 = (35.5 g)(2.09 J/g•°C)(17.5 °C) = 1,298 J = 1.30 kJ

qmelting = (35.5 g)(344 J/g•°C) = 11,857 J = 11.9 kJ

q0→77.3 = (35.5 g)(4.18 J/g•°C)(77.3 °C) = 11,471 J = 11.5 kJ

qtotal = 24.7 kJ

1. How much energy is needed to heat a 68.9g sample of water at 88.5ºC to steam at 103.7ºC?

q88.5→100 = (68.9 g)( 4.18 J/g•°C)(11.5 °C) = 3312J = 3.31 kJ

qvaporization = (68.9 g)(2260 J/g)= 155,714 J = 155 kJ

q100→103.7 = (68.9 g)(2.03 J/g•°C)(3.7 °C) = 518 J = .518 kJ

qtotal = 159 kJ

1. A solution is prepared by dissolving 83.45 grams of potassium bicarbonate (KHCO3) in 524.6 grams of water Calculate the mass percent potassium bicarbonate in the solution.

$$?\% KHCO\_{3}=\left(\frac{mass KHCO\_{3} }{mass solution}\right)×100\%=\left(\frac{83.45 g KHCO\_{3}}{\left(524.6+83.45\right) g soln}\right)×100\%=\left(\frac{83.45 g KHCO\_{3}}{608.1 g soln}\right)×100\%=$$

1. Calculate the molarity of a solution prepared by dissolving 53.2 grams of Li2SO4(109.94 g/mol) in enough water to make 450.0 mL of solution.

$$?M Li\_{2}SO\_{4}=\frac{mol Li\_{2}SO\_{4} }{L soln}=\frac{53.2 g Li\_{2}SO\_{4}×\frac{1 mol Li\_{2}SO\_{4}}{109.94 g Li\_{2}SO\_{4}}}{0.4500 L soln}=\frac{0.484 mol Li\_{2}SO\_{4}}{0.4500 L soln}=1.08 M Li\_{2}SO\_{4}$$

1. Calculate the number of grams of silver nitrate required to prepare 250.0 mL of a 0.3714 M solution AgNO3.

$$?g AgNO\_{3}=250.0 mL soln×\frac{0.3714 mol AgNO\_{3}}{1000 mL soln}×\frac{169.9 g AgNO\_{3}}{1 mol AgNO\_{3}}=$$

1. What volume of 3.523 M CaCl2(110.98 g/mol) is required to prepare 750.0 mL of 0.8442 M CaCl2?

$$M\_{1}V\_{1}=M\_{2}V\_{2}\rightarrow \rightarrow V\_{2}=V\_{1}\left(\frac{M\_{1}}{M\_{2}}\right)=750.0 mL\left(\frac{0.8442 M}{3.523 M}\right)=179.7 mL$$

1. Given the reaction

2 K3PO4(aq) + 3 Ni(NO3)2(aq) 🡪 Ni3(PO4)2(s) + 6 KNO3(aq)

* 1. How many mL of a 4.235 M solution of nickel(II) nitrate are required to react with 0.1800 mol of potassium phosphate?

$$?mL Ni\left(NO\_{3}\right)\_{2}=0.1800 mol K\_{3}PO\_{4}×\frac{3 mol Ni\left(NO\_{3}\right)\_{2}}{2 mol K\_{3}PO\_{4} }×\frac{1000 mL soln}{4.235 mol Ni\left(NO\_{3}\right)\_{2}}=63.75 mL$$

* 1. How many grams of nickel(II) phosphate (366.0 g/mol) will be produced by the reaction of 38.95 mL of 4.235 M nickel(II) nitrate with excess potassium nitrate?

$$?g Ni\_{3}\left(PO\_{4}\right)\_{2}=38.95 mL soln×\frac{4.235 mol Ni\left(NO\_{3}\right)\_{2}}{1000 mL soln}×\frac{1 mol Ni\_{3}\left(PO\_{4}\right)\_{2}}{3 mol Ni\left(NO\_{3}\right)\_{2}}×\frac{366.0 g Ni\_{3}\left(PO\_{4}\right)\_{2}}{1 mol Ni\_{3}\left(PO\_{4}\right)\_{2}}=20.12 g Ni\_{3}\left(PO\_{4}\right)\_{2}$$

1. The solubility of carbon dioxide in water at 3.5 atm is 0.12 M. Calculate the solubility of carbon dioxide in water at a pressure of 7.2 atm.

$$\frac{S\_{1}}{P\_{1}}=\frac{S\_{2}}{P\_{2}} \rightarrow S\_{2}=S\_{1}\left(\frac{P\_{2}}{P\_{1}}\right)=0.12 M\left(\frac{7.2 atm}{3.5 atm}\right)=0.25 M$$