1

A) Which of the following mixtures will form a precipitate:

A) A $BaSO_4$ precipitate will form
B) A K_2CO_3 precipitate will form
C) It is soluble, it won't form a precipitate
D) A K_2CO_3 precipitate will form
E) It is soluble, it won't form a precipitate
F) A K_2CO_3 precipitate will form
G) A $CaCO_3$ precipitate will form
H) It is soluble, it won't form a precipitate

B) For those in (a) that form a precipitate, write a full balanced equation for each

A) $BaCl_2 + K_2SO_4 \rightarrow BaSO_4 + 2KCl$
B) $2KCl + Na_2CO_3 \rightarrow K_2CO_3 + 2NaCl$
D) $2KOH + Na_2CO_3 \rightarrow K_2CO_3 + 2NaOH$
F) $Na_2CO_3 + 2KOH \rightarrow 2NaOH + K_2CO_3$
G) $Na_2CO_3 + CaCl_2 \rightarrow 2NaCl + CaCO_3$

2

A) Which of the following phrases: **ionic**, **polar and covalent**, **non-polar and covalent**, would describe the bonding between the following pairs of atoms.
   a) Na and O Ionic
   b) Cl and Cl Non-polar and covalent
   c) H and F Polar and covalent
   d) H and C Polar and covalent

B) With respect to intermolecular forces, explain why water is a liquid over a wide range of temperatures (0 – 100 °C).

Water has a higher boiling point and melting point because it forms hydrogens bonds. These occur when an H atom is bonded to a small strongly electronegative atom with lone pairs of electrons, in this case oxygen atoms. The hydrogens bonds are not very strong individually but collectively you need a lot of energy to break these sums of bonds.

3

A) Calculate the **molality** of a solution that contains 0.4 moles of naphthalene (i = 1), $C_{10}H_8$, in 500 mL of carbon tetrachloride. The density of CCl_4 is 1.60 g/mL.

Hint: you can work out mass of CCl_4 from the density. Remember what molality means.

M = $\frac{Wb}{Mb} \times \left(\frac{1000}{Wa\ (KG)}\right) = \frac{51.2g \times 1000}{128g * mol^{-1} \times 0.8kg} = 500\ mol * Kg^{-1} = \mathbf{500m}$

0.4 mol $\frac{128\ g}{1\ mol} = 51.2g$ Wb

500 mL $\frac{1.6g}{1\ mL} = 800\ g = 0.8\ kg$ Wa

B) How many microliters will there be in one pint of water?

One pint is equivalent to 473.18 mL. 473.18 mL = **47318000 microliters**.

4

A) Which response includes only those compounds that can exhibit hydrogen bonding in the following list? CH_4, AsH_3, CH_3NH_2, H_2Te, HF

Only (d) CH_3NH_2, HF. Because hydrogen bonding occurs when an H atom is bonded to a small strongly electronegative atom with lone pairs of electrons (F, O and N).

B) Which molecule would have the strongest tendency to form hydrogen bonds with other identical molecules?

(A) NH_3

5

A) Which of the Gas Laws does the following graph represent

The *Volume-Amount* Law. This law gives the relationship between volume and amount when pressure and temperature are held constant.

B) Why do metals conduct electricity?

The metal atoms who are ionized by the loss of their valence electrons, have become cations. They form an ordered and compact three-dimensional network that creates an electronic field of attraction. In this way, the valence electrons surround the cationic lattice and can travel freely within the lattice.

6

Butane has a boiling point of -1 °C and octane has a boiling point of 125 °C. Explain this in terms of intermolecular forces.

Hint: what intermolecular forces are important and how do they work in this case

In this case the most important molecular forces are dispersion forces. That is because they are non-polar covalent molecules. The longer the molecules are, the stronger attractions they have, and more energy is needed to break their bonds.

7

A) What is the freezing point of an aqueous 1.00 m NaCl solution? (K_f = 1.86 °C/m)

▲ Tf= Kf * i * m

▲ Tf = 1.86*2*1= 3.72 °C

Freezing point (H_2O)= O °C

Freezing point total = **3.72 °C**

B) Ion–dipole forces always require

b. an ion and a polar molecule.

8

A) Calculate the boiling point (in °C) of a solution of 285 g of magnesium chloride ($MgCl_2$) in 2.0 kg of water (K_b = 0.52 °C/m)

285g $MgCl_2$ $\frac{1\ mol}{95.21\ g\ MgCl2} = 2.99\ mol$

Molality (m) = $\frac{2.99\ moles}{2\ Kg} = 1.5\ moles * Kg^{-1}$

5 Tb= Kb * i * m

5 Tb= 0.52*3*1.5= **2.34 °C**

B) Put these intermolecular forces in decreasing order of strength.

Ionic> di-pole ion > di-pole di-pole >London

9

Explain why adding sodium chloride to water will raise its boiling point to above 100 °C

In a solution, part of the surface is filled by solute molecules. These molecules are not very likely to leave but to return to the solution. A high level of energy is needed to boil the solution, making the boiling point higher than just the pure solvent.

10

A) A gas at 40.0°C occupies a volume of 2.32L. If the temperature is raised to 75.0°C, what will the new volume be if the pressure is constant?

Following Charles' Law: $V_1 / T_1 = V_2 / T_2$

$V_2 = (V_1 * T_2) / T_1$

75°C $\frac{2.32L}{40°C} = \mathbf{4.35L}$

B) At 1.70 atm, a sample of gas takes up 4.25L. If the pressure in the gas is increased to 2.40 atm, what will the new volume be?

Following Boyle's law, $P_1V_1 = P_2V_2$

$V_2 = (V_1 * P_2) / P_1$

2.40 atm $\frac{4.25L}{1.7\ atm} = 6\ L$