Exam 4

# Part 1: Multiple Choice (2 points each)

## Directions: Please circle the *best* answer for each of the following questions.

1. Which of the following statements are correct?
	1. There is a long-range order in a crystalline solid.
	2. Graphite is an example of an amorphous solid.
	3. Glass, rubber, and plastic are examples of crystalline solids.
	4. Particles in an amorphous solid are arranged in a distinct geometric order.
	5. In a crystalline solid the particles can move past the closet neighboring particles.
2. Compared to a substance with induced dipole forces, a substance with hydrogen bonds generally has:
	1. a higher normal boiling point and vapor pressure, but a lower heat of vaporization.
	2. a lower normal boiling point, but higher vapor pressure and heat of vaporization.
	3. a higher heat of vaporization but lower normal boiling point and vapor pressure.
	4. a lower normal boiling point and heat of vaporization, but higher vapor pressure.
	5. a lower vapor pressure, but higher normal boiling point and heat of vaporization.
3. Consider the open-ended manometer shown below. In this apparatus the arm on the right is open to the atmosphere and feels the full effect of atmospheric pressure. The pressure in the chemistry lab at the time of this experiment is 755 mm Hg. The flask contains O2, N2 and Ne.

Which of the following correctly applies to this apparatus?

* 1. $p\_{O\_{2}}+p\_{N\_{2}}+p\_{Ne}=244 mm Hg$
	2. $p\_{O\_{2}}+p\_{N\_{2}}+p\_{Ne}=999 mm Hg$
	3. $p\_{O\_{2}}+p\_{N\_{2}}+p\_{Ne}=755 mm Hg$
	4. $p\_{O\_{2}}+p\_{N\_{2}}+p\_{Ne}=511 mm Hg$
	5. $p\_{O\_{2}}+p\_{N\_{2}}+p\_{Ne}=760 mm Hg$
1. Given the following relative acid strengths, starting with the weakest: HCO3- < HNO3 < HBr, what is the relative strength of each conjugate base, starting with the weakest?
	1. CO32- < NO3‑ < Br-
	2. Br- < CO32- < NO3-
	3. NO3- < Br- < CO32-
	4. Br- < NO3- < CO32-
	5. CO32- < Br- < NO3-
2. Which of the following properties is traditionally associated with Arrhenius bases?
	1. They cause blue litmus paper to turn red.
	2. They form precipitates with solutions of most metals.
	3. They react with carbonates to release carbon dioxide.
	4. They release hydrogen when zinc is added.
	5. They contain hydronium ions.
3. The graph below represents a temperature versus energy plot for a pure substance.

Identify the point(s) (i) where both liquid and gas exist and (ii) is associated with the heat of condensation

* 1. (i) 1 (ii) 5 and 6
	2. (i) 2 and 3 (ii) 5 and 6
	3. (i) 4 (ii) 5 and 6
	4. (i) 5 and 6 (ii) 5 and 6
	5. (i) 7 (ii) 3 and 3
1. Which of the following solutions is most acidic?
	1. [H+] = 1 × 10-4 M
	2. [H+] = 1 × 10-14 M
	3. [OH-] = 1 × 10-3 M
	4. pH = 10
	5. pOH = 12
2. Stirring a solution into a solution increases the net dissolving rate (reduces the dissolving time to reach equilibrium) because the
	1. dissolving rate remains constant while the crystallization rate is reduced.
	2. dissolving rate remains constant while the crystallization rate is reduced.
	3. dissolving rate is increased while the crystallization rate is reduced.
	4. dissolving rate is increased while the crystallization rate remains constant.
	5. dissolving rate is reduced while the crystallization rate remains constant.
3. When a saturated solution is in equilibrium with undissolved solute:
	1. the solution separates into layers.
	2. dissolving and crystallization stop.
	3. the concentration of the solution remains constant.
	4. the quantity of dissolved solute equals the quantity of undissolved solute.
	5. the temperature increases until more solute dissolves.



1. What is true about the picture?
	1. The equipment is a buret, Erlenmeyer flask, and ring stand.
	2. The equipment is a buret, Volumetric flask, and ring stand.
	3. The equipment is a pipet, Erlenmeyer flask, and ring stand.
	4. The equipment is a buret, Erlenmeyer flask, and hot plate.
	5. The equipment is a pipet, beaker, and hot plate.

# Part 2: Short Answer

## Directions: Answer each of the following questions. Be sure to use complete sentences where appropriate. For full credit be sure to show all of your work.

1. Which halogen, Cl2 or I2 has the higher boiling point? Explain your answer (4 points).

The molar mass of Cl2 is 70.90 g/mol, and the molar mass of I2 is 253.80 g/mol. Since I2 has the higher molar mass, it has stronger dispersion forces and therefore the higher boiling point.

1. One of these compounds is a liquid at room temperature: formaldehyde (CH2O), fluoromethane (CH3F), and hydrogen peroxide (H2O2). Which one and why (5 points)?

The three compounds have similar molar masses:

Formaldehyde 30.03 g/mol, fluoromethane 34.04 g/mol, and hydrogen peroxide 34.02 g/mol

Therefore, the strengths of their dispersion forces are similar. All three compounds are polar, so they have dipole-dipole forces. Hydrogen peroxide, however, is the only compound that contains Hs bonded directly to a N, O, or F. Therefore it has hydrogen bonding and it is most likely to have the highest boiling point of the three and thus the one that is a liquid at room temperature.

1. The solubility of potassium chloride at 20 °C is 34.0g/100 g H2O and at 50 °C is 42.6 g/100 g H2O. Determine whether adding 25.0 g potassium chloride, KCl, to 100 g H2O will produce a saturated or unsaturated solution at 20 °C (4 points).

$$\frac{25.0 g KCl}{100 g H\_{2}O}<\frac{34.0 g KCl}{100 g H\_{2}O}, therefore the solution is unsaturated at 20 °C.$$

1. The equilibrium vapor pressure of water at 24 °C is 22.4 torr. A sealed flask contains air at 24 °C and 764 torr and a glass vial filled with liquid water the vial is broken, allowing some of the water to evaporate. What is the maximum pressure this system can reach (4 points)?

$$P\_{total}=P\_{1}+P\_{2}=22.4 torr+764 torr=786.4 torr ≈786 torr $$

1. A 25.0 g piece of ice at 0.0 °C is added to a sample of water at 6.0 °C. All of the ice melts and the temperature of the water decreases to 0.0 °C. How many grams of water were in the sample? Cice = 2.06 J/g °C, cwater  = 4.184 J/g °C, ∆Hfus = 333 J/g (8 points).

qin = - qout

mice∆Hfus = - mwatercwater∆Twater

(25.0 g)(333 J/g) = - mwater(4.184 J/g °C)(0.0 °C – 6.0 °C)

**832**5 J = - mwater(4.184 J/g °C)(-6.0 °C)

**832**5 J = -mwater(-**25**.104 J/g)

**331**.6204589 g = mwater ≈ 332 g water

1. Silver nitrate, AgNO3, solutions are often used to plate silver onto other metals. What is the maximum amount of silver in grams that can be plated out of 4.8 L of a silver nitrate solution containing 3.4% Ag by mass? (Assume that the density of the solution is 1.01 g/mL) (6 points).

$$4.8 L AgNO\_{3} soln×\frac{1000 mL}{1 L}×\frac{1.01 g AgNO\_{3} soln }{1 mL AgNO\_{3} soln}×\frac{3.4 g Ag}{100 g AgNO\_{3} soln}=164.4832 g Ag ≈160 g Ag $$

1. Human tears have a concentration of H3O+ that is 3.16 × 10-8 M (4 points).
	1. The concentration of OH- is human tears is (greater/less/equal) to 3.16 × 10-8 M.
	2. Human tears are (acidic/basic/neutral).
2. Calculate the hydroxide ion concentration in a 20.00 mL sample of an unknown if 14.75 mL of 0.248 M sulfuric acid is used in a neutralization reaction (8 points).

2 OH- (aq) + H2SO 4 (aq) → 2 ­H­2O (l) + SO42- (aq)

$$14.75 mL H\_{2}SO\_{4} soln×\frac{0.248 mmol H\_{2}SO\_{4} }{1 mL H\_{2}SO\_{4} soln}×\frac{2 mmol OH^{-}}{1 mmol H\_{2}SO\_{4} }=\frac{7.316 mmol OH^{-}}{20.00 mL OH^{-} soln }=0.3658 M OH^{-}≈0.366 M OH^{-}$$

1. Complete the following table (12 points):

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| [H3O+] | [OH-] | pOH | pH | acidic or basic |
| **1.0 × 10-4 M** | 1.0 × 10-10 M  | 10.00 | 4.00 | Acidic |
| 5.5 × 10-3 M  | **1.8 × 10-12 M**  | 11.74 | 2.26 | Acidic |
| 3.1 × 10-9 M  | 3.2 × 10-6 M  | 8.50  | **5.50** | Acidic |

1. Consider the volumetric flask shown. The volume of the flask is 1.000 L. Nitric acid is commercially available at a concentration of 15.9 M. What volume of this solution must be diluted to in this flask to prepare a 4.00 M solution (5 points)?

$$M\_{1}V\_{1}=M\_{2}V\_{2}⇒V\_{2}=\frac{M\_{1}V\_{1}}{M\_{2}}=\frac{\left(4.00 M\right)(1.000 L)}{(15.9 M)}=0.251572327 L≈252 mL$$

Or

$$1.000 L\_{dilute}×\frac{4.00 mol}{1 L\_{dilute}}×\frac{1 L\_{concentrated}}{15.9 mol}=0.251572327 L≈252 mL$$

1. If 23.45 mL of a 0.2345 M sodium phosphate solution is added to 56.00 mL of a 0.5643 M potassium sulfide solution (16 points).
2. Write the balanced conventional, total, and net ionic equations.

2 Na3PO4­ (aq) + 3 K2S (aq) → 2 K3PO4 (aq) + 3 Na2S (aq)

6 Na+ (aq) + 2 PO43- (aq) + 6 K+ (aq) + 3 S2- (aq) → 6 K+ (aq) + 2 PO43- (aq) + 6 Na+ (aq) + 3 S2- (aq)

No net ionic reaction, all ions are spectator ions.

1. Identify the type of chemical reaction. \_\_\_\_double replacement reaction
2. What is the total volume of the resulting solution?

 Vtotal = 23.45 mL + 56.00 mL = 79.45 mL

1. What is the molarity of all of the ions that remain in the solution at the end of the reaction?

$$23.45 mL Na\_{3}PO\_{4} soln×\frac{0.2345 mmol Na\_{3}PO\_{4} }{1 mL Na\_{3}PO\_{4} soln}×\frac{3 mmol Na^{+}}{1 mmol Na\_{3}PO\_{4}}=\frac{16.50 mmol Cl^{-}}{79.45 mL}=0.2076 M Na^{+} $$

$23.45 mL Na\_{3}PO\_{4} soln×\frac{0.2345 mmol Na\_{3}PO\_{4} }{1 mL Na\_{3}PO\_{4} soln}×\frac{1 mmol PO\_{4}^{3-}}{1 mmol Na\_{3}PO\_{4}}=\frac{5.4990 mmol PO\_{4}^{3-}}{79.45 mL}=0.06921 M PO\_{4}^{3-} $

$$56.00 mL K\_{2}S soln×\frac{0.5643 mmol K\_{2}S }{1 mL K\_{2}S soln}×\frac{2 mmol K^{+}}{1 mmol K\_{2}S}=\frac{63.20 mmol K^{+}}{79.45 mL}=0.7955 M K^{+}$$

$$56.00 mL K\_{2}S soln×\frac{0.5643 mmol K\_{2}S }{1 mL K\_{2}S soln}×\frac{1 mmol S^{2-}}{1 mmol K\_{2}S}=\frac{31.60 mmol S^{2-}}{79.45 mL}=0.3978 M S^{2-}$$

1. Which of the following solutes do you expect to be more soluble in cyclohexane, C6H12, , than in water and why (4 points)?
	1. Methylamine 

water, because they can form hydrogen bonds.

* 1. Tetrafulormethane cyclohexane, because they are both nonpolar molecules