Exam 4

# Part 1: Multiple Choice (2 points each)

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

1. A substance that melts at 1022°C is probably...
2. A network solid
3. An ionic crystal
4. A metallic crystal
5. A molecular crystal
6. An amorphous solid
7. What is the term for the resistance of a liquid to spread out and form spherical drops with a minimum surface area?
	1. vapor pressure
	2. boiling point
	3. viscosity
	4. surface tension
	5. melting point
8. Which has the highest vapor pressure?
	1. 5 mL of water at 323 K
	2. 25 mL of water at 282 K
	3. 10 mL of water at 298 K
	4. 50 mL of water at 293 K
	5. 100 mL of water at 298 K
9. Which of the following compounds has the lowest boiling point?
10. CH3CH2OH
11. HOCH2CH2OH
12. H3COCH3
13. CH3CH2CH2CH3
14. all of the above
15. Identify the Lewis acid in the reaction: Cl- + AlCl3 🡪 AlCl4-
	1. Cl-
	2. AlCl3
	3. AlCl4-
	4. none of the above
	5. all of the above
16. Liquids which are capable of mixing and forming a solution are
	1. miscible.
	2. immiscible.
	3. unsaturated.
	4. dilute.
	5. concentrated.
17. Which of the following species is amphoteric?
	1. CO32-
	2. HF
	3. NH4+
	4. HPO42-
	5. none of the above
18. Which of the following is not a conjugate acid-base pair?
	1. NH4+/NH3
	2. H3O+/OH-
	3. H2SO3/HSO3-
	4. C2H3O2-/HC2H3O2
	5. all of the above
19. What is the molar concentration of hydroxide ion in a 0.10 M solution of calcium hydroxide?
	1. Close to zero since calcium hydroxide is insoluble.
	2. Between zero and 0.10 M since calcium hydroxide is a weak base.
	3. 0.10 M
	4. 0.20 M
	5. none of the above
20. What type of glassware is used to accurately and precisely deliver solutions?
21. Beaker
22. Volumetric pipet
23. Balance
24. Scoopula
25. Stirring rod

# 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. Are the following statements true or false (6 points)?

|  |  |  |
| --- | --- | --- |
|  | A saturated solution of solute A is always more concentrated than an unsaturated solution of solute B.  | False  |
|  | A finely divided solute dissolves faster because more surface area is exposed to the solvent.  | True  |
|  | All solubilities increase at higher temperature.  | False  |
|  | Increasing air pressure over water increases the solubility of nitrogen in the water.  | False  |
|  | An ionic solute is more likely to dissolve in a nonpolar solvent than in a polar solvent.  | False |
|  | The concentration of a secondary standard is found by titration generally.  | True |

|  |  |  |
| --- | --- | --- |
| Cyclohexane  | Tetrafluoromethane  | methylamine |

1. Which of the following solutes do you expect to be more soluble in water than in cyclohexane, C6H12 (4 points):
	1. Methylamine, CH3NH2 \_\_\_\_\_\_\_water\_\_\_\_\_\_\_\_\_\_\_\_
	2. Tetrafluoromethane, CF4 \_\_\_\_\_\_\_\_cyclohexane
2. Name the types of intermolecular forces for each molecule (4 points):
	1. ethanol, CH3CH2CH2OH London-dispersion forces, dipole forces, hydrogen bonding
	2. silicon dioxide, SiO2 London-dispersion forces
3. A mixture of nitrogen and xenon gases is maintained in a 6.30 L flask at a temperature of 53 °C. If the partial pressure of nitrogen is 0.276 atm and the partial pressure of xenon is 0.352 atm, what is the total pressure in the flask (4 points)?

$$P\_{total}=P\_{N\_{2}}+P\_{Xe}=0.276 atm+0.352 atm=0.628 atm$$

1. In the laboratory a student finds that it takes 27.6 joules to increase the temperature of 10.7 grams of gaseous xenon from 22.7 to 39.9 degrees Celsius (10 points).
	1. What is the measured specific heat of xenon?

$q=m c ∆T⟹c=\frac{q}{m ∆T}=\frac{27.6 J}{\left(10.7 g\right)(39.9 ℃-22.7℃)}=\frac{27.6 J}{\left(10.7 g\right)(17.2 ℃)}=0.150 \frac{J}{g ℃}$

* 1. If the actual specific heat of xenon is 0.158 J/g °C, what is the percent error?

$$\%error=\frac{experimental value-accepted value}{accepted value}×100\%$$

$$\%error=\frac{\left(0.150\frac{J}{g ℃}-0.158\frac{J}{g ℃}\right)}{0.158\frac{J}{g ℃}}×100\%=\frac{-0.008\frac{J}{g ℃}}{0.158\frac{J}{g ℃}}×100\%$$

$$\%error=-5.063291139\%≈-5\%$$

1. A 0.0250 L solution prepared by mixing 5.881 g of iron(II) phosphate with water (8 points).
	1. What is the molarity of the solution?

$\frac{5.881 g Fe\_{3}(PO\_{4})\_{2}}{0.0250 L soln}×\frac{1 mol Fe\_{3}(PO\_{4})\_{2}}{357.475 g Fe\_{3}(PO\_{4})\_{2}}=0.658 M Fe\_{3}(PO\_{4})\_{2}$

* 1. Inventory the ions in the solution.

$$\frac{0.6581 mol Fe\_{3}(PO\_{4})\_{2}}{1 L soln}×\frac{3 mol Fe^{2+}}{1 mol Fe\_{3}(PO\_{4})\_{2}}=1.97 M Fe^{2+}$$

$$ \frac{0.6581 mol Fe\_{2}(SO\_{4})\_{3}}{1 L soln}×\frac{2 mol PO\_{4}^{3-}}{1 mol Fe\_{3}(PO\_{4})\_{2} }=1.32 M PO\_{4}^{3-} $$

1. Aluminum reacts with hydrochloric acid according to the unbalanced reaction (6 points):

2 Al (s) + 6 HCl (aq) → 2 AlCl3 (aq) + 3 H2 (g)

How many milliliters of 1.50 M hydrochloric acid are required to react with 9.75 g of aluminum?

$$9.75 g Al×\frac{1 mol Al}{26.982 g Al}×\frac{6 mol HCl}{2 mol Al}×\frac{1 L HCl soln}{1.50 mol HCl}×\frac{1000 mL}{1 L}=723 mL HCl soln$$

1. You love the smell of jasmine and have bought a solution of methyl jasmonate, one of the compounds responsible for the characteristic odor of jasmine. If the solution is composed of a 0.5298 molar solution of methyl jasmonate in acetone, how many molecules of methyl jasmonate will you spread around the room if you spritz 0.414 mL of the solution into the air (6 points)?

$?molecule MJ=0.414 mL soln×\frac{0.5298 mol MJ}{1000 mL soln}×\frac{6.022×10^{23}molec MJ}{1 mol MJ}=1.32×10^{20}molec MJ$

1. A 0.115 L sample of an unknown nitric acid solution required 52.15 mL of a 0.200 M barium hydroxide for the indicator, phenolphthalein, to go from colorless to pink (14 points).
	1. What is the evidence of reaction? \_\_\_\_\_\_\_\_\_\_the indicator changed color
	2. Write the balanced conventional, total ionic, and net ionic equations.

2 HNO3 (aq) + Ba(OH)2 (aq) 🡪 2 H2O (l) + Ba(NO3)2 (aq)

2 H+ (aq) + 2 NO3- (aq) + Ba2+ (aq) + 2 OH- (aq) 🡪 2 H2O (l) + Ba2+ (aq) + 2 NO3- (aq)

H+ (aq) + OH- (aq) 🡪 H2O (l)

* 1. Identify the type of reaction as a combination reaction, a combustion reaction, a decomposition reaction, a single replacement reaction, a double replacement reaction, or an acid-base neutralization reaction.

Acid-base neutralization reaction

* 1. What was the concentration of the nitric acid solution?

$$52.15 mL Ba(OH)\_{2}×\frac{1 L}{1000 mL}×\frac{0.200 mol Ba(OH)\_{2} }{1 L Ba(OH)\_{2} soln }×\frac{2 mol HNO\_{3}}{1 mol Ba(OH)\_{2}}×\frac{1}{0.115 L HNO\_{3} soln}=0.181 M HNO\_{3}$$

1. Solution A has a pH of 4.5 and solution B has a pOH of 7.28 (8 points).
	1. Which solution is more acidic? \_\_\_\_\_\_A\_\_\_\_\_\_\_\_\_\_
	2. Complete the following table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | pH | pOH | [H3O+] | [OH-] |
| A | 4.5 | $$pH+pOH=14 $$$$pOH=14-pH$$$$pOH=14-4.5$$$$pOH=9.5$$ | $$\left[H\_{3}O^{+}\right]=10^{-pH}$$$$\left[H\_{3}O^{+}\right]=10^{-4.5}$$$$\left[H\_{3}O^{+}\right]=3×10^{-5} M$$ | $$K\_{w}=\left[H\_{3}O^{+}\right]\left[OH^{-}\right]$$$$\left[OH^{-}\right]=\frac{K\_{w}}{\left[H\_{3}O^{+}\right]}$$$$\left[OH^{-}\right]=\frac{1×10^{-14}}{3×10^{-5} M}$$$$\left[OH^{-}\right]=3×10^{-10} M$$ |
| B | $$pH=14-pOH$$$$=14-7.28$$$$=6.72$$ | 7.28 | $$\left[H\_{3}O^{+}\right]=10^{-pH}$$$$\left[H\_{3}O^{+}\right]=10^{-6.72}$$$$\left[H\_{3}O^{+}\right]=1.9×10^{-7} M$$ | $$\left[OH^{-}\right]=10^{-pOH}$$$$\left[OH^{-}\right]=10^{-7.28}$$$$\left[OH^{-}\right]=5.2×10^{-8} M$$ |

1. Complete the following table (10 points).

|  |  |  |  |
| --- | --- | --- | --- |
| Acid name | Acid formula | Weak or Strong? | Major species in aqueous solution |
| Hydrocyanic acid | HCN (aq) | Weak | HCNmolecules |
| Nitric acid | HNO3 (aq) | Strong | H+and NO3- ions |
| Phosphorous acid | H3PO3 (aq) | Weak | H3PO3 molecules  |