HW1 CHEM 2001 Summer 2008

NAME..... ANSWERS .....

WRITE DOWN ALL YOUR WORK!!!!

Part 1

1. A sample is taken for chemical analysis. Which of the following must be done before the sampling ? .....
   a) interpretation
   b) selection of analytical procedure
   c) elimination of interferents
   d) analysis

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2. What is SI unit for number of objects (amount of substance).....1 mole.....

3. List steps in chemical analysis.....
   1) FORMULATING THE QUESTION
   2) SELECTING ANALYTICAL PROCEDURE
   3) SAMPLING
   4) SAMPLE PREPARATION
   5) ANALYSIS
   6) REPORTING & INTERPRETATION
   7) DRAWING CONCLUSION/INTERPRETATION

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4. How many cubic centimeters are in one cubic meter.....
   $1m^3 = 1 \cdot m^3 \frac{(100cm)^3}{1m^3} = 10^6 cm^3$

5. What is the mass of 1cubic centimeter of a liquid that has density of 13.3g/cm^3.....
   $d = m/V$ $m = d \cdot V = 13.3 g/cm^3 \cdot 1 cm^3 = 13.3 g$

6. What is analyte.....
   ANALYTE IS THE COMPOUND YOU ARE ANALYZING OR LOOKING FOR (say theobromine or caffeine)

7. What is the formal concentration (expressed in M=mol/L) of NaCl when 32g are dissolved in water and diluted to 0.500L.....

$$M = F = \frac{\text{mole}}{\text{Volume}} = \frac{\text{mass } 32g / MM_{NaCl}}{\text{Volume} = 0.5L} = \frac{\frac{32 g}{59 g/mol}}{0.5 L} = 1.1 M = 1.1 \frac{\text{mole}}{\text{Liter}}$$

$M_1V_1 = M_2V_2$ for dilutions

$M_{new} = \frac{V_{new}}{V_{old}} \cdot M_{old} = \frac{50\ ppm}{200\ ppm} \cdot 300\ ppm = 75\ ppm$

8. What is the concentration in ppm of a solution prepared when a 50mL of 300ppm solution is diluted in 200mL of water.....

9. What is the concentration of hydrogen ions, $[H^+]$, in a solution that has pH 5.16 .....

$pH = -\log[H^+] \rightarrow [H^+] = 10^{-pH} = 10^{-5.16} = 6.9 \cdot 10^{-6}$

10. Describe how would you prepare 250mL of approximately 0.10M solution of NH_3 if you have a stock solution of concentrated NH_3 of 14.3 M

Calculation of the volume taken from stock solution:

$V_{add} = \frac{V_{new}}{M_{old}} M_{new} = \frac{0.250L \cdot 0.10M}{14.3\ M} = 1.75\ mL$

11. What is aliqout

A PORTION OF SAMPLE (AFTER PREPARATION)

12. What is standard

KNOWN QUANTITY OF PURE COMPOUND, SAME AS ANALYTE

13. What is blank titration, gravimetric titration, spectrophotometric titration?

BLANK TITRATION: A TITRATION OF SUBSTANCE WITHOUT ANALYTE/BLANK

GRAVIMETRIC -II-: MASS MEASUREMENT OF TITR. PRODUCT (OR REACTANT) NOT VOLUME

SPECTROPHOTOMETRIC -II-: SPECTROSOPIC METHODS ARE USED TO MONITOR CONCENTRATIONS DURING TITRATION

14. What is equivalence point what is end point of titration?

EQUIVALENCE POINT: WHEN the AMOUNTS OF TITRANT IS STOICIOMETRICLY EQUIVALE TO THE ANALY

15. What definitions of acid and bas you know (give two)? How do we call electron donor in Lewis definition?

1) BRONSTED LOWRY
2) LEWIS

ACID: definition BASE: definition

16. What method of analysis does your textbook suggest for the analysis of nitrogen?

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14 EQUIVALENCE POINT: WHEN THE AMOUNT OF TITRANT AND ANALYTE ARE STOICIOMETRICALLY EQUIVALENT

END POINT: WHEN YOU SEE THE END OF TITRATION (indicator color, pH point etc.)

PART 2

1. Find the products, identify their physical state (g, aq, s ..) and balance the reaction:

$2\ Na_3PO_4(aq) + 3\ Ba(NO_3)_2(aq) \rightarrow$ ..... $Ba_3(PO)_4(s)$ + ... $6\ NaNO_3(aq)$

If a solution containing 3.50g of Na_3PO_4 and another solution containing 6.40g of $Ba(NO_3)_2$ are mixed, how many grams of the produced Ba salt can be formed?

LIMITING REACTANT:

(1) $moles(Na_3PO_4) \rightarrow \frac{3.50\ g\ Na_3PO_4}{164\ g/mol\ Na_3PO_4} = 0.0213\ mol\ Na_3PO_4$

For that the equivalent is: $0.0213\ mol\ Na_3PO_4 \cdot \frac{Ba_3(PO_4)_2}{2\ Na_3PO_4} = 0.0107\ mol\ Ba_3(PO_4$

(2) $moles\ (Ba(NO_3)_2 = \frac{6.40\ g\ Ba(NO_3)_2}{261\ g/mol\ Ba(NO_3)_2} = 0.0245\ mol\ Ba_3(NO_3)_2$

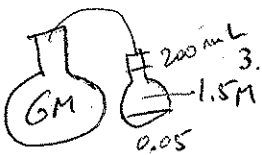
For that the equivalent is: $0.0245\ mol\ Ba(NO_3)_2 \frac{Ba_3(PO_4)_2\ mol}{Ba(NO_3)_2} = 0.00816\ mol$ LR

So: $mass_{Ba\text{-}Product} = mol_{L.R} \cdot MM_{Product} = 0.00816 \cdot 602 = 4.92\ g\ Ba_3(PO_4)_2$

2. How many grams of H_3PO_4 are in 175.0mL of a 3.5M solution of $H_3PO_4(aq)$?

$M = \frac{\frac{mass}{MM}}{V} \Rightarrow mass = M \cdot V \cdot MM = 3.5 \cdot 0.175 \cdot 98 =$

$= 60\ g$



3. What volume (mL) of a concentrated solution of LiOH (6.00M) must be diluted to 200mL , to make 1.5M solution of LiOH?

$M_1V_1 = M_2V_2$

DILUTION

$M_{conc} \cdot V_{conc} = V_{sol} \cdot M_{sol}$

$V_{conc} = \frac{M_{sol} V_{sol}}{M_{conc}} = \frac{1.5 \cdot 0.200}{6}$

$V_{sol} = 0.050\ L$

$\rightarrow HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$

4. In a titration process, what volume (in L) of 0.250M HNO_3 is required to neutralize (end point) a solution prepared by dissolving 17.5 g of NaOH in 350mL of water?

$$mol_{HNO_3} \cdot \frac{1\,mol\,NaOH}{1\,mol_{HNO_3}} = 1\,mol\,NaOH \qquad 1:1$$

$$mol\,NaOH = \frac{mass}{MM} = \frac{17.5\,g\,NaOH}{40\,g/mol\,NaOH} = 0.453\,mol\,NaOH$$

$$\equiv 0.435\,mol_{HNO_3} \equiv V_{HNO_3} \cdot M_{HNO_3}$$

$$V_{HNO_3} = \frac{0.435\,mol\,HNO_3}{0.250M\ HNO_3} = 1.75\,L$$

5. Calculate the pH of a buffer solution which has a concentration of 0.104M of the base NH_3 and 0.259M of the salt NH_4Cl. Kb = 1.8 10^{-5} for the base NH_3,

Buffer: $pH = pK_a + \log \frac{[A^-]\ \text{BASE}}{[HA]\ \text{ACID}}$

$$K_a = \frac{10^{-14}}{K_b} = 0.5 \cdot 10^{-9}$$

$$pH = -\log(0.555 \cdot 10^{-9}) + \log \frac{0.104}{0.259}$$

$$pH = 9.255 - 0.396266 = 8.8590$$

6. An aqueous solution of calcium hydroxide has a pH = 10.3 . What is the concentration of $Ca(OH)_2$?

$$Ca(OH)_2 \rightarrow 1\,mol\,Ca(OH)_2 \cdot \frac{2\,mol\,OH^-}{1\,mol\,(Ca(OH)_2)} \Rightarrow [OH^-]$$

$$pOH = 14 - pH = 14 - 10.3 = 3.7$$

$$\Rightarrow [OH^-] = 10^{-pOH} = 10^{-3.7} \Rightarrow [Ca(OH)_2] = \frac{[OH^-]}{2} = \frac{10^{-3.7}}{2}$$

$$= 9.98 \cdot 10^{-5}\,M\ [Ca(OH)_2]$$

(7) $HA + H_2O = H^+ + A^-$

(H_3O^+)

$$K_a = \frac{x^2}{[M-x]} = 4.9 \cdot 10^{-10}$$

$M = 0.08$

$$x = \sqrt{K_a \cdot M} = \sqrt{4.9 \cdot 10^{-10} \cdot 0.08} =$$

$$= \sqrt{0.392 \cdot 10^{-5}}\ M = 6.26 \cdot 10^{-6}$$

$x = [H^+]$

$$-\log x = -\log 6.26 \cdot 10^{-6} = 5.2$$

$$pH = 5.2$$

(Remy)

(8) $K_b = \frac{10^{-14}}{K_a = 1.8 \cdot 10^{-4}} = 0,555 \cdot 10^{-10}$

$N_1A + H_2O \rightarrow HA^{-} + OH^{-}$ BASIC Salt

$K_b = \frac{x^2}{M-x}$, $x = [OH^-]$, $M - x \approx M$

$\Rightarrow x = \sqrt{K_b \cdot M} = \sqrt{0,555 \cdot 10^{-10} \cdot 0,138} =$

$= 2,7687 \cdot 10^{-6} = [OH^-]$

$pOH = -\log [OH^-] = 5,557$

$pH = 14 - 5,56 = 8,44$

(* or close, depends on 5.55 in their calculations)

(9) $PbF_2 \longrightarrow Pb^{2+} + 2F^-$

$K_{sp} = 3.10^{-8}$ $\qquad x \quad + \quad 2x$

$K_{sp} = [x] \cdot [2x]^2 = 4x^3$

$K_{sp} = 3.10^{-8} = 4 \cdot x^3$

$x^3 = 0,9.10^{-8} = 9.10^{-9} = \sqrt[3]{9.10^{-3}} = 2.08.10^{-3}$

$[F^-] = 2x = 4,16.10^{-3}[M]$

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(10) $MF_{(aq)} \rightarrow H^+_{(aq)} + F^-_{(aq)}$ (W/Acid)

	x	x
	+ 0.10 from HCl	

$K_a = 6,8.10^{-4} = \dfrac{(0,10+x) \cdot x}{0,2-x} \approx \dfrac{0.10 \cdot x}{0,20}$

$x = \dfrac{0,2}{0,10} \cdot 6.8.10^{-4} = 1,4.10^{-3} M \; [F^-]$

$ph = -\log(0.1$
$= 1$

11. $H_2A \Rightarrow H-A-H$

DIPROTIC ACID

moles of H_2A to be neutralized (@ END POINT)

$= M \cdot V = 1.345\,M \cdot 0.05903\,L = 0.07940\,mol\ H_2A$

mol OH^- (NaOH) $= \#\,mol\ H_2A \cdot \frac{2\,mol\ OH^-}{1\,mol\ H_2A} = 2 \cdot 0.07940\,mol$

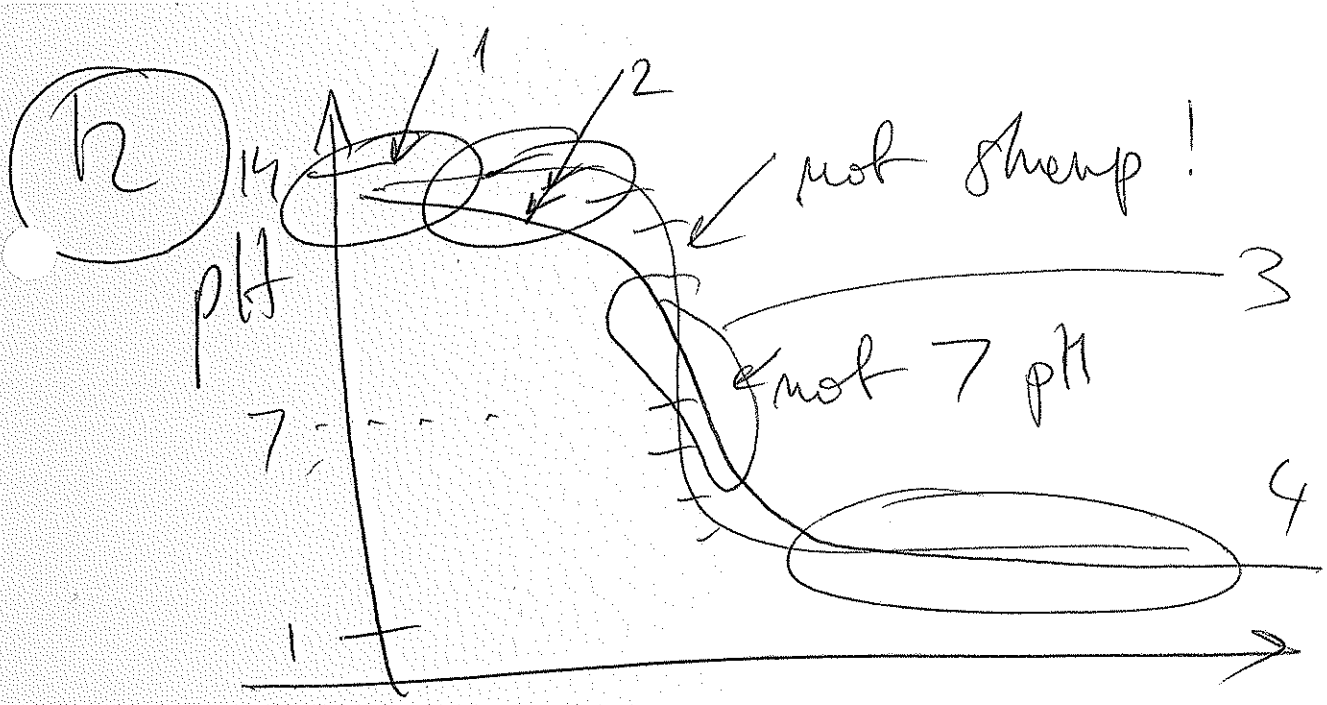
mol OH^- (NaOH) $= 0.15880\,mol\ OH^-$

mol NaOH $=$ # mol $OH^- = 0.15880 = M_{NaOH} \cdot V_{NaOH}$

$$V_{NaOH} = \frac{0.15880\,mol}{0.2054\,M} = 0.773\,L\ NaOH$$

$$= 773\,mL\ NaOH$$

(12)



1. single component only needs base
2. buffer region
3. END POINT
4. excess acid