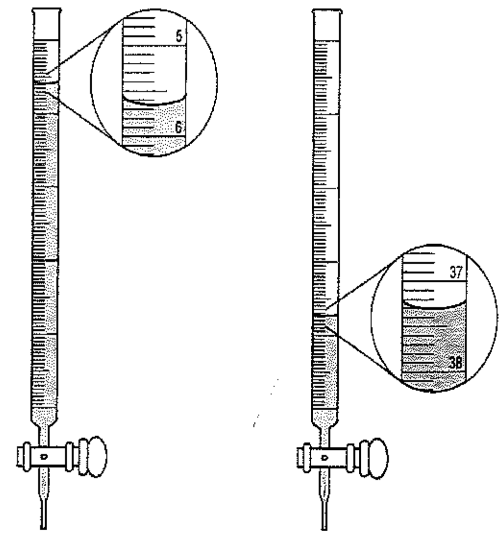
**Unit 3 Test Sample FRQs** **Name** Key

A student is given a 25.0 mL sample of a solution of an unknown monoprotic acid and asked to determine the concentration of the acid by titration. The student uses a standardized solution of 0.110 *M* NaOH(*aq*), a buret, a flask, an appropriate indicator, and other laboratory equipment necessary for the titration.
2016 7




a) The images show the buret before the titration begins (left) and at the end point (right). What should the student record as the volume of NaOH(*aq*) delivered to the flask? *(1pt)*

37.30 mL
5.65 mL
31.65 mL

b) Based on the given information and your answer to part (a), determine the value of the concentration of the acid that should be recorded in the student's lab report. *(1pt)*

$$31.65\text{ mL NaOH} \times \frac{0.110\text{ mol NaOH}}{1000\text{ mL}} \times \frac{1\text{ mol HA}}{1\text{ mol NaOH}} = \frac{0.034815\text{ mol HA}}{0.0250\text{ L}} = 0.139\text{ M HA}$$

$$25.0\text{ mL} \times \frac{1\text{ L}}{1000\text{ mL}}$$

c) In a second trial, the student accidentally added more NaOH(*aq*) to the flask than was needed to reach the end point, and then recorded the final volume. Would this error increase, decrease, or have no effect on the calculated acid concentration for the second trial? Justify your answer. *(2pts)*

The error would increase the calculated acid concentration since a larger volume of NaOH used would lead to an increased calculated moles of acid in solution and thus increased MM.

Answer the following questions that relate to laboratory observations and procedures. 2005 #5c

c) Each of three beakers contains a 0.1 *M* solution of one of the following solutes: potassium chloride, silver nitrate, or sodium sulfide. The three beakers are labeled randomly as solution 1, solution 2, and solution 3. Shown here is a partially completed table of observations made of the results of combining small amounts of different pairs of the solutions.

| | Solution 1 ($AgNO_3$) | Solution 2 ($Na_2S$) | Solution 3 (KCl) |
|---|---|---|---|
| Solution 1 ($AgNO_3$) | | black precipitate ($Ag_2S$) | |
| Solution 2 ($Na_2S$) | | | no reaction |
| Solution 3 (KCl) | ppt | | |

(i) Write the chemical formula of the black precipitate. *(1pt)*

$Ag_2S$

(ii) Describe the expected results of mixing solution 1 with solution 3. *(1pt)* precipitate forms

$KCl + AgNO_3 \rightarrow AgCl\downarrow + KNO_{3(aq)}$

(iii) Identify each of the solutions 1, 2, and 3. *(1pt)*

1) $AgNO_3$ 2) $Na_2S$ 3) KCl

A 75.0 mL sample of 0.250M $MgCl_2$ is added to 225.0 mL of 0.0550M $AgC_2H_3O_2$ solution. Answer the following questions about this reaction. (molar mass of silver chloride = 143.32 g/mol)

a) Write the net ionic equation for the reaction that occurs. *(2pts)*

$$MgCl_2(aq) + 2AgC_2H_3O_2(aq) \longrightarrow 2AgCl(s) + Mg(C_2H_3O_2)_2(aq)$$

$$\cancel{2}Cl^-(aq) + \cancel{2}Ag^+(aq) \rightarrow \cancel{2}AgCl(s)$$

b) Calculate the mass of the precipitate produced by this reaction. *(4pts)*

ER $$75.0\,mL\ MgCl_2 \times \frac{0.250\,mol\ MgCl_2}{1000\,mL} \times \frac{2\,mol\ AgCl}{1\,mol\ MgCl_2} \times \frac{143.32\,g\ AgCl}{1\,mol} = 5.37\ AgCl$$

↓ ↓

LR $$225.0\,mL\ AgAc \times \frac{0.0550\,mol\ AgAc}{1000\,mL} \times \frac{2\,mol\ AgCl}{2\,mol\ AgAc} \times \frac{\quad}{\quad} = 1.77\,g\ AgCl$$

c) Determine the molarity of each ion present in *solution* at the end of the reaction. $225.0 + 75.0 = 300.0\,mL$ Soln

i) Identify the ions in the solution at the end of the reaction *(1pt)*

$Mg^{+2}$, $C_2H_3O_2^-$ ← spectators $Cl^-$ (due to excess $MgCl_2$) $\boxed{Ag^+ \text{ all used}}$

ii) Find the molarity of each spectator ion first *(6pts)* mol/L

$Mg^{+2}$ $$\frac{75.0\,mL\,(MgCl_2)}{0.3000\,L\ soln} \times \frac{0.250\,mol\ MgCl_2}{1000\,mL} \times \frac{1\,mol\ Mg^{+2}}{1\,mol\ MgCl_2} = 0.0625\ M\ Mg^{+2}$$

or find mol then ÷ L soln

$C_2H_3O_2^-$ $$\frac{225.0\,mL\,(AgAc)}{0.3000\,L\ soln} \times \frac{0.0550\,mol\ AgAc}{1000\,mL} \times \frac{1\,mol\ C_2H_3O_2^-}{1\,mol\ AgAc} = 0.0413\,M\ C_2H_3O_2^-$$

iii) One ion was not completely used in the reaction – find the "leftover" moles to determine its molarity *(6pts)*

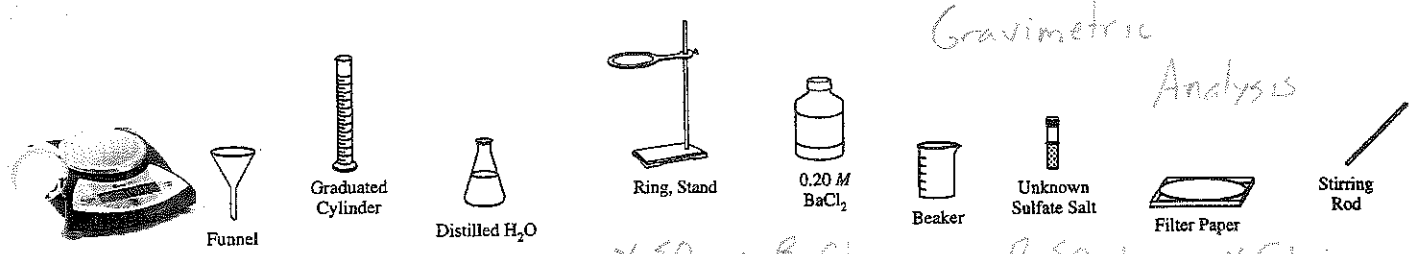
mol ($Cl^-$ used) $$225.0\,mL\ AgAc \times \frac{0.0550\,mol\ AgAc}{1000\,mL} \times \frac{1\,mol\ MgCl_2}{2\,mol\ AgAc} \times \frac{2\,mol\ Cl^-}{1\,mol\ MgCl_2} = 0.012375\ mol\ Cl^-$$

mol ($Cl^-$ at start) $$75.0\,mL\ MgCl_2 \times \frac{0.250\,mol\ MgCl_2}{1000\,mL} \times \frac{2\,mol\ Cl^-}{1\,mol\ MgCl_2} = 0.0375\,mol\ Cl^-$$

amt left over
$$\begin{array}{r} 0.0375\,mol \\ -0.012375\,mol \\ \hline 0.025125\,mol\ Cl^- \end{array}$$

conc $$\frac{0.0251\,mol\ Cl^-}{0.3000\,L} = 0.0837\,M$$

Gravimetric Analysis




balance

$X SO_4 + BaCl_2 \rightarrow BaSO_4\downarrow + XCl$

An experiment is to be performed to determine the mass percent of sulfate in an unknown soluble sulfate salt. The equipment shown above is available for the experiment. A drying oven is also available. 1997

a) Briefly list/describe the steps needed to carry out this experiment. (4pts)

① Weigh 1-3g of unknown sulfate salt in zeroed/tared beaker
② Dissolve salt in Dist $H_2O$
③ add $BaCl_2$ soln until no more precip forms (excess?)
④ mass filter paper, filter precip using filter paper, funnel + ringstand
rinse out all precip from beaker, wash precip w/more dist $H_2O$ - Check filtrate w/ drop of $BaCl_2$
⑤ remove filter paper w/ precip + dry to constant mass in oven
⑥ find mass of paper + precip

b) List the experimental data to be collected to calculate the mass percent of sulfate in the unknown. (2pts)

mass of unknown sulfate salt
mass of filter paper
mass of filter paper + precip

c) List the calculations necessary to determine the mass percent of sulfate in the unknown. (3pts)

(Subtraction for mass of unk? - if not in tared beaker) molar mass $BaSO_4$

mass of precip = paper + precip − paper

mass of $SO_4^{-2}$ in precip ($BaSO_4$)

$g\,BaSO_4 \times \frac{1\,mol}{g} \times \frac{1\,SO_4^{-2}}{1\,BaSO_4} \times \frac{g\,SO_4^{-2}}{1\,mol\,SO_4^{-2}}$

or % $SO_4^{-2}$ in $BaSO_4$ = 41.68 0.416 × mass precip

$\% SO_4^{-2} = \frac{\text{mass } SO_4^{-2} \text{ in precip}}{\text{mass unknown}} \times 100$

d) Would 0.20-molar $MgCl_2$ be an acceptable substitute for the $BaCl_2$ solution provided for this experiment? Explain. (1pt)

No a precip would not form since $MgSO_4$ is soluble

Sulfates — soluble except Ca, Ba, Sr

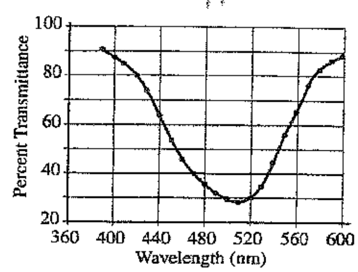
A student is instructed to determine the concentration of a solution of $CoCl_2$ based on absorption of light (spectrometric/colorimetric method). The student is provided with a 0.10 *M* solution of $CoCl_2$ with which to prepare standard solutions with concentrations of 0.020 *M*, 0.040 *M*, 0.060 *M*, and 0.080 *M*. **2003 #5**

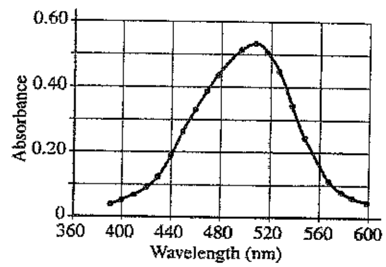
a) Describe the procedure for diluting the 0.10 *M* solution to a concentration of 0.020 *M* using distilled water, a 100 mL volumetric flask, and a pipet or buret. Include specific amounts where appropriate.

$M_1V_1 = M_2V_2$ $\quad V_1 = \frac{(0.020\,M)(100\,mL)}{0.10\,M} = 20.\,mL$

Use a pipet or buret to dispense 20. mL of 0.10 M $CoCl_2$ into the 100 mL volumetric flask then add dist water to reach the 100 mL mark on the flask. Stopper + mix.

The student takes the 0.10 *M* solution and determines the percent transmittance and the absorbance at various wavelengths. The two graphs represent the data.

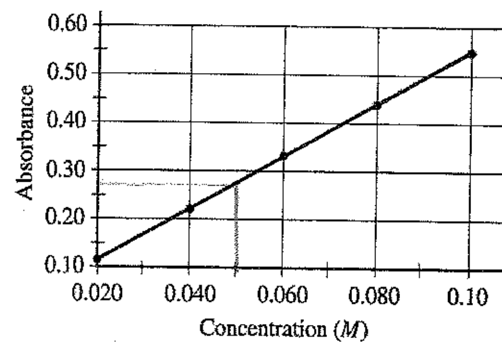



b) Identify the optimum wavelength for the analysis.

510 (nm) 490 - 520

The student measures the absorbance of the 0.020 *M*, 0.040 *M*, 0.060 *M*, 0.080 *M*, and 0.10 *M* solutions. The data are plotted in the graph.




c) The absorbance of the unknown solution is 0.275. What is the concentration of the solution?

0.050 M 0.045 - 0.055

d) Beer's Law is an expression that includes three factors that determine the amount of light that passes through a solution. Identify two of these factors.

$A = abc$

a = molar absorptivity constant

b = path length of cuvette

c = concentration

e) The student handles the sample container (e.g., test tube or cuvette) that holds the unknown solution and leaves fingerprints in the path of the light beam. How will this affect the calculated concentration of the unknown? Explain your answer.

Finger prints block/scatter light so less light the reading of absorbance will increase leading to higher than expected concentration

f) Why is this method of determining the concentration of $CoCl_2$ solution appropriate, whereas using the same method for measuring the concentration of NaCl solution would not be appropriate?

NaCl dissolved in water is clear $Na^+$ ions do not absorb energy in the visible spectrum whereas $Co^{+2}$ does (red color) excess $\quad X + 2HCl \rightarrow H_2 + XCl_2$

A 0.2726g sample of an unknown metal "X" was reacted with 50.00mL of 0.5000M HCl. After all the metal had reacted, the left-over acid was titrated with 0.1054M $Ba(OH)_2$. If 12.18 mL of 0.1054M $Ba(OH)_2$ was required to neutralize the leftover acid, determine the identity of the metal. The metal forms the $X^{2+}$ ion upon reaction with HCl. *(12pts)*

a) write net ionic equation for the titration reaction

$$2HCl + Ba(OH)_2 \rightarrow BaCl_2 + 2H_2O$$

$$H^+ + OH^- \rightarrow H_2O$$

$$2H^+ + 2Cl^- + Ba^{2+} + 2OH^- \rightarrow Ba^{+2} + 2Cl^- + 2H_2O$$

b) determine moles HCl leftover

$$12.18\,mL\ Ba(OH)_2 \times \frac{0.1054\,mol\ Ba(OH)_2}{1000\,mL} \times \frac{2\,mol\ HCl}{1\,mol\ Ba(OH)_2} = 0.002568\,mol\ HCl$$

c) find moles of HCl originally available

$$50.00\,mL\ HCl \times \frac{0.5000\,mol\ HCl}{1000\,mL} = 0.02500\,mol\ HCl$$

d) find moles of HCl used

$$\begin{array}{r} 0.02500\,mol \\ -\ 0.002568\,mol \\ \hline 0.022432\,mol\ HCl \end{array}$$

e) write equation for reaction of metal "X" with HCl $\quad X^{+2}$

$$X + 2HCl \rightarrow XCl_2 + H_2$$

f) determine molar mass of "X" and identify the metal

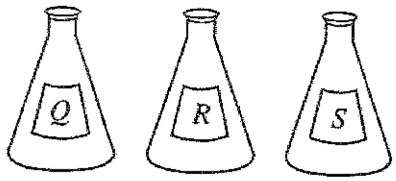
$$0.022432\,mol\ HCl \times \frac{1\,mol\ X}{2\,mol\ HCl} = 0.01122\,mol\ X$$

$$\frac{0.2726\,g\ X}{0.01122\,mol} = 24.30\,g/mol \rightarrow \text{Magnesium}$$

In a laboratory class, a student is given three flasks that are labeled *Q*, *R*, and *S*. Each flask contains one of the following solutions: 1.0 *M* $Pb(NO_3)_2$, 1.0 *M* NaCl, or 1.0 *M* $K_2CO_3$. The student is also given two flasks that are labeled *X* and *Y*. One of these flasks contains 1.0 *M* $AgNO_3$, and the other contains 1.0 *M* $BaCl_2$. This information is summarized in the diagram below. 2004 #5

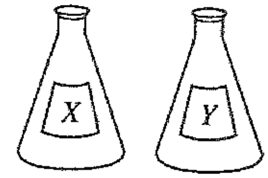
Each flask contains one of the following solutions:

$Pb(NO_3)_2$
NaCl
$K_2CO_3$




Each flask contains one of the following solutions:

$AgNO_3$
$BaCl_2$




a) When the student combined a sample of solution *Q* with a sample of solution *X*, a precipitate formed. A precipitate also formed when samples of solutions *Q* and *Y* were combined.

(i) Identify solution *Q*. *(1pt)*

$K_2CO_3$

Q X
$K_2CO_3 + AgNO_3 \rightarrow Ag_2CO_3 \downarrow$

(ii) Write the chemical formulas for each of the two precipitates. *(1pt)*

$Ag_2CO_3$ $BaCO_3$

Q Y
$K_2CO_3 + BaCl_2 \rightarrow BaCO_3 \downarrow$

b) When solution *Q* is mixed with solution *R*, a precipitate forms. However, no precipitate forms when solution *Q* is mixed with solution *S*.

(i) Identify solution *R* and solution *S*. *(1pt)*

$R = Pb(NO_3)_2$ $S =$ NaCl

Q R
$K_2CO_3 + Pb(NO_3)_2 \rightarrow PbCO_3$

(ii) Write the chemical formula of the precipitate that forms when solution *Q* is mixed with solution *R*. *(1pt)*

$PbCO_3$

c) The identity of solution *X* and solution *Y* are to be determined using only the following solutions: 1.0 *M* $Pb(NO_3)_2$, 1.0 *M* NaCl, and 1.0 *M* $K_2CO_3$.

$AgNO_3$ $BaCl_2$

(i) Describe a procedure to identify solution *X* and solution *Y*. *(1pt)*

add NaCl to each the one that produces a white precip is $AgNO_3$

or add $Pb(NO_3)_2$ to each the one that produces a white precip is $BaCl_2$

(ii) Describe the observations that would allow you to distinguish between solution *X* and solution *Y*. *(1pt)*

$NaCl + AgNO_3 \rightarrow AgCl \downarrow$ white, No ppt w/ $BaCl_2$

or $Pb(NO_3)_2 + BaCl_2 \rightarrow PbCl_2 \downarrow$ white, No ppt w/ $AgNO_3$

(iii) Explain how the observations would enable you to distinguish between solution *X* and solution *Y*. *(1pt)*

With each test when you add either NaCl or $Pb(NO_3)_2$ only one ppt rxn will occur

(unlike adding $K_2CO_3$ which would for ppts w/ both)

Three pure, solid compounds labeled *X*, *Y*, and *Z* are placed on a lab bench with the objective of identifying each one. It is known that the compounds (listed in random order) are KCl , $Na_2CO_3$ , and $MgSO_4$ . A student performs several tests on the compounds; the results are summarized in the table below. 2006 #5 ☆

| Compound | pH of an Aqueous Solution of the Compound | Result of Adding 1.0 *M* NaOH to a Solution of the Compound | Result of Adding 1.0 *M* HCl Dropwise to the Solid Compound |
|---|---|---|---|
| *X* | $Na_2CO_3$ > 7 | No observed reaction | Evolution of a gas $CO_2$ |
| *Y* | KCl 7 | No observed reaction | No observed reaction |
| *Z* | $MgSO_4$ 7 | $Mg(OH)_2$ Forms white precipitate | No observed reaction |

a) Identify each compound based on the observations recorded in the table. *(2pts)*

Compound *X* $Na_2CO_3$

Compound *Y* KCl

Compound *Z* $MgSO_4$

b) Write the chemical formula for the precipitate produced when 1.0 *M* NaOH is added to a solution of compound *Z*. *(2pts)*

$$NaOH + MgSO_4 \rightarrow \boxed{MgSO_4 \downarrow} + Na_2SO_4\,(aq)$$

c) Explain why an aqueous solution of compound *X* has a pH value greater than 7. Write an equation as part of your explanation. *(2pts)*

☆ $$CO_3^{-2}(aq) + \overset{H(OH)}{H_2O(l)} \rightarrow HCO_3^-(aq) + OH^-(aq)$$

d) One of the testing solutions used was 1.0 *M* NaOH. Describe the steps for preparing 100. mL of 1.0 *M* NaOH from a stock solution of 3.0 *M* NaOH using a 50 mL buret, a 100 mL volumetric flask, distilled water, and a small dropper. *(2pts)*

$$M_1V_1 = M_2V_2 \qquad V_2 = \frac{(1.0M)(100\,mL)}{(3.0M)} = 33\,mL \text{ of } 3.0M\ NaOH$$

1) Fill buret w/ 3.0 M NaOH transfer 33mL to 100mL volumetric
2) add dist $H_2O$ to below neck of flask → swirl to mix
3) add more dist $H_2O$ to just below calibration line use dropper until meniscus is level w/ calibration line insert stopper invert flask + mix

e) Describe a simple laboratory test that you could use to distinguish between $Na_2CO_3(s)$ and $CaCO_3(s)$. In your description, specify how the results of the test would enable you to determine which compound was $Na_2CO_3(s)$ and which compound was $CaCO_3(s)$. *(2pts)*

- water solubility $Na_2CO_3$ would be soluble and $CaCO_3$ is insoluble
- flame test yellow-orange is $Na^+$ red-orange is $Ca^{+2}$

A 0.150 g sample of solid lead(II) nitrate is added to 125 mL of 0.100 *M* sodium iodide solution. Assume no change in volume of the solution. The chemical reaction that takes place is represented by the following equation. 2008B 3

$$Pb(NO_3)_2(s) + 2\,NaI(aq) \rightarrow PbI_2(s) + 2\,NaNO_3(aq)$$

a) List an appropriate observation that provides evidence of a chemical reaction between the two compounds. *(1pt)*

a precipitate forms with an appearance that is different from that of the solid dissolving

b) Calculate the number of moles of each reactant. *(2pts)* $4.53 \times 10^{-4}$

$Pb$ 207.2
$N$ $2 \times 14.01$
$O$ $6 \times 16.00$
331.22 g

$$0.150\,g\ Pb(NO_3)_2 \times \frac{1\,mol\ Pb(NO_3)_2}{331.22\,g} = 0.000453\,mol\ Pb(NO_3)_2$$

$$125\,mL\ NaI \times \frac{0.100\,mol\ NaI}{1000\,mL} = 0.0125\,mol\ NaI$$

c) Identify the limiting reactant. Show calculations to support your identification. *(2pts)*

$$LR\ \ 0.000453\,mol\ Pb(NO_3)_2 \times \frac{1\,mol\ PbI_2}{1\,mol\ Pb(NO_3)_2} = 0.000453\,mol$$

$$0.01025\,mol\ NaI \times \frac{1\,mol\ PbI_2}{2\,mol\ NaI} = 0.005125\,mol$$

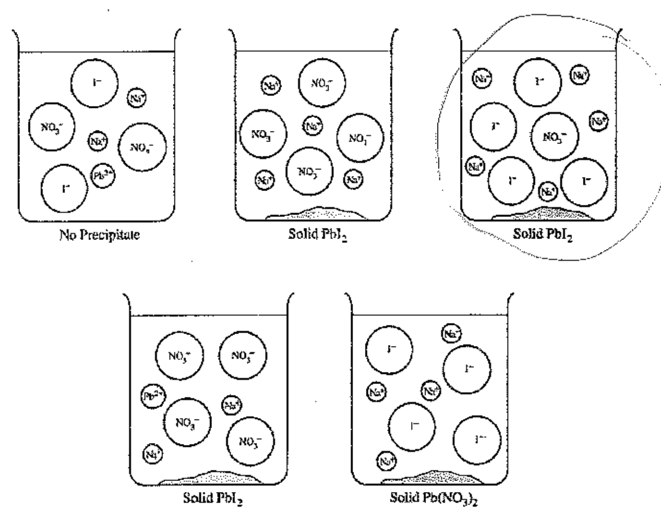
need 1 $Pb(NO_3)_2$ for 2 NaI

d) Calculate the molar concentration of $NO_3^-(aq)$ in the mixture after the reaction is complete. *(2pts)*

$$[NO_3^{-1}] = \frac{2(0.000453\,mol)}{0.125\,L} = 0.00725\,M$$

from 2 $NaNO_3$

e) Circle the diagram that best represents the results after the mixture reacts as completely as possible.
Explain the reasoning used in making your choice. *(2pts)*




$PbI_2$ precipitates and $Pb(NO_3)_2$ is the LR so there is essentially no $Pb^{+2}$ in solution. Since NaI is in excess $Na^+$ and $I^-$ remain in solution with $NO_3^-$ (other spectator ion)

$$2\ Al(s) + 2\ KOH(aq) + 4\ H_2SO_4(aq) + 22\ H_2O(l) \rightarrow 2\ KAl(SO_4)_2 \cdot 2H_2O(s) + 3\ H_2(g)$$ 2005 B 5

In an experiment, a student synthesizes alum, $KAl(SO_4)_2 \cdot 12H_2O(s)$, by reacting aluminum metal with potassium hydroxide and sulfuric acid, as represented in the balanced equation above.

a) In order to synthesize alum, the student must prepare a 5.0 *M* solution of sulfuric acid. Describe the procedure for preparing 50.0 mL of 5.0 *M* $H_2SO_4$ using any of the chemicals and equipment listed below. Indicate specific amounts and equipment where appropriate. *(4pts)*

| | | | |
|---|---|---|---|
| 10.0 *M* $H_2SO_4$ | 50.0 mL volumetric flask | Distilled water | 50.0 mL buret |
| 100 mL graduated cylinder | 25.0 mL pipet | 100 mL beaker | 50 mL beaker |

Goggles Apron

$M_1V_1 = M_2V_2$

$V_2 = \dfrac{(50.0\,mL)(5.0\,M)}{10.0\,M}$

$V_2 = 25.0\,mL\ (10.0\,M)$ dilute to 50.0 mL

① Put on goggles and an apron. Measure about 20 mL of dist. $H_2O$ Using the 100 mL grad. cylinder add the water to the 50.0 mL volumetric flask

② Measure 25.0 mL of 10.0 M $H_2SO_4$ with the pipet - transfer the conc acid to the flask slowly, swirling occasionally

③ Carefully add more dist. $H_2O$ until the meniscus is at the calibration line on the flask stopper, invert to mix

b) Calculate the minimum volume of 5.0 *M* $H_2SO_4$ that the student must use to react completely with 2.7 g of aluminum metal. *(3pts)*

$$2.7\,g\ Al \times \frac{1\,mol\ Al}{26.98\,g} \times \frac{4\,mol\ H_2SO_4}{2\,mol\ Al} \times \frac{1\,L}{5.0\,mol\ H_2SO_4} = 0.040\,L$$

c) As the reaction solution cools, alum crystals precipitate. The student filters the mixture and dries the crystals, then measures their mass.

i) If the student weighs the crystals before they are completely dry, would the calculated percent yield be greater than, less than, or equal to the actual percent yield? Explain. *(1pt)*

If the crystals are not dry excess $H_2O$ will make the mass of the product greater than it should be and the calculated percent yield will be greater than the actual percent yield

ii) Cooling the reaction solution in an ice bath improves the percent yield obtained. Explain. *(1pt)*

The solubility of the alum must decrease with decreasing temperature therefore precipitation will increase the yield of Alum

d) The student heats crystals of pure alum, $KAl(SO_4)_2 12H_2O(s)$, in an open crucible to a constant mass. The mass of the sample after heating is less than the mass before heating. Explain. *(1pt)*

Alum is a hydrate $(KAl(SO_4)_2 \cdot 12H_2O)$ The water of hydration is lost during heating decreasing the sample mass

$NaHCO_3(s) + HC_2H_3O_2(aq) \rightarrow NaC_2H_3O_2(aq) + H_2O(l) + CO_2(g)$ 2016 FRQ#2

2) A student designs an experiment to study the reaction between $NaHCO_3$ and $HC_2H_3O_2$. The reaction is represented by the equation above. The student places 2.24 g of $NaHCO_3$ in a flask and adds 60.0 mL of 0.875 *M* $HC_2H_3O_2$. The studer' observes the formation of bubbles and that the flask gets cooler as the reaction proceeds.

a) Identify the reaction represented above as an acid-base reaction, precipitation reaction, or redox reaction. Justify your answer. *(2pts)*

A/B

$HC_2H_3O_2$ reacts with $HCO_3^-$ (donates a proton) to form $H_2CO_3$ which decomposes to $H_2O + CO_2$

b) Based on the information above, identify the limiting reactant. Justify your answer with calculations. *(2pts)*

$2.24g\ NaHCO_3 \times \frac{1\ mol\ NaHCO_3}{84.01g} = 0.0267\ mol\ NaHCO_3$ LR

$60.0\ mL\ HAc \times \frac{0.875\ mol}{1000\ mL} = 0.0525\ mol\ HC_2H_3O_2$

Stoich is 1:1 so

Na 22.99
H 1.01
C 12.01
O 3×16 = 48
84.01

$\overset{+1\ +1\ -2}{2\ NaHCO_3(s)} \rightarrow \overset{+1\ \ -2}{Na_2CO_3(s)} + \overset{+4\ -2}{CO_2(g)} + H_2O(g)$ 2016 Practice #2

+1 +1 +4 -6 +2 +4 -6

2) $NaHCO_3(s)$ (baking soda) decomposes upon heating to produce $Na_2CO_3(s)$ and two gaseous products, as shown by the equation above.

a) A student claims that the reaction is an oxidation-reduction reaction because the oxidation number of carbon changes. Do you agree with the claim? In your answer include the oxidation number of carbon in each of the three carbon-containing species in the reaction. *(1 pt)*

No. C is always +4