Friday, October 3, 2025 AP Chemistry

Ch. 4 Reactions in Solution

AQUEOUS

A solution is a homogeneous mixture of a solute dissolved in a solvent, usually water.

3 kinds of solute:

	Dissolved Particles	Conducts Electricity	Examples
Non-electrolytes	Whole, neutral molecules	No	Polar molecules (sugar)
Electrolytes	Ionic compounds which dissociate into ions, completely	Yes	Strong acids & soluble ionic compounds
Weak electrolytes	Whole, neutral molecules; Partial dissociation	Slightly	Weak acids and bases

(Demo conductivity tester )

Electrolyte solutions can conduct electricity b/c the cation (+) and anions (−) can move freely in solution.

Because the ions are separate in solution they can participate separately in reactions.

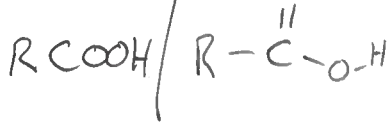
$NaCl_{(s)} \xrightarrow{H_2O} Na^+_{(aq)} + Cl^-_{(aq)}$ | $AgNO_{3(s)} \xrightarrow{H_2O} Ag^+_{(aq)} + NO_3^-{}_{(aq)}$

$Na^+_{(aq)} + Cl^-_{(aq)} + Ag^+_{(aq)} + NO_3^-{}_{(aq)} \rightarrow AgCl_{(s)} + \underbrace{Na^+_{(aq)} + NO_3^-{}_{(aq)}}_{\text{UNCHANGED}}$

(1)

WEAK ELECTROLYTES ARE MOLECULAR COMPOUNDS THAT REACT WITH WATER TO FORM IONS IN SOLUTION. THIS IS REVERSIBLE AND ONLY A SMALL FRACTION OF MOLECULES IS IN THE FORM OF IONS AT ANY MOMENT. 0.0001%

WEAK ACIDS: HF HCN HCH_3COO (ACETIC)

AND ANY ORGANIC ACIDS — RCOOH / 

WEAK BASES: NH_3, CH_3NH_2, AND C-N COMPOUNDS

ACIDS AND BASES

ACIDS = H^+

BASES = OH^-

SEVEN STRONG ACIDS (MEMORIZE)

COMMON LAB ACIDS	
HCl	HYDROCHLORIC
HNO_3	NITRIC
H_2SO_4	SULFURIC

HBr HYDROBROMIC
HI HYDROIODIC
$HClO_3$ CHLORIC
$HClO_4$ PERCHLORIC

NOTE: HF HYDROFLUORIC IS NOT STRONG (IT'S A WEAK ACID)

"STRONG" MEANS 100% DISSOCIATION INTO IONS IN SOLUTION AND IS NOT RELATED TO CONCENTRATION.

$HCl_{(g)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$

START	1 mol	∅	∅
END	∅ mol	1 mol	1 mol

STRONG BASES

SOLUBLE COMPOUNDS CONTAINING HYDROXIDE ION (OH^-).

LiOH
NaOH
KOH $Ca(OH)_2$
RbOH $Sr(OH)_2$
CsOH $Ba(OH)_2$

} MEMORIZE THIS LIST

OTHER COMPOUNDS OF OH^- ARE INSOLUBLE IN WATER (REM. $Fe(OH)_3$ PIGMENT)

ACID-BASE REACTIONS

ACID + BASE → SALT + WATER

SALT — ANY IONIC COMPOUND

FOR EX.

$HCl + NaOH \rightarrow NaCl + H_2O$ — DEMO WITH BROMOTHYMOL BLUE

$HBr + KOH \rightarrow KBr + H_2O$

$HNO_3 + LiOH \rightarrow LiNO_3 + H_2O$ — MOLECULAR EQUATION

→ TAKE EVERYTHING APART INTO SOLUBLE IONS (STRONG ELECTROL.)

TOTAL IONIC EQUATION

$H^+ + NO_3^- + Li^+ + OH^- \rightarrow Li^+ + NO_3^- + H_2O$

$Li^+ + NO_3^-$ — UNCHANGED IN THIS RXN

SPECTATOR IONS

→ TAKE AWAY SPECTATOR IONS, LEAVING ONLY IONS OR MOLECULES WHICH UNDERGO A CHANGE

NET IONIC EQUATION

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

TO ID SPECTATOR IONS, LOOK FOR IONS THAT ARE THE SAME ON BOTH SIDES.

IN NET IONIC EQUATIONS INSOLUBLE IONIC COMPOUNDS, MOLECULAR COMPOUNDS, AND WEAK ELECTROLYTES ARE WRITTEN WHOLE — NOT SEPARATED INTO IONS.

REACTION PREDICTION FOR ACID-BASE REACTIONS

(SEE ALSO THE PACKET ABOUT RXN PRED. THAT YOU WILL DO ALONG WITH THE PSET)

NET IONIC EQUATION FOR MOST ACID-BASE RXNS IS $H^+ + OH^- \rightarrow H_2O$

(STRONG ACID + SOLUBLE HYDROXIDE)

FOR EX. (INCL. AN INSOLUBLE HYDROXIDE)

$$H_2SO_{4(aq)} + Fe(OH)_{3(s)} \rightarrow ?$$

WHAT IS THE TOTAL IONIC BREAKDOWN OF REACTANTS?

$$2H^+ + SO_4^{2-} + Fe(OH)_3$$

INSOLUBLE BUT THINK $Fe^{3+} + 3OH^-$

PREDICT PRODUCTS

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

$$2H^+ + SO_4^{2-} + Fe(OH)_3 \rightarrow H_2O + Fe^{3+} + SO_4^{2-}$$

WRITE A MOLECULAR EQN.

$$3H_2SO_4 + 2Fe(OH)_3 \rightarrow 6H_2O + Fe_2(SO_4)_3$$

BALANCE ↗

NET IONIC EQUATION: $\overset{3}{6}H^+ + \overset{1}{2}Fe(OH)_3 \rightarrow \overset{3}{6}H_2O + \overset{1}{2}Fe^{3+}$

(SO_4^{2-} IS LEFT OUT AS A SPECTATOR ION)

F 2025-10-03 APCHEM

YOU TRY:

$H_3PO_{4(aq)} + KOH_{(aq)} \rightarrow ?$

WEAK ACID

MOLECULAR EQUATION

FILL IN [

NET IONIC EQUATION

[

ANSWERS:

$H_3PO_4 + 3KOH \rightarrow 3H_2O + K_3PO_4$

$H_3PO_4 + 3OH^- \rightarrow 3H_2O + PO_4^{3-}$

(K^+ IS THE ONLY SPECTATOR ION)

(STOPPED HERE F2025-10-03 X)

PRECIPITATION REACTIONS

A TYPE OF DOUBLE-REPLACEMENT REACTION (AKA, AN EXCHANGE RXN). ACID-BASE IS ALSO A DBL-RPL RXN.

ACID-BASE $HB + COH \rightarrow H_2O + CB$

HB: ACID; COH: BASE; CB: SALT

PRECIP. $AB + CD \rightarrow AD + CB$

AB, CD: SOLUBLE SALTS; AD: INSOLUBLE SALT; CB: SOLUBLE SALT

A PRECIP. RXN IS ONE IN WHICH AN INSOLUBLE IONIC COMPOUND FORMS THROUGH THE EXCHANGE OF IONS.

FOR EX. (DEMO)

$3CuCl_{2(aq)} + 2Na_3PO_{4(aq)} \rightarrow Cu_3(PO_4)_{2(s)} + 6NaCl_{(aq)}$

STOPPED HERE GROUP X Tu 2025-10-07 AFTER CH. 3 QUIZ

$$3CuCl_2 + 2Na_3PO_4 \rightarrow Cu_3(PO_4)_{2(s)} + 6NaCl$$

TOTAL IONIC EQN

$$3Cu^{2+} + 6Cl^- + 6Na^+ + 2PO_4^{3-} \rightarrow Cu_3(PO_4)_{2(s)} + 6Na^+ + 6Cl^-$$

SPECTATOR IONS

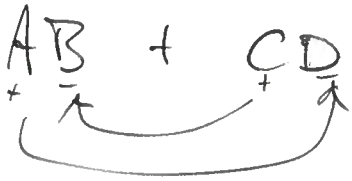
NET IONIC EQN

$$3Cu^{2+} + 2PO_4^{3-} \rightarrow Cu_3(PO_4)_{2(s)}$$

MEMORIZE THE SOLUBILITY GUIDELINES BY REPEATED APPLICATION OF THE RULES. USE TABLE 4.1 ON pg 129 IN YOUR BOOK OR IN MY PREDICTING RXNS HANDOUT.

YOU NEED TO BE ABLE TO PREDICT PRODUCTS FOR PRECIPITATION REACTIONS. HERE'S HOW:

1. ID THE IONS (WRITE A TOTAL IONIC EQN IF YOU WANT)
2. EXCHANGE IONS BTWN. THE TWO COMPOUNDS



3. DETERMINE WHICH PRODUCT IS THE PRECIPITATE (THAT IS, INSOLUBLE) USING THE SOLUBILITY GUIDELINES.

TRY THESE (PREDICT PRODUCTS AND THEN GIVE A NET IONIC EQN)

$$Mg(NO_3)_2 + NaOH \rightarrow$$

AND

$$CaCl_2 + AgNO_3 \rightarrow$$

Tu 2025-10-07
AP Chem

ANSWERS: $Mg(NO_3)_2 + 2NaOH \rightarrow Mg(OH)_{2(s)} + 2NaNO_3$

NET $Mg^{2+} + 2OH^- \rightarrow Mg(OH)_{2(s)}$

$CaCl_2 + 2AgNO_3 \rightarrow 2AgCl + Ca(NO_3)_2$

NET $Ag^+ + Cl^- \rightarrow AgCl$

STOPPED HERE Tu 2025-10-07 GROUPY

OXIDATION-REDUCTION REACTIONS

(SET UP $Cu + AgNO_3$ DEMO — IT TAKES A WHILE)
COILED WIRE, PREV. CLEANED W/STEEL WOOL
+ H_2O TO COVER
+ ~2mL 0.2M $AgNO_3$

A.K.A. REDOX RXNS

ELECTRON EXCHANGE RXNS

OXIDATION IS LOSS OF ELECTRONS | OIL
REDUCTION IS GAIN OF ELECTRONS | RIG

(ADDING e^-'s REDUCES CHARGE)

METAL REDUCTIONS

$+ \rightarrow \emptyset$

ION	NEUTRAL
OXIDIZED	REDUCED
METAL CATION	PURE METAL

NON-METAL REDUCTIONS

$\emptyset \rightarrow -$

NEUTRAL	ION
OXIDIZED	REDUCED
NEUTRAL NON-METAL	NON-METAL ANION

[COMBUSTION RXNS ARE ALSO REDOX RXNS: FUEL IS OXIDIZED, OXYGEN IS REDUCED]
ALSO, SYNTHESIS

Oxidation Numbers

Ox. nos. are how we trace e^- exchange in redox rxns. Bonds are composed of e^-s and the ox. no. idea assigns those e^-s to one or the other atom in the bond.

Rules

1. Pure elements have an oxid. no. of zero.
   Fe Ag Cu H_2 N_2 O_2 P_4 S_8
2. Metals in compounds <u>always</u> have a positive ox. no.
3. Non-metals in compounds have a negative ox. no. if they are monatomic anions but a positive ox. no. if they are the central atom in an oxyanion or in some molecular compounds (ClO_4^- PCl_3)

How to Assign Oxidation Numbers

1. Elements = zero
2. For monatomic ions ion charge = ox. no.
3. a. Oxygen is -2 in most compounds and ions (not in H_2O_2)
   b. Hydrogen is $+1$ in compounds with non-metals
      is -1 in compounds with metals
   c. Fluorine is -1 in all its compounds

TH 2025-10-09 APCHEM

④ ALL OX. NOS. IN A FORMULA MUST ADD UP (WHEN MULTIPLIED BY THE ATOMS' SUBSCRIPTS) TO THE OVERALL IONIC CHARGE.

EXAMPLES:

H_2O $\quad 2(+1) + 1(-2) = \emptyset$ (H, O)

NH_3 $\quad 3(+1) + 1(?) = \emptyset$ (H, N) $\quad$ N IS −3

NO_3^- $\quad 1(+5) + 3(-2) = -1$ (N, O)

Na_2SO_4 $\quad 2(+1) + 1(+6) + 4(-2) = \emptyset$ (Na, S, O)

THE VALUE OF THIS IS THAT WE CAN USE IT TO HAVE INSIGHT INTO CHEMICAL RXNS. SPECIFICALLY, WE CAN FIND WHICH ELEMENT IS REDUCED AND WHICH IS OXIDIZED IN A RXN.

TRY THIS

$$Cr_2O_7^{2-} + 14H^+ + 6I^- \rightarrow 2Cr^{3+} + 3I_2 + 7H_2O$$

Cr, O | H | I | Cr | I | H, O

ASSIGN OX NOS., IDENTIFY WHICH ELEMENTS ARE OX/RED.

Cr +6, O −2 | H +1 | I −1 | Cr +3 | I Ø | H +1, O −2

Cr +6 → +3 so $Cr^{6+} + 3e^- \rightarrow Cr^{3+}$

Cr IS REDUCED

I −1 → Ø so $2I^- \rightarrow I_2 + 2e^-$

I IS OXIDIZED

Single Replacement Rxns

In these rxns a pure element becomes an ion in a compound and in the process replaces another element which changes from an ion to a pure element.

$$AB + C \longrightarrow CB + A$$

Metals replace metal ions
Non-metals replace non-metal ions

For ex (demo)

$$\overset{\emptyset}{Cu}_{(s)} + 2\overset{+1}{Ag}\overset{+5\ -2}{NO_3}_{(aq)} \rightarrow \overset{+2}{Cu}\overset{+5\ -2}{(NO_3)_2}_{(aq)} + 2\overset{\emptyset}{Ag}_{(s)}$$

$$Cu \rightarrow Cu^{2+} + 2e^- \quad \text{OXIDATION}$$

$$2(Ag^+ + 1e^- \rightarrow Ag) \quad \text{REDUCTION}$$

For ex.

$$3Zn + 2FeCl_3 \rightarrow 3ZnCl_2 + 2Fe$$

$$2HCl + Sn \rightarrow SnCl_2 + H_2$$

Acid + metal $\rightarrow$ H_2 + salt

$$\overset{\emptyset}{Cl_2} + 2\overset{-1}{NaBr} \rightarrow \overset{\emptyset}{Br_2} + 2\overset{-1}{NaCl}$$

Demo: $Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$ thermite

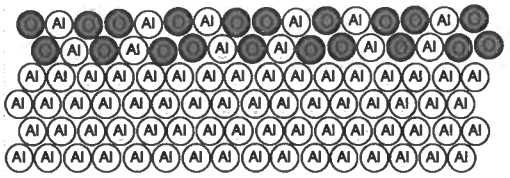
Demo: Dancing Flames

(Stopped here after demo Group Y 2025-10-09 Th)

Same Group X W 2025-10-15

Student Worksheet for the Demonstration Dancing Flames

Aluminum is one of the more active metals in the activity series. It is so active that it can replace hydrogen in water. And yet, we never see aluminum dissolve in water. The reason is that the surface of aluminum is coated with a thin layer of aluminum oxide which protects the metal from contacting air or water. This oxide is very unreactive and even protects aluminum from dissolving in some acids. However, in the presence of certain ions, such as the chloride ion (Cl^-), aluminum will suddenly react vigorously with water and the ions of less active metals.



Aluminum is very reactive and when exposed to air is quickly coated with a hard, nearly impervious layer of aluminum oxide (Al_2O_3).

Copper(II) chloride is green in color but when it is added to water, the solution is blue. In this demonstration 3.5 g of copper(II) chloride dihydrate ($CuCl_2 \cdot 2H_2O$) (a green solid) is added to 50 mL of 1 M hydrochloric acid (HCl) to make a blue solution. Next, a 30 cm by 6 cm piece aluminum foil is submerged in the mixture. To demonstrate the presence of one of the chemical products, a flame is brought to the mouth of the flask. The demonstration is best enjoyed in a darkened room.

SET A WATCH GLASS ON IT!

Questions

1. In this demonstration one chemical reaction that occurs involves aluminum (Al) and copper(II) chloride ($CuCl_2$). Predict the products of this reaction and write a balanced chemical equation.

$2Al + 3CuCl_2 \rightarrow 2AlCl_3 + 3Cu$

2. What physical evidence do you have for the reaction between Al and $CuCl_2$? Describe the observations that show this reaction is taking place.

Al DISSOLVED AWAY
WATER CHANGED FROM BLUE TO CLEAR
Cu GUNK APPEARED (FINE POWDER)

3. One important observation involves a color change. What does this color change tell you about the limiting reactant in the reaction between $CuCl_2$ and Al?

WE KNOW $CuCl_2$ WAS THE LR B/C THE WATER LOST THE COLOR DUE TO Cu^{2+}.

4. Aluminum undergoes another chemical reaction in this demonstration. Predict the products of the reaction between hydrochloric acid (HCl) and aluminum and write a balanced chemical equation.

$2Al + 6HCl \rightarrow 3H_2 + 2AlCl_3$

5. What observations of the demonstration show that the reaction between Al and HCl has taken place?

FIRE (?) H_2 IS FLAMMABLE
BUBBLES (OF H_2, PROBS) WATCH GLASS TICKING SOUND
CONDENSATION ON INSIDE (HEAT EVAP. H_2O, CONDENSED ON GLASS — OR MAYBE FROM $2H_2 + O_2 \rightarrow 2H_2O$)

6. Most or all of the aluminum foil is gone. What happened to it? Where is it?

IT DISSOLVED AND BECAME $AlCl_3$

7. The demonstration includes a dramatic demonstration of the flammability of the gaseous product of one of the reactions. Write a balanced chemical reaction to account for this flame.

$$2H_2 + O_2 \rightarrow 2H_2O$$

8. The amount of copper(II) chloride dihydrate ($CuCl_2 \cdot 2H_2O$) used in this demonstration is 3.5 g. Since it is a limiting reactant, how many grams of aluminum are consumed by reacting with all of the copper(II) chloride?

$$3.5\text{g } CuCl_2 \cdot 2H_2O \cdot \frac{1\text{mol}}{170.482\text{g}} \cdot \frac{2Al}{3CuCl_2} \cdot \frac{26.985\text{g}}{1\text{mol}} = 0.369\text{g Al}$$

Also, how many grams of copper form?

$$\rightarrow \cdot \frac{3Cu}{3CuCl_2} \cdot \frac{63.54\text{g}}{1\text{mol}} = 1.30\text{g Cu}$$

9. The hydrochloric acid solution has a concentration of 1.0 M (1.0 moles per liter). A volume of 50 mL of the solution is used in the demonstration. How many grams of hydrogen gas are formed when this amount of acid reacts with aluminum?

$$0.0500\text{L} \cdot \frac{1.0\text{mol HCl}}{1\text{L}} \cdot \frac{3H_2}{6HCl} \cdot \frac{2.016\text{g}}{1\text{mol}} = 0.050\text{g } H_2$$

50.0mL

Th 2024-10-10 APCHEM

THE ACTIVITY SERIES — NO NEED TO MEMORIZE

pg 144 TABLE 4.5

THE A.S. ALLOWS YOU TO PREDICT WHICH DISSOLVED IONS WILL REACT WITH WHICH PURE SUBSTANCES

IT IS A LIST OF OXIDATION HALF-REACTIONS IN ORDER FROM MOST LIKELY TO BE OXIDIZED TO LEAST LIKELY.

TO USE IT TO MAKE A PREDICTION YOU COMBINE TWO HALF-REACTIONS. THE ONE HIGHER UP SIMPLY AS WRITTEN; THE ONE LOWER DOWN WRITTEN IN REVERSE. MULTIPLY HALF-RXNS AS NEEDED TO EQUATE THE NO. OF e^-S AND ADD.

$Cu \rightarrow Cu^{2+} + 2e^-$ COPPER $\frac{1}{2}$-RXN

$-2(Ag \rightarrow Ag^+ + 1e^-)$ SILVER $\frac{1}{2}$-RXN

$+ 2Ag^+ + 2e^- \rightarrow 2Ag$

$$Cu + 2Ag^+ + \cancel{2e^-} \rightarrow Cu^{2+} + \cancel{2e^-} + 2Ag$$

$$Cu + 2Ag^+ \rightarrow Cu^{2+} + 2Ag$$

YOU TRY: BUILD TWO SINGLE REPL. RXNS. OF YOUR CHOICE USING THE ACTIVITY SERIES

A.S. ENTRIES

$Mg \rightarrow Mg^{2+} + 2e^-$

$Zn \rightarrow Zn^{2+} + 2e^- \rightarrow Zn^{2+} + 2e^- \rightarrow Zn$

$Mg + Zn^{2+} \rightarrow Mg^{2+} + Zn$

MY EXAMPLES

$Cr \rightarrow Cr^{3+} + 3e^-$) $\times 2 = 2Cr \rightarrow 2Cr^{3+} + 6e^-$

$H_2 \rightarrow 2H^+ + 2e^-$) $\times 3$

$6H^+ + 6e^- \rightarrow 3H_2$

$2Cr + 6H^+ \rightarrow 2Cr^{3+} + 3H_2$

Dancing Flames Demo

See handout

Did with Group Y 10/10 Group X 10/16 (but not all Q's on handout just No. 1)

Making Solutions

Concentration is meas. in $\frac{mol}{L}$ or M

"moles per liter" "molar" "molarity"

mol of solute
per
L of solution

How to mix a solution (an example)

We want 250 mL of a 0.10 M soln. of NaCl

(1) Calc. mass of NaCl needed:

$$\frac{0.10\ mol\ NaCl}{1\ L} \cdot \frac{0.250\ L}{1} \cdot \frac{58.44\ g}{1\ mol\ NaCl} = 1.461\ g\ NaCl$$

(2) Dissolve this mass in ~200 mL of water and then transfer to a volumetric flask, rinsing all drops left behind.

(3) Add water almost to the mark, mix thoroughly, then fill precisely to the mark.

Stopped here Th 2024-10-10 APChem Y

F 2024-10-18 AP CHEM

DILUTIONS

$M = \frac{mol}{L}$ OR $\frac{mmol}{mL}$

$M_1V_1 = M_2V_2$ ← TO CALC. CONC. AND VOL. FOR A DILUTION

$\left(\frac{mol}{L}\right)(L) = \left(\frac{mol}{L}\right)(L)$

(mL) (mL)

M_1 CONC. OF THE GIVEN OR STOCK SOLUTION (SOLN)

V_1 VOL. OF STOCK SOLN.

M_2 FINAL OR DESIRED CONC.

V_2 FINAL OR DESIRED VOL.

FOR EX. I HAVE A $\underset{M_1}{12.0M}$ SOLN.

I WANT $\underset{V_2}{250mL}$ OF A $\underset{M_2}{6.0M}$ SOLN.

$M_1V_1 = M_2V_2$

$(12.0M)V_1 = (6.0M)(250mL)$

$V_1 = \frac{6.0M}{12.0M}(250mL) = 125mL$

Solution Stoich

Instead of mass (g) and molar mass (g/mol) we now use volume (mL) and molarity (mol/L) (conc.)

Given vol. and conc. for two reactants:

1. Calc moles of each one and ID the LR
2. Use molar ratios from the balanced chem. eqn. and the moles of the LR to calc. moles of the product or excess reactant consumed.
3. For a precipitate use molar mass to calc. mass. For dissolved substances calc. conc. as moles over total combined volume.

pg 152 Ex. 4.15

How many g of $Ca(OH)_2$ are needed to neutralize 25.0 mL of 0.10 M HNO_3 soln?

What is the balanced eqn? Ca^{2+} NO_3^{-1}

$$Ca(OH)_2 + 2HNO_3 \rightarrow 2H_2O + Ca(NO_3)_2$$

1000 mL = 1 L

$$\frac{0.0250\,L}{1} \cdot \frac{0.10\,mol\,HNO_3}{1\,L} \cdot \frac{1\,Ca(OH)_2}{2\,HNO_3} \cdot \frac{74.092\,(g)}{1\,mol\,Ca(OH)_2} = \boxed{0.093\,g\ Ca(OH)_2}$$

After the rxn is complete, what is the conc. of $Ca(NO_3)_2$?

$$0.0250\,L \cdot \frac{0.10\,mol\,HNO_3}{1\,L} \cdot \frac{1\,Ca(NO_3)_2}{2\,HNO_3} = 0.00125\,mol$$

$$\text{Conc.} \quad \frac{0.00125\,mol}{0.0250\,L} = \boxed{0.05\,M}$$

THURSDAY, OCTOBER 9, 2025 AP CHEMISTRY

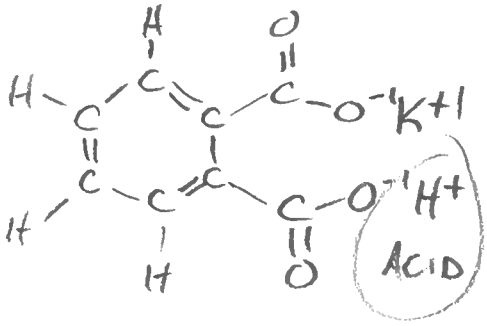
GROUP X
GROUP Y 2025-10-15 Wed

LAB: ACID-BASE TITRATION

GOALS

1. USE KHP TO DETERMINE THE CONCENTRATION IN mol/L OF A SODIUM HYDROXIDE SOLUTION (APPROX. $0.5M = 0.5 \frac{mol}{L}$)
2. USE OUR MEASURED CONC. OF NaOH SOLN. TO REACT WITH VINEGAR TO MEASURE ITS ACETIC ACID CONC.

KHP STANDS FOR POTASSIUM HYDROGEN PHTHALATE



① FOR EACH TITRATION (OF TWO) YOU'LL MEAS. OUT ≈ 1.0 - 1.2g OF KHP

② DISSOLVE IN 25-30mL H_2O

③ ADD 1-2 DROPS PHENOLPHTHALEIN ACID-BASE INDICATOR (IT TURNS PINK AT EQUIVALENCE)

(DEMO: FILL A BURET)

④ READ V_i AND V_f TO NEAREST 0.01mL & RECORD (MENISCUS)

⑤ CALC. CONC. OF NaOH $\Delta V = V_f - V_i$ (mL OF NaOH)

$$\text{mol NaOH} = \text{g KHP} \cdot \frac{1\,\text{mol}}{204.22\,\text{g}} \cdot \frac{1\,\text{NaOH}}{1\,\text{KHP}} \Big\| \frac{\text{mol NaOH}}{\text{L}} \leftarrow \Delta V$$

$$KHP + NaOH \rightarrow H_2O + NaKP$$

DO THIS TWICE.

AFTER EST. THE CONC. OF NaOH YOU'LL USE THAT SOLN. TO ANALYZE SOME DISTILLED VINEGAR. THE PROC. IS THE SAME EXCEPT INSTEAD KHP YOU DSE PRECISELY 10.00 mL OF VINEGAR SOLN. (DEMO: VOLUMETRIC PIPET)

PRE-LAB QUESTIONS

(1) GIVEN 1.106g KHP AND THAT YOU USE 9.85 mL OF NaOH SOLN. CALC. THE CONC. OF NaOH

$$1.106\text{g KHP} \cdot \frac{1\text{ mol}}{204.22\text{g}} \cdot \frac{1\text{ mol NaOH}}{1\text{ mol KHP}} = 5.416\times10^{-3}\text{ mol NaOH}$$

$$\frac{5.416\times10^{-3}\text{ mol NaOH}}{0.00985\text{ L}} = \boxed{0.5498\text{ mol/L}}$$

$$NaOH + HCH_3COO \rightarrow H_2O + NaCH_3COO$$

(2) TO REACH EQUIV. WITH 10.00 mL OF VINEGAR SOLN., 15.39 mL OF NaOH AT 0.5035M IS USED. CALC. MOLAR CONC. OF ACETIC ACID IN THE VINEGAR

$$0.01539\text{ L} \cdot \frac{0.5035\text{ mol NaOH}}{1\text{ L}} \cdot \frac{1\ HCH_3COO}{1\ NaOH} = 7.749\times10^{-3}\text{ mol } HCH_3COO$$

YOU DO THE REST

$$\frac{7.749\times10^{-3}\text{ mol}}{0.01000\text{ L}} = \boxed{0.7749\ \frac{\text{mol } CH_3COOH}{1\text{ L}}}$$

(3) CALC THE % BY MASS CONC. OF ACETIC ACID

$$\text{ex. } \frac{7.749\times10^{-3}\text{ mol } HCH_3COO \cdot \frac{60.05\text{g}}{1\text{ mol}} \times 100\%}{10.02\text{g}} = \boxed{4.64\%}$$

LETS GO DO THE LAB!