AP Chem Unit 2 - Reactions and Solutions

Key

Unit 2 Test Review

Unit Goal: Ability to identify a substance as either an acid, base, or salt. Also be able to determine whether the acid or base is strong or weak

Arrhenius Acid: a substance able to donate a H^+ ion (a proton) and hence increase the H^+ ion concentration when it dissolves in water

Arrhenius Base: a substance able to produce a OH^- ion when it dissolves in water.

Salt: an ionic compound made up of one or more positive ions and negative ions: all salts are ionic compounds and all ionic compounds are salts. Salts can be easily identified since they usually consist of positive ions from a **metal** with negative ions from a **non metal**

COMMON Strong acids: HCl, HBr, HI, HNO_3, H_2SO_4, $HClO_3$, $HClO_4$

COMMON Strong bases: Oxides and Hydroxides of I & II A metals
Most common weak base is ammonia NH_3

1. Circle all the acids, box all bases and underline all salts.

HCl	KOH	K_3PO_4	$Ca(OH)_2$	NH_3
H_3PO_3	NaCl	AgBr	$Zn(OH)_2$	$MgCO_3$

2. Circle all of the strong acids in the list below:
   $HC_2H_3O_2$ HBr H_2SO_4 HNO_2 H_2CO_3

3. Circle all of the strong bases in the list of bases below:
   AgOH $Fe(OH)_2$ $Fe(OH)_3$ $Ca(OH)_2$ LiOH

Unit Goal: Predict whether a substance is a nonelectrolyte, strong electrolyte, or weak electrolyte.

For #4-7 circle "T" for true statements and "F" for false statements. If false correct statement.

4. All strong acids and strong bases are considered strong electrolytes. (T) F

5. All weak acids and weak bases are considered weak electrolytes. (T) F

6. Water is a weak electrolyte. T (F) Pure H_2O is a very poor conductor

7. Aqueous salts are strong electrolytes and solid salts are ~~weak~~ non electrolytes. T (F)

8. Circle all strong electrolytes. Underline all weak electrolytes

$H2O_{(L)}$	$NaCl_{(aq)}$	$NaCl_{(s)}$	$NaCl_{(g)}$	$CO_{2(s)}$	$CO_{2(g)}$
$HNO_{3(ag)}$	$HNO_{3(s)}$	$HBr_{(ag)}$	$H_2CO_{3(aq)}$	$Cl_{2(g)}$	$Br_{2(l)}$
$Mg(OH)_{2(aq)}$	$Ba(OH)_{2(aq)}$	$NH_{3(aq)}$	$NH_{3(g)}$	Sugar	Lead

All the Rest are nonelectrolytes

9. Place an "S" next to each salt which is soluble in water.
Place an "I" next to each salt which is insoluble in water

S KBr	I $MgCO_3$	S $AgNO_3$
I $PbSO_4$	S $Ca(C_2H_3O_2)_2$	S $NaBrO_3$
S NH_4I	I $Zn_3(PO_4)_2$	I $Fe(OH)_3$

Ion	Solubility	Exceptions
NO_3^-	soluble	none
ClO_4^-	soluble	none
Cl^-	soluble	except Ag^+, Hg_2^{2+}, *Pb^{2+}
I^-	soluble	except Ag^+, Hg_2^{2+}, Pb^{2+}
SO_4^{2-}	soluble	except Ca^{2+}, Ba^{2+}, Sr^{2+}, Hg^{2+}, Pb^{2+}, Ag^+
CO_3^{2-}	insoluble	except Group IA and NH_4^+
PO_4^{3-}	insoluble	except Group IA and NH_4^+
$-OH$	insoluble	except Group IA, *Ca^{2+}, Ba^{2+}, Sr^{2+}
S^{2-}	insoluble	except Group IA, IIA and NH_4^+
Na^+	soluble	none
NH_4^+	soluble	none
K^+	soluble	none
		*slightly soluble

10. Write balanced molecular and net ionic equation for each of the following. List any spectator ions for each reaction.

a) Aqueous potassium carbonate and aqueous lead (II) nitrated are mixed

Balanced $K_2CO_{3(aq)} + Pb(NO_3)_{2(aq)} \rightarrow PbCO_{3(s)} + 2KNO_{3(aq)}$

$2K^+_{(aq)} + CO_3^{-2}{}_{(aq)} + Pb^{+2}_{(aq)} + 2NO_3^-{}_{(aq)} \rightarrow PbCO_{3(s)} + 2K^+ + 2NO_3^-{}_{(aq)}$

Spectator $K^+_{(aq)}$, $NO_3^-{}_{(aq)}$

Net $CO_3^{-2}{}_{(aq)} + Pb^{+2}{}_{(aq)} \rightarrow PbCO_{3(s)}$

b) Aqueous ammonium phosphate and aqueous calcium sulfide are mixed

Balanced $2(NH_4)_3PO_{4(aq)} + 3CaS_{(aq)} \rightarrow Ca_3(PO_4)_{2(s)} + 3(NH_4)_2S_{(aq)}$

$6NH_4^+{}_{(aq)} + 2PO_4^{-3}{}_{(aq)} + 3Ca^{+2}{}_{(aq)} + 3S^{-2}{}_{(aq)} \rightarrow Ca_3(PO_4)_{2(s)} + 6NH_4^+{}_{(aq)} + 3S^{-2}{}_{(aq)}$

Spectator $NH_4^+{}_{(aq)}$, $S^{-2}{}_{(aq)}$

Net $2PO_4^{-3}{}_{(aq)} + 3Ca^{+2}{}_{(aq)} \rightarrow Ca_3(PO_4)_{2(s)}$

Be able to recognize double replacement reactions that produce either CO_2, H_2S, or NH_3 gases

- products are H_2SO_3 or H_2CO_3 it will continue to decompose into H_2O+SO_2 or H_2O+CO_2
- Base + NH_4 will have products that include $NH_{3(g)}$ and H_20
- Metallic sulfides and Acids will have a product of $H_2S_{(g)}$

11. List the gases produced upon mixing the following chemicals:
    a. acetic acid and sodium hydrogen carbonate ___CO_2___
    b. strontium hydroxide and ammonium chloride ___NH_3___
    c. potassium sulfide and nitric acid ___H_2S___ → smell Rotten eggs

12. Write a balanced net ionic equation for each of the following:
    a. 2.0 M HCl is mixed with solid sodium carbonate

$2HCl_{(aq)} + Na_2CO_{3(s)} \rightarrow 2NaCl_{(aq)} + CO_{2(g)} + H_2O_{(l)}$

Net $2H^+_{(aq)} + 2Cl^-_{(aq)} + Na_2CO_{3(s)} \rightarrow 2Na^+_{(aq)} + 2Cl^-_{(aq)} + CO_{2(g)} + H_2O_{(l)}$

    b. 2.0 M sodium hydroxide is mixed with 1.0 M ammonium iodide

$NaOH_{(aq)} + NH_4I_{(aq)} \rightarrow NaI_{(aq)} + NH_{3(g)} + H_2O_{(l)}$

$Na^+_{(aq)} + OH^-_{(aq)} + NH_4^+_{(aq)} + I^-_{(aq)} \rightarrow Na^+_{(aq)} + I^-_{(aq)} + NH_{3(g)} + H_2O_{(l)}$

Net $OH^-_{(aq)} + NH_4^+_{(aq)} \rightarrow NH_{3(g)} + H_2O_{(l)}$

Unit Goal: Be able determine whether a chemical reaction involves oxidation and reduction.

13. List the oxidation state of the underlined element in each of the following:

$\underline{H}NO_3$ (N^{+5}) $\quad H_3\underline{P}O_4$ (P+5) $\quad K\underline{N}O_3$ (O^{-2}) $\quad \underline{Pb}(SO_4)_2$ (Pb +4, S +6)

$\underline{C}O_2$ (C+4) $\quad K\underline{Mn}O_4$ (Mn+7) $\quad \underline{Cu}(OH)_2$ (Cu+2) $\quad \underline{N}_2$ (0)

14. Which 2 of the following reactions are redox reactions? In each case, identify the element being reduced and the element being oxidized.

Reactant Reaction 1: $\overset{-4\ +1}{CH_4} + \overset{0}{2O_2} \rightarrow \overset{+4\ -2}{CO_2} + 2\overset{-2}{H_2O}$ O gain 2e's ⇒ Reduction; C lose 8e's - Oxidation

Reaction 2: $\overset{+1\ -2\ +1}{3KOH} + \overset{+1\ +5\ -2}{H_3PO_4} \rightarrow \overset{+1\ +5\ -2}{K_3PO_4} + \overset{+1\ -2}{3H_2O}$ (HOH!) No Δ in Charge ∴ Not Redox

Reaction 3: $\overset{0}{Mg} + \overset{0}{O_2} \rightarrow 2\overset{+2\ -2}{MgO}$

Mg lost 2e⁻ ⇒ oxidation

O gain 2e⁻ ⇒ Reduction

Unit Goal: Solve stoichiometry problems involving solutions. Including probloms making solutions by dilutions, titration, and using lab results.

15. What is the morality of an aqueous HBr solution if 35.0 mL is neutralized with 70.0 mL of a 0.500 M NaOH solution?

$M = \frac{moles}{L}$

$HBr_{(aq)} + NaOH \rightarrow H_2O_{(\ell)} + NaBr_{(aq)}$

35.0 mL, ? M — 70.0 mL, 0.500 M

$$\left(\frac{0.500 \text{ moles NaOH}}{1 \text{ L}}\right)\left(\frac{0.0700 \text{ L NaOH}}{1}\right)\left(\frac{1 \text{ mole HBr}}{1 \text{ mole NaOH}}\right)\left(\frac{1}{0.0350 \text{ L HBr}}\right) = 1.00 \text{ M HBr}$$

Part II Solve the following problems on a separate sheets of paper. Please show ALL of your work and box in your final solutions.

16. Some sulfuric acid is spilled on a lab bench. It can be neutralized by sprinkling sodium bicarbonate ($NaHCO_3$) on it and then mopping it up the resulting solution. If 35.0 mL of 6.0M sulfuric acid was spilled, what is the minimum mass of the sodium bicarbonate that can be used to neutralize the acid?

17. By titration, 15.0 mL of 0.1008 M sodium hydroxide is required to neutralize a 0.2053 g sample of a organic acid. What is the molar mass of the acid? Assume the acid is monoprotic.

18. A 20.05 mL sample of vinegar (HC2H3O2) has a density of 1.061 g/mL. The vinegar is neutralized with 40.10 mL of 0.4100 M KOH. What is the percent by mass of acetic acid in the vinegar?

19. Answer each of the following questions. In each case use a diagram to help support your answers.
    a. Explain how water dissolves a small sample of solid sodium nitrate.
    b. Which dissolves more easily, salt or sugar? Justify your answer
    c. Do you agree or disagree with the following statement? Justify your answer
       "1.0 M HCl is stronger than 0.10M HCl"
    d. Explain the difference between a strong , weak and nonelectrolyte.

(16)

$$H_2SO_{4(aq)} + 2NaHCO_{3(s)} \rightarrow 2CO_{2(g)} + 2H_2O_{(l)} + Na_2SO_{4(aq)}$$

35.0mL → 0.035L ? g

6.0M

$$\left(\frac{6.0 \text{ moles } H_2SO_4}{1 \text{ L}}\right)\left(\frac{0.035 \text{ L}}{1}\right)\left(\frac{2 \text{ mole } NaHCO_3}{1 \text{ mole } H_2SO_4}\right)\left(\frac{84.01 \text{ g } NaHCO_3}{1 \text{ mole } NaHCO_3}\right) =$$

$$= 35 \text{g } NaHCO_3$$

(17) Monoprotic Acid ∴ HX

$$HX + NaOH \rightarrow NaX + HOH$$

molar mass of HX?

0.2053g HX — 15.0mL NaOH, 0.1008M NaOH

? g/mole

molarity of Base ↓ Balanced Eqn ↙

$$\frac{? \text{ g}}{\text{mole}} HX \quad \left(\frac{.2053 \text{g HX}}{0.0150 \text{ L NaOH}}\right)\left(\frac{1 \text{ L NaOH}}{0.1008 \text{ M NaOH}}\right)\left(\frac{1 \text{ mole NaOH}}{1 \text{ mole HX}}\right)$$

$$= 136 \text{ g/mole } HX$$

18) $HC_2H_3O_2(aq) + KOH(aq) \rightarrow KC_2H_3O_2(aq) + H_2O_l$

20.05 mL 40.10 mL

1.061 g/mL 0.4100 M

? % mass Acetic Acid

need → ? g

$$\left(\frac{0.4100 \text{ moles KOH}}{\text{L}}\right)\left(\frac{0.04010 \text{ L}}{1}\right)\left(\frac{1 \text{ mole } HC_2H_3O_2}{1 \text{ mole KOH}}\right)\left(\frac{60.05 \text{ g } HC_2H_3O_2}{1 \text{ mole } HC_2H_3O_2}\right)$$

$= 0.9873 \text{ g } HC_2H_3O_2$

H $4 \times 1.008 = 4.032$

C $2 \times 12.01 = 24.02$

O $2 \times 16.00 = 32.00$

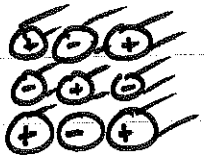
60.05

Amount of Vinegar $\left(\frac{20.05 \text{ mL}}{1}\right)\left(\frac{1.061 \text{ g}}{1 \text{ mL}}\right) = 21.27 \text{ g Vinegar}$

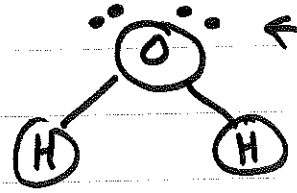
$$\% \, HC_2H_3O_2 = \frac{0.9873 \text{ g}}{21.27 \text{ g}} \times 100$$

$= 4.641\% \, HC_2H_3O_2$

19) (A) $NaNO_3$ is ionic and looks something like this



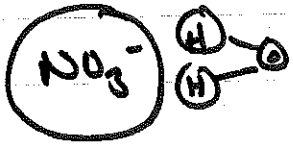
Water is a polar molecule which means it has a positive side & a negative side

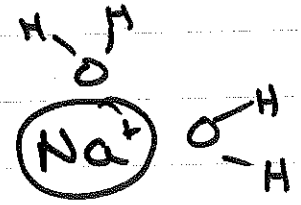


← Negative side

Positive side

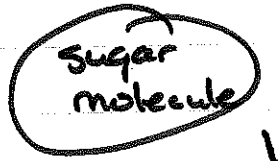
The water molecules will ~~direct~~ orient themselves around the solid salt so the negative side of H_2O molecules will be pointed towards the positive Na^+. While the positive side of H_2O will point toward the negative NO_3^- ion.





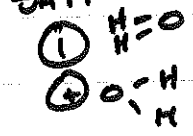
* The Sum of the Attractions Btwn the H_2O molecules and ions will be greater than the ionic Bonds in the salt, so the salt dissolves

(B) Salts generally dissolve more Readily than Sugars. Salts are made up of Ions (+ & −) which "feel" more Attraction to water than Neutral sugar molecules



.... water molecule

little Attraction

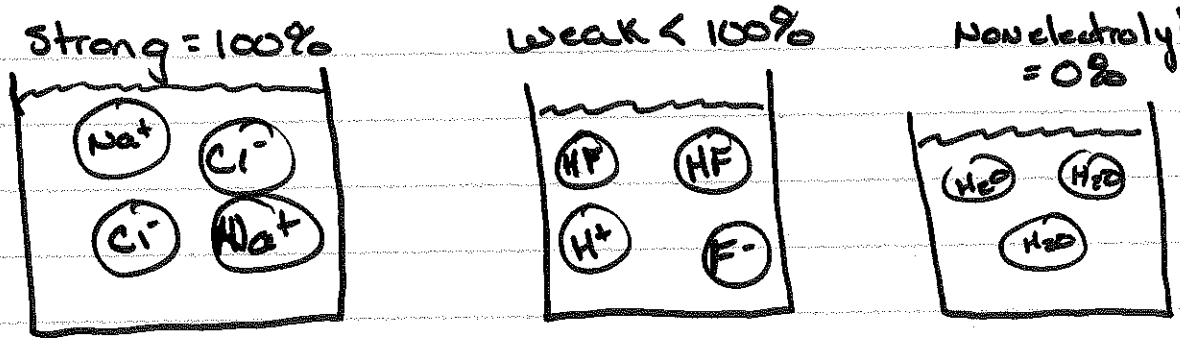


much Attraction!

19) c) Disagree, HCl is a strong acid, independent of its concentration. HCl ionizes 100%

$$H\text{-}Cl \xrightarrow{100\%} H^+ + Cl^-$$

d) The difference Btwn the 3 Types of Electrolytes is based upon the % it ionizes



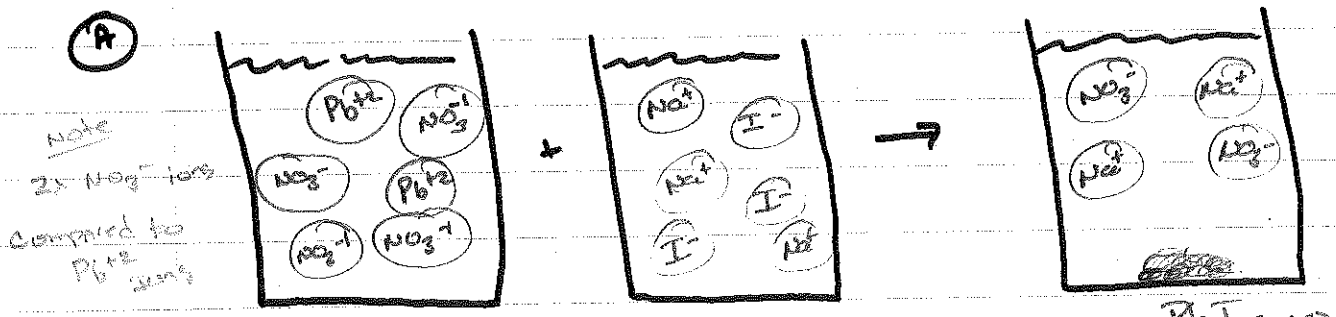
NaCl (aq)
All ions

HF (aq)
Some Ions

H_2O ℓ
No Ions!

20) Beaker A + Beaker B → Beaker C

(A)



500 mL $Pb(NO_3)_2$ 1.0 M

500. mL NaI 2.0 M

(B) $Pb(NO_3)_{2(aq)} + 2NaI_{(aq)} \rightarrow PbI_{2(s)} + 2NaNO_{3(aq)}$

500. mL 1.0 M; 500. mL 2.0 M

Net Ionic $Pb^{+2}_{(aq)} + 2I^-_{(aq)} \rightarrow PbI_{2(s)}$

(C)

R	$Pb(NO_3)_{2(aq)}$	$2NaI_{(aq)}$	$\rightarrow$	$2NaNO_{3(aq)}$
I	.500 moles	1.00 moles		0
	$-x$	$-2x$		$2x$
	$-(.500)$	$-2(.500)$		$2(.500)$
	$\emptyset$	$\emptyset$		1.00 Moles

$x = .500$

Both Limiting!!

(D)

$\left(\frac{1.00 \text{ moles } Pb(NO_3)_2}{1L}\right)\left(\frac{.500L}{1}\right) = .500 \text{ moles } Pb(NO_3)_2$ Concentration in Beaker A

$\left(\frac{2.00 \text{ moles NaI}}{1L}\right)\left(\frac{.500L}{1}\right) = 1.00 \text{ moles NaI}$

20) cont:

(c) continued

From Rice Table, Both Reactants "Run" out at the same time, ∴ Both are Limiting.

Neither Pb^{+2} or I^- ions will be left over in Beaker C

(e) From RICE Table you will see that there is 1.00 moles $NaNO_{3(aq)}$ in Beaker C, which are the Spectator Ions Na^+, NO_3^-

$$\frac{1.00 \text{ moles } NaNO_{3(aq)}}{1.00 \text{ L}} = 1.00 \text{ M } Na^+_{(aq)}$$

↑ New Total Volume in Beaker C

↑ $NO_{3(aq)}^-$ ions

21) $2K_{(s)} + ZnCl_{2(aq)} \rightarrow 2KCl_{(aq)} + Zn_{(s)}$

occur?

Yes, K is more Reactive than Zn

22) Add HCl to Both

$Na_2S + HCl \rightarrow H_2S_{(g)} + NaCl$ ⇒ Rotten Egg Smell

$Na_2CO_3 + HCl \rightarrow CO_{2(g)} + H_2O_{(l)} + NaCl$

⇒ lots of Bubbles

23)