Solutions & Solubility Unit Review

3. $n_{NaNO_3} = \frac{m}{M}$

$= \frac{(1.00g)}{(85.0 g/mol)}$

$\doteq 0.011765$ mol $NaNO_3$

$C = \frac{n}{V}$

$= \frac{(0.011765 \text{ mol})}{(0.315L)}$

$\doteq 0.037M$

∴ the $[NaNO_3]$ is $0.037M$

4. $Ca(NO_3)_{2(aq)} \rightarrow Ca^{2+}{}_{(aq)} + 2NO_3^-{}_{(aq)}$

$n = 5.0 \times 10^{-2}$ mol

$\frac{2 \text{ mol } NO_3^-}{5.0 \times 10^{-2} \text{ mol}} = \frac{1 \text{ mol } Ca(NO_3)_2}{x}$

$x = 0.025$ mol $Ca(NO_3)_2$

$V = \frac{n}{c}$

$= \frac{(0.025 \text{ mol})}{(4.00 \times 10^{-2} \text{ mol/L})}$

$= 0.625L$

∴ 0.625L of $Ca(NO_3)_2$ contains 5.0×10^{-2} mol of NO_3^-

5. $C_1V_1 = C_2V_2$

$C_2 = \frac{C_1V_1}{V_2}$

$= \frac{(4.00M)(0.080L)}{(0.400L)}$

$= 0.8M$

∴ the $[H_2SO_4]$ is $0.8M$

6. $n = CV$

$= (0.00100M)(0.100L)$

$= 1.0 \times 10^{-4}$ mol NaOH

∴ there are 1.0×10^{-4} mol of NaOH

S.S.U.R.

7. $m/m\% = \frac{\text{mass of solute (g)}}{\text{mass of solution (g)}} \times 100$

$= \frac{(0.02\,g)}{(70000\,g)} \times 100$

$\doteq 2.86 \times 10^{-5}\,\%$

nic/day = nic./cig × cig/day
$= (0.001g) \times 20$
$= 0.02g$ nic

8. $n_{Na^+} = \frac{m}{M}$

$= \frac{(3.4\,g)}{(22.99\,g/mol)}$

$\doteq 0.1479$ mol Na^+

$C = \frac{n}{V}$

$= \frac{(0.1479\,mol)}{(1\,L)}$

$= 0.1479\,M$

∴ $[Na^+]$ is 0.1479 M

9. a) $H_2SO_4\,(aq)$ sulphuric acid

b) $HNO_3\,(aq)$ nitric acid

c) $HBr\,(aq)$ hydrobromic acid

d) $HCl\,(aq)$ hydrochloric acid

e) $HF\,(aq)$ hydrofluoric acid

10. a) $[H_3O^+] = 10^{-pH}$
$= 10^{-2.5}$
$\doteq 3.16 \times 10^{-3}\,M$
∴ the $[H_3O^+]$ is $3.16 \times 10^{-3}\,M$

10. b) $NaOH\,(aq) + HCl\,(aq) \longrightarrow H_2O\,(l) + NaCl\,(aq)$

NaOH: $V = 0.032L$

HCl: $V = 0.020L$, $C = 1.0M$

$n_{HCl} = CV$
$= (1.0M)(0.020L)$
$= 0.020$ mol HCl

$\frac{1 \text{ mol HCl}}{0.020 \text{ mol}} = \frac{1 \text{ mol NaOH}}{x}$

$x = 0.020$ mol NaOH

$C = \frac{n}{V}$
$= \frac{(0.020\,mol)}{(0.032L)}$
$= 0.625M$

$V = \frac{n}{c}$
$= \frac{(0.020\,mol)}{(0.625)}$
$= 0.032L$

∴ 0.032L is required

S.S.U.R

11. $Ca(OH)_{2(aq)} \leftrightarrow Ca^{2+}{}_{(aq)} + 2OH^-{}_{(aq)}$

$C = 1.0 \times 10^{-5} M$ $\qquad$ $C = 2.0 \times 10^{-5} M$

$$pOH = -\log[OH^-]$$
$$= -\log[2.0 \times 10^{-5}]$$
$$\doteq 4.70$$
$$pH = 14 - pOH$$
$$= 14 - 4.70$$
$$= 9.3$$

$\therefore$ the pH of $Ca(OH)_2$ is 9.3

12. $n_{NaOH} = \frac{m}{M}$

$$= \frac{(2.5g)}{(40.0g/mol)}$$
$$= 0.0625 \text{ mol NaOH}$$

$$C = \frac{n}{V}$$
$$= \frac{(0.0625 mol)}{(0.100L)}$$
$$= 0.625 M$$

$$pOH = -\log[OH^-]$$
$$= -\log[0.625]$$
$$\doteq 0.204$$
$$pH = 14 -$$
$$= 12.8$$

$\therefore$ the pH is 12.8

13. a) $HF_{(aq)} + NH_{3(aq)} \rightarrow NH_4^+{}_{(aq)} + F^-{}_{(aq)}$
acid, base, conj acid, conj base

b) $Fe(H_2O)_6^{3+}{}_{(aq)} + H_2O_{(l)} \rightarrow Fe(H_2O)_5(OH)_2^+{}_{(aq)} + H_3O^+{}_{(aq)}$
acid, base, conj base, conj acid

c) $NH_4^+{}_{(aq)} + CN^-{}_{(aq)} \rightarrow HCN_{(aq)} + NH_3$
acid, base, conj acid, conj base

13.d) $(CH_3)_3N_{(aq)}$ + $H_2O_{(l)}$ → $(CH_3)_3NH^+_{(aq)}$ + $OH^-_{(aq)}$
base — acid — conj acid — conj base

14. $HCl + H_2O \rightarrow H_3O^+ + Cl^-$

$n_{HCl} = CV$
$= (4.00M)(0.07L)$
$= 0.28$ mol HCl

$HNO_3 + H_2O \rightarrow H_3O^+ + NO_3^-$

$n_{HNO_3} = CV$
$= (8.00M)(0.030L)$
$= 0.24$ mol HNO_3

$\frac{1 \text{ mol HCl}}{0.28 \text{ mol}} \rightarrow \frac{1 \text{ mol } H_3O^+}{x}$

$x = 0.28$ mol H_3O^+

$\frac{1 \text{ mol } HNO_3}{0.24 \text{ mol}} = \frac{1 \text{ mol } H_3O^+}{x}$

$x = 0.24$ mol H_3O^+

$n_{H_3O^+ \text{ total}} = 0.28 + 0.24$
$= 0.52$ mol H_3O^+

$V_{total} = 0.070 + 0.030$
$= 0.100L$

$[H_3O^+] = \frac{n}{V}$
$= \frac{0.52 \text{ mol}}{0.100L}$
$= 5.2M$

$C_2 = \frac{C_1V_1}{V_2}$
$= \frac{(5.2M)(0.100L)}{(0.500)}$
$= 1.04M$

$pH = -\log[H_3O^+]$
$= -\log[1.04]$
$\doteq -0.017$
$= 0$

∴ the pH of the solution is 0.

Solutions & Solubility Sample Questions

1. $$m/m\% = \frac{m_{solute}(g)}{m_{solution}(g)} \times 100$$

$$= \frac{(4.58g)}{(23.47g)} \times 100$$

$$\doteq 19.5\%$$

∴ the m/m% of $CaCl_2$ is 19.5%.

2. $$ppb = \frac{m_{solute}(g)}{m_{solution}(g)} \times 10^9$$

$$m_{solute} = \frac{ppb \times m_{solution}}{10^9}$$

$$= \frac{(25)(20000000)}{10^9}$$

$$= 0.5g$$

∴ 0.5g is the maximum mass allowed.

3. $$n_{NaCl} = \frac{m}{M}$$

$$= \frac{(0.90g)}{(58.44g/mol)}$$

$$\doteq 0.0154 \text{ mol NaCl}$$

$$c = \frac{n}{V}$$

$$= \frac{(0.0154mol)}{(0.100L)}$$

$$\doteq 0.15M$$

∴ the [NaCl] is 0.15M

4. $$V_1 = \frac{C_2V_2}{C_1}$$

$$= \frac{(0.10M)(2.0L)}{(18M)}$$

$$= 0.0111L$$

$$V_{H_2O} = V_{total} - V_1$$

$$= 2.0 - 0.0111$$

$$= 1.989L\ H_2O$$

∴ Mr. Arthur needs 0.0111L of 18M H_2SO_4 & 1.989L of H_2O.

SSSQ

5. $Na_2S_{(aq)} + FeSO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + FeS_{(s)}$

$\cancel{2Na^+_{(aq)}} + S^{2-}_{(aq)} + Fe^{2+}_{(aq)} + \cancel{SO_4^{2-}{}_{(aq)}} \rightarrow \cancel{2Na^+_{(aq)}} + \cancel{SO_4^{2-}{}_{(aq)}} + FeS_{(s)}$

spectator ions: $Na^+_{(aq)}$ & $SO_4^{2-}{}_{(aq)}$

$Fe^{2+}_{(aq)} + S^{2-}_{(aq)} \rightarrow FeS_{(s)}$

6. Add <u>one</u> crystal if it
- ↳ dissolves = unsaturated
- ↳ does not dissolve = saturated
- ↳ recrystallizes = supersaturated

7. $Na_2S_{(aq)} + Hg(NO_3)_{2(aq)} \rightarrow HgS_{(s)} + 2NaNO_{3(aq)}$

Na_2S: $V = 0.025L$, $C = 0.085M$

$Hg(NO_3)_2$: $V = 0.0565L$, $C = 0.10M$

HgS: $m = ?$

$n_{Na_2S} = CV$
$= (0.085)(0.025)$
$= 2.125 \times 10^{-3}$ mol

$n_{Hg(NO_3)_2} = CV$
$= (0.10)(0.0565)$
$= 5.65 \times 10^{-3}$ mol

$\frac{1 \text{ mol } Na_2S}{2.125 \times 10^{-3}} = \frac{1 \text{ mol } HgS}{x}$

L.R. $x = 2.125 \times 10^{-3}$ mol HgS

$\frac{1 \text{ mol } Hg(NO_3)_2}{5.65 \times 10^{-3}} = \frac{1 \text{ mol } HgS}{x}$

$x = 5.65 \times 10^{-3}$ mol HgS

$m_{HgS} = nM$
$= (2.125 \times 10^{-3})(232.65)$
$\doteq 0.493$ g

∴ 0.493 g of HgS is expected to precipitate

8. $HCN_{(aq)} + H_2O_{(l)} \leftrightarrow H_3O^+_{(aq)} + CN^-_{(aq)}$

acid | base | conj acid | conj base

9. $pH = -\log[H_3O^+]$
$= -\log[3.8 \times 10^{-3}]$
$= 2.42$ ∴ the pH of the solution is 2.42.

SSSQ

10. $HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

$V = 0.01384L$ $\quad V = 0.025L$

$C = ?$ $\quad C = 0.100M$

$$n_{NaOH} = CV$$
$$= (0.100M)(0.025L)$$
$$= 2.5\times10^{-3}\text{mol NaOH}$$

$$\frac{1\text{ mol NaOH}}{2.5\times10^{-3}\text{mol}} = \frac{1\text{ mol HCl}}{x}$$
$$x = 2.5\times10^{-3}\text{mol HCl}$$

$$C_{HCl} = \frac{n}{V}$$
$$= \frac{(2.5\times10^{-3})}{(0.01384L)}$$
$$\doteq 0.1806M$$

$\therefore$ the [HCl] is 0.1806 M.

Name: ANSWERS Date: ____________

BCI SCIENCE

SCH 3U

2DI Chemistry Review II

A. Fill in the blanks (use the following list)

catalyst	ionization	acid	base	neutralization
indicator	electrolyte	rate	pH	concentration

1. A(n) **ACID** is a substance that when dissolved in water ionizes to form H^+ ions and anions.
2. The _**pH**____ scale is used to determine the degree of acidity or alkalinity.
3. The amount of pure acid or base per 1 L of water is the definition of _**CONCENTRATION**___.
4. When an ionic substance is dissolved in water it undergoes the process of __**IONIZATION**___.
5. A(n) _**BASE**__ is a substance that when dissolved in water ionizes to form cations and OH^- ions.
6. An aqueous solution that is capable of conducting electricity is known as a(n) _**ELECTROLYTE**__.
7. A substance that speeds up chemical reactions is called a __**CATALYST**__.
8. The speed at which a reaction occurs is the __**RATE**_ of reaction.
9. A(n) _**INDICATOR**_ is a substance that changes colour at a specific pH range.
10. Water and salt are the products of a __**NEUTRALIZATION**___ reaction.

B. **True or False** (If the statement is false, rewrite the statement to make it true)

11. A strong base and a weak base could have the same pH level.

T

12. An acid with a pH of 2 is ~~20~~ times stronger than an acid with a pH of 4.

F **200**

13. Each 1 unit on the pH scale represents a tenfold increase in concentration.

T

14. ~~Decreasing~~ the surface area of a reactant would increase the rate of reaction.

F INCREASING

15. Increasing the concentration of the reactants would increase the rate of reaction.

T

16. ~~Decreasing~~ the temperature of the reaction would increase the rate of reaction.

F INCREASING

17. Phenolphthalein turns pink in an ~~acid~~.

F **BASE**

C. **Similarities/Differences** (describe similarities/differences between each pair)

18. acid/base
- **BOTH DISSOCIATE TO FORM IONS**
- **ACIDS FORM H_3O^+**
- **BASES FORM OH^-**

19. red litmus/blue litmus
- **BOTH INDICATE pH OF SOLUTION**
- **RED LITMUS TURNS BLUE IN A BASE**
- **BLUE LITMUS TURNS RED IN AN ACID**

20. surface area/temperature
- **BOTH AFFECT THE RATE OF REACTION**
- **INCREASING SURFACE AREA INCREASES RATE**
- **INCREASING TEMPERATURE INCREASES RATE**

21. concentration/ionization
- **BOTH INDICATE AMOUNT OF IONS IN SOL'N**
- **[ ] IS AMOUNT OF SOLUTE (mol) / LITRE**
- **IONIZATION IS AMOUNT OF IONS / MOLECULE**

22. strong acid/weak acid
- **BOTH INDICATE THE POTENTIAL TO IONIZE**
- **STRONG ACIDS FULLY IONIZE**
- **WEAK ACIDS PARTIALLY IONIZE**

23. bromothymol blue/phenolphtalein
- **BOTH ARE INDICATORS**
- **BTB TURNS YELLOW IN ACIDS**
- **PHENOLPHTHALEIN TURNS PINK IN A BASE**

24. H^+/OH^-
- **TOGETHER MAKE H_2O**
- **H^+ RELEASED FROM ACIDS**
- **OH^- RELEASED FROM BASES**

25. metal oxides/non-metal oxides
- **BOTH ARE OXIDES**
- **METAL OXIDES IN WATER MAKE BASES**
- **NON-METAL OXIDES IN WATER MAKE ACIDS**

D. Multiple choice (Choose the best answer)

26. Which of the following is an acid?
    a) NaOH
    b) H_2O
    c) HCH_3CO_2
    d) $Mg(OH)_2$

27. Which of the following would make an acid when dissolved in water?
    a) sulphur trioxide $SO_{3(g)} + H_2O_{(l)} \rightarrow H_2SO_{4(aq)}$
    b) magnesium oxide
    c) aluminum oxide
    d) copper(I) oxide

28. Which of the following would make a base when dissolved in water?
    a) carbon dioxide
    b) sulphur trioxide
    c) sodium oxide $Na_2O_{(s)} + H_2O_{(l)} \rightarrow 2NaOH_{(aq)}$
    d) nitrogen dioxide

29. What type of reaction occurs between NaOH + HCl?
    a) synthesis
    b) decomposition
    c) single displacement
    d) double displacement

30. The pH of the reaction in # 29 should be
    a) 0
    b) 5
    c) 7
    d) 9

31. When Alkaseltzer is ground into a powder, it reacts more quickly in water. This is an example of the effect of:
    a) concentration
    b) surface area
    c) temperature
    d) a catalyst

32. Cake batter rises when the cake is baked. This is an example of the effect of:
    a) concentration
    b) surface area
    c) temperature
    d) a catalyst

33. Which of the following is a strong acid?
    a) HCH_3CO_2
    b) NaOH
    c) HCl
    d) $HC_2H_5O_2$

E. **Characteristics of Acids & Bases** (fill in the following chart)

INDICATOR/TEST	ACID	BASE
Red Litmus Paper	RED	BLUE
Blue Litmus Paper	RED	BLUE
Phenolphthalein	CLEAR	PINK
Bromothymol Blue	YELLOW	BLUE
Feel	N/A	SLIPPERY
Taste	SOUR	BITTER
Reaction with Mg	RELEASES $H_{2(g)}$	NR
Reaction with baking soda	RELEASES $CO_{2(g)}$	NR
Conductivity	STRONG = YES WEAK = POOR	STRONG = YES WEAK = POOR

F. **Making Acids & Bases** (write out the acid or base product and then balance the equation)

34. ____ $SO_{3(g)}$ + ____ $H_2O_{(l)} \rightarrow$ **$H_2SO_{4(aq)}$**

35. ____ $K_2O_{(s)}$ + ____ $H_2O_{(l)} \rightarrow$ **$2KOH_{(aq)}$**

36. ____ $Na_2O_{(s)}$ + ____ $H_2O_{(l)} \rightarrow$ **$2NaOH_{(aq)}$**

37. ____ $CO_{(g)}$ + ____ $H_2O_{(l)} \rightarrow$ **$H_2CO_{2(aq)}$** **CARBONOUS ACID**

38. ____ $MgO_{(s)}$ + ____ $H_2O_{(l)} \rightarrow$ **$Mg(OH)_{2(aq)}$**

G. Neutralization (Write down the acid and base required to produce the following salts)

39. Na_2SO_4 — $NaOH_{(aq)} + H_2SO_{4(aq)}$

40. $MgCl_2$ — $Mg(OH)_{2(aq)} + HCl_{(aq)}$

41. $NaNO_3$ — $NaOH_{(aq)} + HNO_{3(aq)}$

42. Li_3PO_4 — $LiOH_{(aq)} + H_3PO_{4(aq)}$

43. KCl — $KOH_{(aq)} + HCl_{(aq)}$

H. Identification of unknowns. (Explain how to identify each substance in the beakers by using different tests)

44. Suppose you are given five beakers, each containing an unknown liquid. One is distilled water, one is a strong acid, one is a weak acid, one is a base and one is a salt solution. Describe how you would find out which was which.

- PHENOLPHTHALEIN: DISTILLED WATER = CLEAR, ACIDS = CLEAR, SALT = CLEAR, BASE = PINK
- CONDUCTIVITY TEST: DISTILLED WATER = NO, STRONG ACID = BRIGHT, WEAK ACID = POOR, SALT = BRIGHT
- BTB = STRONG ACID = YELLOW, SALT SOLUTION =

I. Acid-Base Application.

45. Explain why putting lemon on bitter tasting fish helps to minimize the bitter taste of fish.

- LEMON (ACID) NEUTRALIZES FISH (BASIC) MAKING IT TASTE LESS BASIC

46. A healthy pool has a pH level between 6.7 and 7.2. When a pool's pH level becomes too basic, algae starts to grow. If algae began to grow in the pool, what would you recommend that the pool owner should do to counter act the algae growth?

- ADD CHLORINE OR BROMINE (ACID) TO MAKE IT LESS BASIC SO ALGAE STOPS GROWING.