

Solutions & Solubility Unit Review

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$$3. n_{\text{NaNO}_3} = \frac{m}{M}$$

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

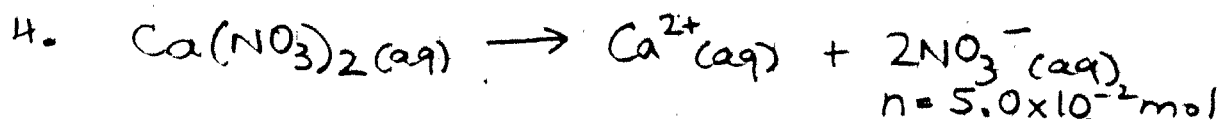
$$\approx 0.011765 \text{ mol NaNO}_3$$

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

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

$$\approx 0.037 \text{ M}$$

\therefore the $[\text{NaNO}_3]$ is 0.037 M



$$\frac{2 \text{ mol NO}_3^{-}}{5.0 \times 10^{-2} \text{ mol}} = \frac{1 \text{ mol Ca}(\text{NO}_3)_2}{x}$$

$$x = 0.025 \text{ mol Ca}(\text{NO}_3)_2$$

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

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

$$= 0.625 \text{ L}$$

\therefore 0.625 L of $\text{Ca}(\text{NO}_3)_2$ contains $5.0 \times 10^{-2} \text{ mol}$ of NO_3^{-}

$$5. C_1 V_1 = C_2 V_2$$

$$C_2 = \frac{C_1 V_1}{V_2}$$

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

$$= 0.8 \text{ M}$$

\therefore the $[\text{H}_2\text{SO}_4]$ is 0.8 M

$$6. n = CV$$

$$= (0.00100 \text{ M})(0.100 \text{ L})$$

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

\therefore there are $1.0 \times 10^{-4} \text{ mol}$ of NaOH

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

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

$$= 2.86 \times 10^{-5} \%$$

$$\begin{aligned} \text{nic/day} &= \text{nic./cig} \times \text{cig/day} \\ &= (0.001 \text{ g}) \times 20 \\ &= 0.02 \text{ g nic} \end{aligned}$$

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

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

$$= 0.1479 \text{ mol Na}^+$$

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

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

$$= 0.1479 \text{ M}$$

$\therefore [\text{Na}^+]$ is 0.1479 M

9. a) $\text{H}_2\text{SO}_4(\text{aq})$
sulphuric acid

b) $\text{HNO}_3(\text{aq})$
nitric acid

c) $\text{HBr}(\text{aq})$
hydrobromic acid

d) $\text{HCl}(\text{aq})$
hydrochloric acid

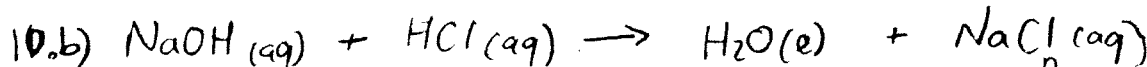
e) $\text{HF}(\text{aq})$
hydrofluoric acid

$$10. a) [\text{H}_3\text{O}^+] = 10^{-\text{pH}}$$

$$= 10^{-2.5}$$

$$= 3.16 \times 10^{-3} \text{ M}$$

\therefore the $[\text{H}_3\text{O}^+]$ is $3.16 \times 10^{-3} \text{ M}$



$$V = 0.032 \text{ L}$$

$$V = 0.020 \text{ L}$$

$$C = 1.0 \text{ M}$$

$$\begin{aligned} n_{\text{HCl}} &= CV \\ &= (1.0 \text{ M})(0.020 \text{ L}) \\ &= 0.020 \text{ mol HCl} \end{aligned}$$

$$\begin{aligned} \frac{1 \text{ mol HCl}}{0.020 \text{ mol}} &= \frac{1 \text{ mol NaOH}}{x} \\ x &= 0.020 \text{ mol NaOH} \end{aligned}$$

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

$$= \frac{(0.020 \text{ mol})}{(0.032 \text{ L})}$$

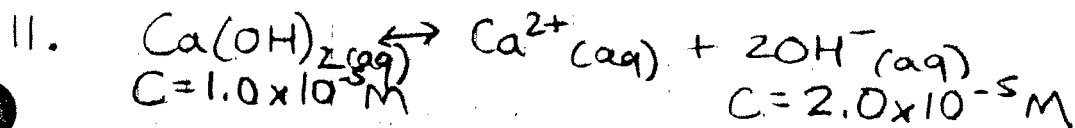
$$= 0.625 \text{ M}$$

$\therefore 0.032 \text{ L}$ is required

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

$$= \frac{(0.020 \text{ mol})}{(0.625 \text{ M})}$$

$$= 0.032 \text{ L}$$



$$\begin{aligned} \text{pOH} &= -\log [\text{OH}^-] \\ &= -\log [2.0 \times 10^{-5}] \\ &= 4.70 \end{aligned}$$

$$\begin{aligned} \text{pH} &= 14 - \text{pOH} \\ &= 14 - 4.70 \\ &= 9.3 \end{aligned}$$

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

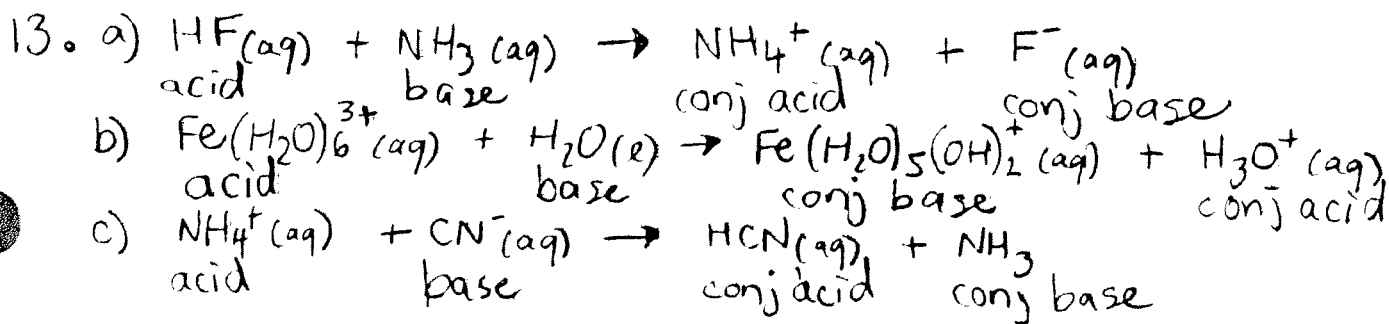
12. $n_{\text{NaOH}} = \frac{m}{M}$
 $= \frac{(2.5 \text{ g})}{(40.0 \text{ g/mol})}$
 $= 0.0625 \text{ mol NaOH}$

$$\begin{aligned} C &= \frac{n}{V} \\ &= \frac{(0.0625 \text{ mol})}{(0.100 \text{ L})} \\ &= 0.625 \text{ M} \end{aligned}$$

$$\begin{aligned} \text{pOH} &= -\log [\text{OH}^-] \\ &= -\log [0.625] \\ &= 0.204 \end{aligned}$$

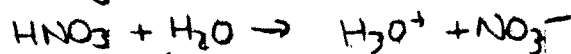
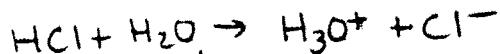
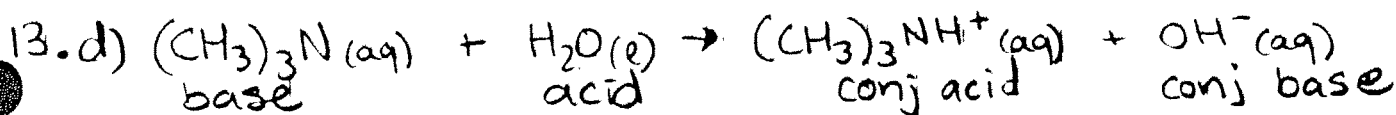
$$\begin{aligned} \text{pH} &= 14 - \\ &= 12.8 \end{aligned}$$

\therefore the pH is 12.8



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14. $n_{\text{HCl}} = CV$
 $= (4.00\text{M})(0.07\text{L})$
 $= 0.28 \text{ mol HCl}$

$n_{\text{HNO}_3} = CV$
 $= (8.00\text{M})(0.030\text{L})$
 $= 0.24 \text{ mol HNO}_3$

$\frac{1 \text{ mol HCl}}{0.28 \text{ mol}} \rightarrow \frac{1 \text{ mol H}_3\text{O}^+}{x}$
 $x = 0.28 \text{ mol H}_3\text{O}^+$

$\frac{1 \text{ mol HNO}_3}{0.24 \text{ mol}} = \frac{1 \text{ mol H}_3\text{O}^+}{x}$
 $x = 0.24 \text{ mol H}_3\text{O}^+$

$n_{\text{H}_3\text{O}^+ \text{ total}} = 0.28 + 0.24$
 $= 0.52 \text{ mol H}_3\text{O}^+$

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

$[\text{H}_3\text{O}^+] = \frac{n}{V}$
 $= \frac{0.52 \text{ mol}}{0.100\text{L}}$
 $= 5.2\text{M}$

$C_2 = \frac{C_1 V_1}{V_2}$
 $= \frac{(5.2\text{M})(0.100\text{L})}{(0.500)}$
 $= 1.04\text{M}$

$\text{pH} = -\log [\text{H}_3\text{O}^+]$
 $= -\log [1.04]$
 $= -0.017$
 ≈ 0

∴ the pH of the solution is 0.

Solutions & Solubility Sample Questions

①

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

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

$$\hat{=} 19.5\%$$

∴ the m/m% of CaCl_2 is 19.5%.

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

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

$$= \frac{(25)(20,000,000)}{10^9}$$

$$= 0.5g$$

∴ 0.5g is the maximum mass allowed.

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

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

$$\hat{=} 0.0154 \text{ mol NaCl}$$

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

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

$$\hat{=} 0.15M$$

∴ the $[\text{NaCl}]$ is 0.15M

$$4. \quad V_1 = \frac{C_2 V_2}{C_1}$$

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

$$= 0.0111L$$

$$V_{\text{H}_2\text{O}} = V_{\text{total}} - V_1$$

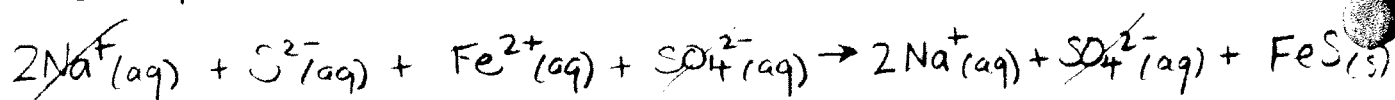
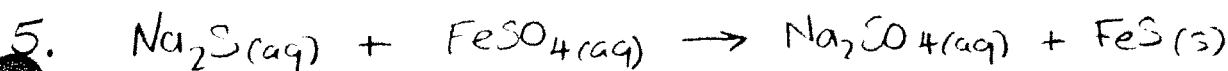
$$= 2.0 - 0.0111$$

$$= 1.989L \text{ H}_2\text{O}$$

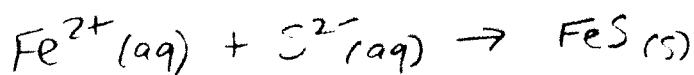
∴ Mr. Arthur needs 0.0111L of 18M H_2SO_4 & 1.989L of H_2O .

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spectator ions: $\text{Na}^+(\text{aq})$ & $\text{SO}_4^{2-}(\text{aq})$

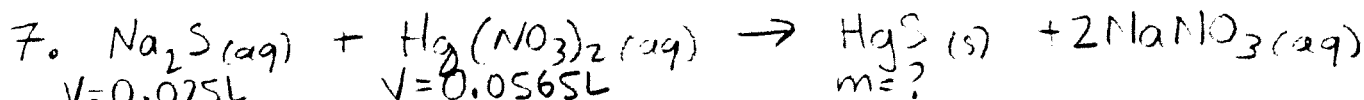


6. Add one crystal if it

↳ dissolves = unsaturated

↳ does not dissolve = saturated

↳ recrystallizes = supersaturated



$V = 0.025\text{L}$

$V = 0.0565\text{L}$

$m = ?$

$C = 0.085\text{M}$

$C = 0.10\text{M}$

$n_{\text{Na}_2\text{S}} = CV$
 $= (0.085)(0.025)$
 $= 2.125 \times 10^{-3} \text{mol}$

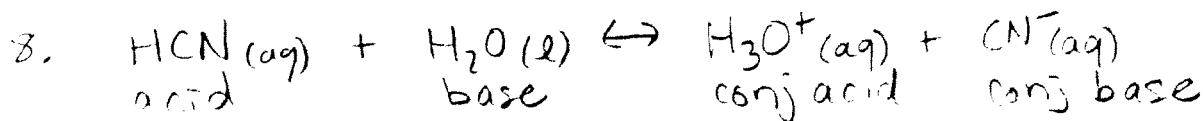
$n_{\text{Hg}(\text{NO}_3)_2} = CV$
 $= (0.10)(0.0565)$
 $= 5.65 \times 10^{-3} \text{mol}$

$m_{\text{HgS}} = n M$
 $= (2.125 \times 10^{-3})(232.65)$
 $= 0.493 \text{g}$

$\frac{1 \text{mol Na}_2\text{S}}{2.125 \times 10^{-3}} = \frac{1 \text{mol HgS}}{x}$
L.R. $x = 2.125 \times 10^{-3} \text{mol HgS}$

$\frac{1 \text{mol Hg}(\text{NO}_3)_2}{5.65 \times 10^{-3}} = \frac{1 \text{mol HgS}}{x}$
 $x = 5.65 \times 10^{-3} \text{mol HgS}$

∴ 0.493g of HgS is expected to precipitate

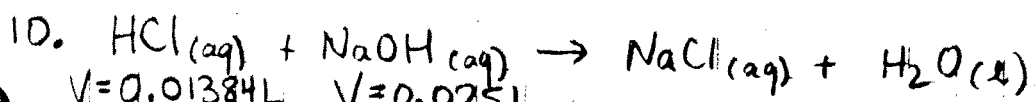


9. $\text{pH} = -\log [\text{H}_3\text{O}^+]$
 $= -\log [3.8 \times 10^{-3}]$

$= 2.42$ ∴ the pH of the solution is 2.42.

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③



$$V = 0.01384 \text{ L}$$

$$V = 0.025 \text{ L}$$

$$C = ?$$

$$C = 0.100 \text{ M}$$

$$n_{\text{NaOH}} = CV$$

$$= (0.100 \text{ M})(0.025 \text{ L})$$

$$= 2.5 \times 10^{-3} \text{ mol NaOH}$$

$$\frac{1 \text{ mol NaOH}}{2.5 \times 10^{-3} \text{ mol}} = \frac{1 \text{ mol HCl}}{x}$$

$$x = 2.5 \times 10^{-3} \text{ mol HCl}$$

$$x = 2.5 \times 10^{-3} \text{ mol HCl}$$

$$C_{\text{HCl}} = \frac{n}{V}$$

$$= \frac{(2.5 \times 10^{-3})}{(0.01384 \text{ L})}$$

$$= 0.1806 \text{ M}$$

$$= 0.1806 \text{ M}$$

∴ the $[\text{HCl}]$ is 0.1806 M .

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- 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) $\text{Mg}(\text{OH})_2$

27. Which of the following would make an acid when dissolved in water?

- a) sulphur trioxide** $\text{SO}_{3(g)} + \text{H}_2\text{O}_{(l)} \rightarrow \text{H}_2\text{SO}_{4(aq)}$
- 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** $\text{Na}_2\text{O}_{(s)} + \text{H}_2\text{O}_{(l)} \rightarrow 2\text{NaOH}_{(aq)}$
- d) nitrogen dioxide

29. What type of reaction occurs between $\text{NaOH} + \text{HCl}$?

- 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

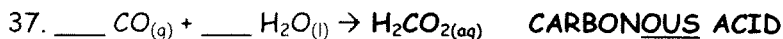
33. Which of the following is a strong acid?

- a) HCH_3CO_2
- b) NaOH
- c) HCl**
- d) $\text{HC}_2\text{H}_3\text{O}_2$

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)



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



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.