

PROBLEM SET FOR ACIDS AND BASES

1. From the list of compounds below, determine which compounds are:

a.	Arrhenius acids	H_2SO_4 , HBr
b.	Bronsted-Lowry bases	NH_3 , KOH , CaCO_3 , Na_2CO_3 , $\text{Ba}(\text{OH})_2$, KHCO_3
c.	weak bases	NH_3 , CaCO_3 , Na_2CO_3 , KHCO_3
d.	Lewis acids	H_2SO_4 , HBr , BCl_3
e.	salts	Na_2SO_4 , KBr

NH_3 , KOH , Na_2SO_4 , H_2SO_4 , CaCO_3 , Na_2CO_3 , H_2O , $\text{Ba}(\text{OH})_2$, HBr , KHCO_3 , KBr , BCl_3

2. How many mL of 0.234 M HCl are required to neutralize 45.0 mL of 0.135 M KOH ?
35.0 mL of 0.88M $\text{Mg}(\text{OH})_2$?



For 1:1 stoichiometry $M_a V_a = M_b V_b$

$$0.234 \text{ M} \times V_a = 0.135 \text{ M} \times 45.0 \text{ mL}$$

$$V_a = 26.0 \text{ mL HCl}$$

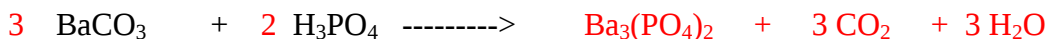
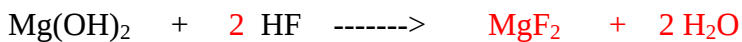
For stoichiometry other than 1:1 you need to use stoichiometric ratios

$$M_b V_b = \text{mol}_b = 0.88 \text{ M} \times 35.0 \text{ mL} = 3.08 \text{ mmol Mg}(\text{OH})_2$$

$$3.08 \text{ mmol Mg}(\text{OH})_2 \times \frac{2 \text{ mol HCl}}{1 \text{ Mg}(\text{OH})_2} = 6.16 \text{ mmol HCl}$$

$$M = \frac{\text{mol}}{\text{L}} \quad L = \frac{\text{mol}}{M} = \frac{6.16 \text{ mmol}}{0.234 \text{ M}} = 26.3 \text{ mL HCl}$$

3. Complete and balance the following reactions:



4. A 10.67 g sample of a solution of alanine (a monoprotic aminoacid with the formula $\text{CH}_3\text{CH}(\text{NH}_2)\text{COOH}$) requires 42.3 mL of a 0.250 M NaOH solution to be neutralized. What is the w/w% of the acid solution?

$$M_b V_b = \text{mol}_b = \frac{0.250 \text{ mol}}{\text{L}} \times 0.0423 \text{ L} = 0.0106 \text{ mol NaOH} = 0.0106 \text{ mol alanine}$$

$$0.0106 \text{ mol alanine} \times \frac{89.0 \text{ g alanine}}{1 \text{ mol alanine}} = 0.943 \text{ g alanine}$$

$$\frac{0.943 \text{ g alanine}}{10.67 \text{ g solution}} \times 100\% = 8.84 \% \text{ w/w alanine}$$

5. Determine the pH and pOH of the following solutions:

$$\text{pH} = -\log [\text{H}^+] \quad \text{pOH} = -\log [\text{OH}^-] \quad \text{pH} + \text{pOH} = 14$$

		pH	pOH
a.	$3.4 \times 10^{-3} \text{ M HCl}$	2.47	11.53
b.	$7.78 \times 10^{-4} \text{ M NaOH}$	10.891	3.109
c.	$4.55 \times 10^{-6} \text{ M Mg(OH)}_2$	8.959	5.041
d.	0.000822 M HNO_3	3.085	10.915

6. Determine the H^+ and OH^- concentrations for solutions that have:

$$\text{H}^+ = 10^{-\text{pH}} \quad \text{OH}^- = 10^{-\text{pOH}} \quad [\text{H}^+] [\text{OH}^-] = 1.00 \times 10^{-14} \quad \text{or} \quad \text{pH} + \text{pOH} = 14$$

		H^+	OH^-
a.	pH = 4.56	2.8×10^{-5}	3.6×10^{-10}
b.	pOH = 11.90	7.9×10^{-3}	1.3×10^{-12}
c.	pH = 12.78	1.7×10^{-13}	6.0×10^{-2}
d.	pH = 6.6	2.5×10^{-7}	4.0×10^{-8}