IB Chemistry II Topic 8 Acids and Bases Review

8.1 Theories of Acids and Bases

1. Define acids and bases according to the following theories:
   Arrhenius, Bronstead-Lowry, Lewis
2. In aqueous solution, sodium hydroxide is a strong base and ammonia is a weak base. Use the Bronsted-Lowry theory to outline why both substances are classified as bases.
3. Sodium hydrogencarbonate dissolves in water forming an alkaline solution according to the following equilibrium:

   $HCO_3^-(aq) + H_2O(l) \longrightarrow H_2CO_3(aq) + OH^-(aq)$

   a) Why is the solution alkaline?
   b) Using the Bronsted-Lowry theory, state, with a brief explanation, whether the $HCO_3^-(aq)$ ion is behaving as an acid or a base.
   c) Identify the conjugate base of carbonic acid, H_2CO_3

4. The simplest amino acid has the structure NH_2CH_2COOH.

   a) Draw its structural formula
   b) Circle and name the two functional groups. Identify them as acidic or basic.
   c) Write the formula for its conjugate acid.

5. Identify the acid/base conjugate pairs for:
   a) $NH_3 + H_2O \longrightarrow NH_4^+ + OH^-$
   b) $CO_3^{2-} + H_2O \longrightarrow HCO_3^- + OH^-$
   c) $HNO_3 + H_2O \longrightarrow NO_3^- + H_3O^+$

6. Substances can act as Bronsted-Lowry acids and/or bases if they give rise to a stable product. Identify the conjugate acid and base form of the following species and identify which of A-E is the most likely to be a Bronsted-Lowry acid or base.

	Conjugate Acid	Conjugate Base
A. CH_4		
B. NH_4		
C. NH_3		
D. H_2O		

7. Consider a weak acid HA dissolved in water:

   $HA(aq) + H_2O(l) \longrightarrow H_3O^+(aq) + A^-(aq)$

Which statements are correct?
I. $A^-(aq)$ is a much stronger base than $H_2O(l)$.
II. HA dissociates only to a small extent in aqueous solution.
III. The concentration of $H_3O^+(aq)$ is much greater than the concentration of $HA(aq)$

8. Which equation represents an acid-base reaction according to Lewis theory **but not** according to Bronsted-Lowry theory?
A. $CO_3^{2-}(aq) + 2H^+(aq) \longrightarrow H_2O(l) + CO_2(l)$
B. $Fe^{2+} + 6\ H_2O \longrightarrow [\ Fe\ (H_2O)_6]^{2+}$
C. $BaO(s) + H_2O(l) \longrightarrow Ba^{2+}(aq) + 2OH^-(aq)$
D. $NH_3(g) + HCl(g) \longrightarrow NH_4Cl(s)$

8.2 Properties of Acids and Bases

1. List the key properties of acids and bases.
2. Which one of the following substances would an acid not react with?
A. blue litmus paper
B. sodium carbonate
C. magnesium ribbon
D. silver chloride

3. Which one of the following solutions could you distinguish from the others using universal indicator paper?
A. Aqueous ammonia
B. Aqueous sodium chloride
C. Aqueous sodium carbonate
D. Aqueous calcium hydroxide

4. Write balanced equations for the following reactions:
a) iron with dilute sulfuric acid
b) lead carbonate with nitric acid
c) zinc oxide with hydrochloric acid
d) calcium hydroxide with nitric acid
e) sodium hydrogen carbonate with sulfuric acid

5. a) Write the formulae of the oxides of sodium, phosphorus and sulfur
b) Describe their acid/base nature.
c) Write balanced chemical equations for their reactions with water.

6. State the name used to describe a substance that can act as an acid and a base. Using an example illustrate how it can behave as both an acid and a base.

7. A household cleaner contains aqueous ammonia. A 2.447g sample of the cleaner is diluted with water to 20.0cm_3. This solution required 28.51cm_3 of 0.04040 $moldm_{-3}$ sulfuric acid to neutralize all the alkali.
a) Write a balanced chemical equation for the reaction of sulfuric acid with ammonia to form ammonium sulfate.
b) Calculate the amount (moles) of sulfuric acid required for this reaction, and the amount (moles), mass and percentage by mass of ammonia present in the household cleaner.

8. Discuss the acid-base nature of the period three oxides. Write an equation to illustrate the reaction of one of these oxides to produce an acid and another equation of another of these oxides to produce a hydroxide.

9. a) State the bonding in the oxides of sodium, magnesium, silicon and phosphorus.
b) What happens to the pH of pure water when these oxides are added to separate samples of the water? Give equations for any reactions that occur.