Acid Base Equilibrium Qualitative Questions

1.   Write formulas for the conjugate bases for each of these acids

(a) HCl (d) H_2SO_4
(b) CH_4 (e) NH_3
(c) HSO_3^{1-} (f) $HClO_4$

2.   Show how each of these acids react with water and forms a conjugate
     acid–base pair. Show the conjugate acid base pairs, identify the bases
     competing for protons, indicate which base is the better base, which
     side the equilibrium will lye on (left or right) and finally if the
     resulting equilibrium is acidic or basic.

(a) HCl (d) $HClO_4$
(b) HNO_3 (e) H_2S
(c) H_2SO_4 (f) H_3PO_4

3.   Draw the electron–dot structures for these species and show that each
     has an unshared pair of electrons.

(a) NH_3 (f) SO_4^{2-}
(b) CH_3^{1-} (g) S^{2-}
(c) H_2O (h) NH_2^{1-}
(d) CH_3OH (i) HSO_3^{1-}
(e) Cl^{1-}

4.   Write the reaction of water with each of the species listed in Question
     3. Show the conjugate acid base pairs, identify the bases competing for
     protons, indicate which base is the better base, which side the
     equilibrium will lye on (left or right) and finally if the resulting
     equilibrium is acidic or basic.

5.   Use Table 15–1 to predict whether a reaction between these pairs occurs
     to any appreciable extent. Answer each question fully using the
     instructions from question #2

(a) $HCl + H_2O$ (e) $CH_3COOH + H_2SO_4$
(b) $H_2O + H_2SO_4$ (f) $HClO_4 + OH^{1-}$
(c) $HSO_4^{1-} + H_3O^{1+}$ (g) $HCO_3^{1-} + OH^{1-}$
(d) $HS^{1-} + H_3O^{1+}$ (h) $NH_3 + HSO_3^{1-}$

6.   The formation of products is strongly favored in this acid–base system:

$$HB + X^{1-} \rightleftharpoons HX + B^{1-}$$
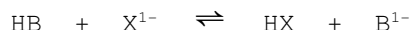
(a)   Identify the bases competing for protons.
(b)   Which base is stronger?
(c)   Which is the weaker acid, HX or HB?
(d)   Does the K for this system have a large or small value?
(e)   How is the equilibrium affected by the addition of the soluble salt NaB?

7. Write the equation for the reaction of each of these ions with water. Experiments show that (b), (c), and (d) form acid solutions. Answer each question fully using the instructions from question #2

(a) HCO_3^{1-} (e) HS^{1-}
(b) $H_2PO_4^{1-}$ (f) HPO_4^{2-}
(c) HSO_4^{1-} (g) CO_3^{2-}
(d) NH_4^{1+}

8. Which of these 1.0 kmol/m^3 solutions is acidic or basic? Explain. Fully as per instructions from question #2. If multiple equilibrium exist, treat accordingly

(a) Na_2CO_3 (f) $MgSO_4$
(b) Na_2S (g) $KHCO_3$
(c) $FeCl_3$ (h) $AgNO_3$
(d) $(NH_4)_2SO_4$ (i) NH_4I
(e) $Al_2(SO_4)_3$ (j) $NaHSO_4$