Multiple Choice: select the best answer for each question

(1)

1. In the laboratory, $H_2(g)$ can be produced by adding which of the following to 1.0 M $HCl(aq)$?
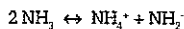
   I. 1 M $NH_3(aq)$
   II. $Zn(s)$
   III. $NaHCO_3(s)$

     (A) I only
     (B) II only
     (C) III only
     (D) I and II only
     (E) I, II, and III

(2)

At 25°C, aqueous solutions with a pH of 8 have hydroxide concentration, $[OH^-]$, of

     (A) $1 \times 10^{-14}\ M$
     (B) $1 \times 10^{-8}\ M$
     (C) $1 \times 10^{-6}\ M$
     (D) $1.0\ M$
     (E) $8.0\ M$

(3)

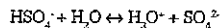$$2\,NH_3 \leftrightarrow NH_4^+ + NH_2^-$$

. In liquid ammonia, the reaction represented above occurs. In the reaction, NH_4^+ acts as

     (A) a catalyst
     (B) both an acid and a base
     (C) the conjugate acid of NH_3
     (D) the reducing agent
     (E) the oxidizing agent

(4)

$$HSO_4^- + H_2O \leftrightarrow H_3O^+ + SO_4^{2-}$$

. In the equilibrium represented above, the species that act as bases include which of the following?
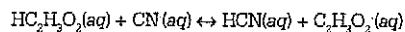
   I. HSO_4^-
   II. H_2O
   III. SO_4^{2-}

     (A) II only
     (B) III only
     (C) I and II
     (D) I and III
     (E) II and III

(5)

All of the following species can function as Brønsted-Lowry bases in solution EXCEPT

     (A) H_2O
     (B) NH_3
     (C) S^{2-}
     (D) NH_4^+
     (E) HCO_3^-

(6)

$$HC_2H_3O_2(aq) + CN^-(aq) \leftrightarrow HCN(aq) + C_2H_3O_2^-(aq)$$

The reaction represented above has an equilibrium constant equal to 3.7×10^4. Which of the following can be concluded from this information?

     (A) $CN^-(aq)$ is a stronger base than $C_2H_3O_2^-(aq)$.
     (B) $HCN(aq)$ is a stronger acid than $HC_2H_3O_2(aq)$.
     (C) The conjugate base of $CN^-(aq)$ is $C_2H_3O_2^-(aq)$.
     (D) The equilibrium constant will increase with an increase in temperature.
     (E) The pH of a solution equimolar amounts of $CN^-(aq)$ and $HC_2H_3O_2(aq)$ is 7.0.

Writing chemical reactions. Please write balanced net ionic equations as you would on the AP test.

(A) A 0.1 M nitrous acid solution is added to the same volume of a 0.1 M sodium hydroxide solution

(B) Hydrogen iodide gas is bubbled into a solution of lithium carbonate:

(C) Concentrated hydrochloric acid is added to a solution of sodium sulfide:

(D) Solid calcium carbonate is added to a solution of ethanoic (acetic) acid

(E) Boron trifluoride gas is added to ammonia gas:

(F) Sulfur trioxide gas is bubbled into a solution of sodium hydroxide:

(G) A solution of ethanoic (acetic) acid is added to a solution of barium hydroxide:

(H) Ammonia gas is bubbled into a solution of hydrofluoric acid:

(I) Hydrogen phosphide (phosphine) gas is added to boron trichloride gas:

Free Response Questions

(A)(i) Excess nitric acid is added to solid calcium carbonate.

(ii) Briefly explain why statues made of marble (calcium carbonate) displayed outdoors in urban areas are deteriorating.

(b) $K_a = [H_3O^+][OCl^-]/[HOCl] = 3.2 \times 10^{-8}$

Hypochlorous acid, HOCl, is a weak acid in water.
The K_a expression for HOCl is shown above.

(a) Write a chemical equation showing how HOCl behaves as an acid in water.