CHEMISTRY 12 –BRÖNSTED-LOWRY ACIDS & BASES WORKSHEET

1) Define Brönsted-Lowry acid. **(1 mark)**

A substance that donates a proton to another substance

2) Define Brönsted-Lowry base. **(1 mark)**

A substance that accepts a proton from another substance

3) Write balanced equations showing the reaction of the following weak acids with water: **(8 marks)**

(a) $H_2C_6H_6O_6$

$H_2C_6H_6O_6 + H_2O \rightleftharpoons HC_6H_6O_6^- + H_3O^+$

(b) C_6H_5OH

$C_6H_5OH + H_2O \rightleftharpoons C_6H_5O^- + H_3O^+$

(c) CH_3COOH

$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

(d) HCO_3^-

$HCO_3^- + H_2O \rightleftharpoons CO_3^{2-} + H_3O^+$

(e) H_3BO_3

$H_3BO_3 + H_2O \rightleftharpoons H_2BO_3^- + H_3O^+$

(f) HPO_4^{2-}

$HPO_4^{2-} + H_2O \rightleftharpoons PO_4^{3-} + H_3O^+$

(g) NH_4^+

$NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$

(h) H_2O_2

$H_2O_2 + H_2O \rightleftharpoons HO_2^- + H_3O^+$

4) Write balanced equations showing the reaction of the following weak bases with water: **(8 marks)**

(a) F^-

$F^- + H_2O \rightleftharpoons HF + OH^-$

(b) HPO_4^{2-}

$HPO_4^{2-} + H_2O \rightleftharpoons H_2PO_4^- + OH^-$

(c) CH_3NH_2

$CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH^-$

(d) NH_3

$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

(e) $HC_6H_5O_7^{2-}$

$HC_6H_5O_7^{2-} + H_2O \rightleftharpoons H_2C_6H_5O_7^- + OH^-$

(f) CN^-

$CN^- + H_2O \rightleftharpoons HCN + OH^-$

(g) N_2H_4

$N_2H_4 + H_2O \rightleftharpoons N_2H_5^+ + OH^-$

(h) $C_2O_4^{2-}$

$C_2O_4^{2-} + H_2O \rightleftharpoons HC_2O_4^- + OH^-$

5) Identify the conjugate acid of the following: **(4 marks)**

(a) PO_4^{3-} HPO_4^{2-} (c) $HAsO_4^{2-}$ $H_2AsO_4^-$

(b) $H_2BO_3^-$ H_3BO_3 (d) H_2O H_3O^+

6) Identify the conjugate base of the following: **(4 marks)**

(a) HCN CN^- (c) $H_2PO_4^-$ HPO_4^{2-}

(b) $H_2C_5H_5O_7^-$ $HC_5H_5O_7^{2-}$ (d) H_2O OH^-

7) Circle the Brönsted-Lowry acids in the following equilibria: **(4 marks)**

(a) $HS^- + (H_3BO_3) \rightleftarrows H_2BO_3^- + (H_2S)$ (c) $HC_2O_4^- + (HSO_4^-) \rightleftarrows (H_2C_2O_4) + SO_4^{2-}$

(b) $C_6H_5NH_2 + (H_2O) \rightleftarrows (C_6H_5NH_3^+) + OH^-$ (d) $NO_2^- + (H_2SO_3) \rightleftarrows HSO_3^- + (HNO_2)$

8) Circle the Brönsted-Lowry bases in the following equilibria: **(4 marks)**

(a) $HSO_3^- + (H_2PO_4^-) \rightleftarrows (SO_3^{2-}) + H_3PO_4$ (c) $H_2PO_4^- + (HCO_3^-) \rightleftarrows (HPO_4^{2-}) + H_2CO_3$

(b) $HC_2O_4^- + (H_2BO_3^-) \rightleftarrows H_3BO_3 + (C_2O_4^{2-})$ (d) $(HCO_3^-) + H_2O \rightleftarrows H_2CO_3 + (OH^-)$

9) (a) Write the Brönsted-Lowry acid-base equation for the reaction between HCN and NH_3. **(1 mark)**

$$\underset{A}{HCN} + \underset{B}{NH_3} \rightleftharpoons CN^- + NH_4^+$$

(b) Write a conjugate acid-base pair from the equation above. **(1 mark)**

$\underset{A}{HCN}$ & $\underset{B}{CN^-}$ OR $\underset{A}{NH_4^+}$ & $\underset{B}{NH_3}$

10) (a) Write the Brönsted-Lowry acid-base equation for the reaction between HNO_2 and $C_2O_4^{2-}$. **(1 mark)**

$$\underset{A}{HNO_2} + \underset{B}{C_2O_4^{2-}} \rightleftharpoons NO_2^- + HC_2O_4^-$$

(b) Write a conjugate acid-base pair from the equation above. **(1 mark)**

$\underset{A}{HNO_2}$ & $\underset{B}{NO_2^-}$ OR $\underset{A}{HC_2O_4^-}$ & $\underset{B}{C_2O_4^{2-}}$

11) (a) Write the balanced equation representing the reaction of H_2S with H_2O. **(1 mark)**

$$\underset{A}{H_2S} + \underset{B}{H_2O} \rightleftharpoons HS^- + H_3O^+$$

(b) Identify the Brönsted-Lowry acids in the above equation. **(1 mark)**

H_2S & H_3O^+

12) (a) Write the balanced equation representing the reaction of IO_3^- with H_2O. **(1 mark)**

B A

$IO_3^- + H_2O \rightleftharpoons HIO_3 + OH^-$

(b) Identify the Brönsted-Lowry bases in the above equation. **(1 mark)**

IO_3^- & OH^-

13) (a) Write the acid-base equation for the reaction between H_3BO_3 and HSO_3^-. **(1 mark)**

A B

$H_3BO_3 + HSO_3^- \rightleftharpoons H_2BO_3^- + H_2SO_3$

(b) Write a conjugate acid-base pair from the equation above. **(1 mark)**

H_3BO_3 & $H_2BO_3^-$ OR H_2SO_3 & HSO_3^-

A B A B

14) In an acid-base reaction, the two Brönsted-Lowry acids are hydrofluoric acid (HF) and the hydrogen sulphite ion (HSO_3^-). Write the equation for this reaction. **(2 marks)**

$HF + SO_3^{2-} \rightleftharpoons HSO_3^- + F^-$

A B A B

15) In an acid-base reaction, the two Brönsted-Lowry bases are $HC_2O_4^-$ and $H_2BO_3^-$. Write the equation for this reaction. **(2 marks)**

$HC_2O_4^- + H_3BO_3 \rightleftharpoons H_2BO_3^- + H_2C_2O_4$

B A B A