Chemistry 20 – Lesson 25
Theories of Acids and Bases

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1. Compare and contrast a *weak* acid and a *dilute* acid.

/2 **A *weak* acid refers to an acid that does not ionize 100% when it reacts with water, while a *dilute* acid refers to a solution with a relatively small amount of dissolved solute. The terms weak and dilute refer to different chemical properties.**

2. Compare and contrast a *strong* acid and a *concentrated* acid.

/2 **A *strong* acid refers to an acid that ionizes 100% when it reacts with water, while a *concentrated* acid refers to a solution with a relatively large amount of dissolved solute. The terms strong and concentrated refer to different chemical properties.**

3.

/2 each

a. sodium carbonate

$Na_2CO_{3\,(s)} \rightarrow 2\,Na^+_{(aq)} + CO_3^{2-}{}_{(aq)}$

neutral ionic, strong electrolyte

b. propanoic acid

$C_2H_5COOH_{(aq)} + H_2O_{(l)} \rightarrow C_2H_5COO^-{}_{(aq)} + H_3O^+{}_{(aq)}$

acidic, weak electrolyte

c. Rb_2S

$Rb_2S_{(s)} \rightarrow 2\,Rb^+{}_{(aq)} + S^{2-}{}_{(aq)}$

neutral ionic, strong electrolyte

d. $Al(OH)_3$

$Al(OH)_{3\,(s)} \rightarrow Al^{3+}{}_{(aq)} + 3\,OH^-{}_{(aq)}$

basic, strong electrolyte

e. $KHSO_4$

$KHSO_{4\,(s)} \rightarrow K^+{}_{(aq)} + HSO_4^-{}_{(aq)}$

neutral ionic, strong electrolyte

f. CO_2

$CO_{2\,(g)} + H_2O_{(l)} \rightarrow H_2CO_{3\,(aq)}$

$H_2CO_{3\,(aq)} + H_2O_{(l)} \rightarrow HCO_3^-{}_{(aq)} + H_3O^+{}_{(aq)}$

acidic, weak electrolyte

g. $H_2Cr_2O_7$

$H_2Cr_2O_{7\,(aq)} + H_2O_{(l)} \rightarrow HCr_2O_7^-{}_{(aq)} + H_3O^+{}_{(aq)}$

acidic, weak electrolyte

h. NaNO3

$$\mathbf{NaNO_{3\,(s)} \rightarrow Na^+_{(aq)} + NO_3^-{}_{(aq)}}$$

neutral ionic, strong electrolyte

i. C_2H_5OH

$$\mathbf{C_2H_5OH_{(l)} \rightarrow C_2H_5OH_{(aq)}}$$

neutral molecular, non-electrolyte

j. NH_3

$$\mathbf{NH_{3\,(aq)} + H_2O_{(l)} \rightarrow NH_4^+{}_{(aq)} + OH^-{}_{(aq)}}$$

basic, weak electrolyte

k. H_2SO_3

$$\mathbf{H_2SO_{3\,(aq)} + H_2O_{(l)} \rightarrow HSO_3^-{}_{(aq)} + H_3O^+{}_{(aq)}}$$

acidic, weak electrolyte

l. FrOH

$$\mathbf{FrOH_{(s)} \rightarrow Fr^+{}_{(aq)} + OH^-{}_{(aq)}}$$

basic, strong electrolyte

m. HI

$$\mathbf{HI_{(aq)} + H_2O_{(l)} \rightarrow I^-{}_{(aq)} + H_3O^+{}_{(aq)}}$$

acidic, strong electrolyte

n. $Fe(H_2PO_4)_3$

$$\mathbf{Fe(H_2PO_4)_{3\,(s)} \rightarrow Fe^{3+}{}_{(aq)} + 3\ H_2PO_4^-{}_{(aq)}}$$

neutral ionic, strong electrolyte

o. HCOOH

$$\mathbf{HCOOH_{(aq)} + H_2O_{(l)} \rightarrow HCOO^-{}_{(aq)} + H_3O^+{}_{(aq)}}$$

acidic, weak electrolyte

p. H_3BO_3

$$\mathbf{H_3BO_{3\,(aq)} + H_2O_{(l)} \rightarrow H_2BO_3^-{}_{(aq)} + H_3O^+{}_{(aq)}}$$

acidic, weak electrolyte

q. $C_{12}H_{22}O_{11}$

$$\mathbf{C_{12}H_{22}O_{11\,(s)} \rightarrow C_{12}H_{22}O_{11\,(aq)}}$$

neutral molecular, non-electrolyte

4.

1/ each

a. A neutral solution has equal concentrations of $H^+_{(aq)}$ and $OH^-_{(aq)}$. **(B)**

b. An acid contains $H_3O^+_{(aq)}$ in solution. **(MA)**

c. A base dissociates to produce free $OH^-_{(aq)}$ in solution. **(A)**

d. $NH_{3\,(aq)}$ produces a basic solution. **(MA)**

e. The theory(ies) cannot predict whether $H_2PO_4^-{}_{(aq)}$ will act as an acid or as a base. **(B)**

f. Neutralization occurs when $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$ **(A)**

g. The theory(ies) involve(s) the creation of a hydronium ion. **(MA)**

h. Basic solutions are formed when substances react with water to produce hydroxide ions. **(MA)**

i. Water has no reactive role to play in the formation of acidic and basic solutions. **(A)**

j. The theory(ies) can only predict the basic behaviour of substances containing the hydroxide ion. **(A)**

k. This theory can explain the acid or base behaviours of more substances than the other theory. **(MA)**

l. The theory(ies) need(s) revision to improve the ability to predict new results. **(A)**

5. For the following reactions, write the non-ionic, total ionic and net ionic reaction equations.

a. Excess hydrochloric acid in gastric fluid may be neutralized by a magnesium hydroxide suspension.

/3 **$2\ HCl_{(aq)} + Mg(OH)_{2\,(s)} \rightarrow MgCl_{2\,(aq)} + 2\ H_2O_{(l)}$ (non–ionic)**

$2\ H_3O^+_{(aq)} + 2\ Cl^-_{(aq)} + Mg(OH)_{2\,(s)} \rightarrow 4\ H_2O_{(l)} + Mg^{2+}_{(aq)} + 2\ Cl^-_{(aq)}$ (total ionic)

$2\ H_3O^+_{(aq)} + Mg(OH)_{2\,(s)} \rightarrow 4\ H_2O_{(l)} + Mg^{2+}_{(aq)}$ (net ionic)

b. Chloric acid is neutralized by a potassium hydroxide solution.

/3 $HClO_{3\,(aq)} + KOH_{(aq)} \rightarrow KClO_{3\,(aq)} + H_2O_{(l)}$ **(non–ionic)**

$HClO_{3\,(aq)} + K^{+}_{(aq)} + OH^{-}_{(aq)} \rightarrow K^{+}_{(aq)} + ClO_3^{-}{}_{(aq)} + H_2O_{(l)}$ **(total ionic)**

$HClO_{3\,(aq)} + OH^{-}_{(aq)} \rightarrow ClO_3^{-}{}_{(aq)} + H_2O_{(l)}$ **(net ionic)**

c. Iron pipes are strongly attacked and corroded by hydrochloric acid.

/3 $6\,HCl_{(aq)} + 2\,Fe_{(s)} \rightarrow 2\,FeCl_{3\,(aq)} + 3\,H_{2\,(g)}$ **(non–ionic)**

$6\,H_3O^{+}_{(aq)} + 6\,Cl^{-}_{(aq)} + 2\,Fe_{(s)} \rightarrow 2\,Fe^{3+}_{(aq)} + 6\,Cl^{-}_{(aq)} + 3\,H_{2\,(g)} + 6\,H_2O_{(l)}$ **(total ionic)**

$6\,H_3O^{+}_{(aq)} + 2\,Fe_{(s)} \rightarrow 2\,Fe^{3+}_{(aq)} + 3\,H_{2\,(g)} + 6\,H_2O_{(l)}$ **(net ionic)**

d. Hydrocyanic acid can be used to neutralize a barium hydroxide solution.

/3 $2\,HCN_{(aq)} + Ba(OH)_{2\,(aq)} \rightarrow Ba(CN)_{2\,(aq)} + 2\,H_2O_{(l)}$ **(non–ionic)**

$2\,HCN_{(aq)} + Ba^{2+}_{(aq)} + 2\,OH^{-}_{(aq)} \rightarrow Ba^{2+}_{(aq)} + 2\,CN^{-}_{(aq)} + 2\,H_2O_{(l)}$ **(total ionic)**

$HCN_{(aq)} + OH^{-}_{(aq)} \rightarrow CN^{-}_{(aq)} + H_2O_{(l)}$ **(net ionic)**