Acid/Base terminology

1. Which species is the **conjugate base** of H_2CO_3?

A. CO_3^{2-}
B. HCO_3^-
C. H_3O^+
D. OH^-
E. H_3CO_4

2. In the reaction

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

Which is a conjugate acid–base pair?

A. NH_3 / NH_4^+
B. NH_3 / OH^-
C. H_2O / OH^-
D. NH_4^+ / OH^-
E. H_2O / NH_4^+

3. Which base is **strongest** in water?

A. NO_3^-
B. Cl^-
C. CH_3COO^-
D. SO_4^{2-}

4. Which acid is **diprotic**?

A. HNO_3
B. HCl
C. CH_3COOH
D. H_3PO_4
E. H_2SO_4

5. Which species can donate **three protons** in aqueous solution?

A. CH_3COOH
B. H_3PO_4
C. CH_3CH_2COOH
D. NH_4^+
E. NH_3

6. Which reaction represents the **second ionisation** of sulfuric acid?

A. $H_2SO_4 \rightarrow H^+ + SO_4^{2-}$
B. $H_2SO_4 \rightarrow H^+ + HSO_4^-$
C. $H_2O \rightarrow H^+ + OH^-$
D. $SO_4^{2-} \rightarrow H^+ + SO_4^{3-}$
E. $HSO_4^- \rightarrow H^+ + SO_4^{2-}$

7. Which species is **amphiprotic**?

A. CO_3^{2-}
B. H_3O^+
C. NO_3^-
D. Na^+
E. HCO_3^-

8. Which statement is **correct**?

A. All amphoteric substances are amphiprotic
B. Amphoteric substances react only with acids
C. Amphiprotic substances donate and accept protons
D. Amphoteric means only proton transfer
E. Amphiprotic substances react only with bases

9. Which statement is correct?

A. Strong acids have weak conjugate bases
B. Weak acids have weak conjugate bases
C. Strong acids have strong conjugate bases
D. Acid strength does not affect conjugate strength
E. Conjugate acids and bases have equal strength

10. In the reaction

$$H_2PO_4^- + H_2O \rightleftharpoons HPO_4^{2-} + H_3O^+$$

$H_2PO_4^-$ is acting as a:

A. Base only
B. Acid only
C. Spectator ion
D. Salt
E. Both an acid and a base

Short-answer questions

1. Define the term **conjugate acid–base pair**.

2. Identify the conjugate acid and conjugate base in the reaction:

$$HCl + H_2O \rightarrow H_3O^+ + Cl^-$$

3. Explain why CH_3COO^- is a stronger base than NO_3^-..

4. A student described the species HCO_3^- as amphoteric. Is the student correct? Explain your answer.

5. Al_2O_3 undergoes two reactions as shown below.

   $Al_2O_3(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2O(l)$
   and
   $Al_2O_3(s) + 2NaOH(aq) + 3H_2O(l) \rightarrow 2NaAl(OH)_4(aq)$
   i. Compare and contrast an amphoteric substance and an amphiprotic substance.

ii. Using aluminium oxide as an example classify this substance as an amphiprotic or amphoteric substance. Explain why.

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6. Consider the following species, SO_4^{2-}, NO_3^- and CH_3COO^- .
   a. Write the balanced equation for the reaction of each base with water.
      i. $SO_4^{2-}(aq) + H_2O(l) \rightarrow$ ____________________________
      ii. $NO_3^-(aq) + H_2O(l) \rightarrow$ ____________________________
      iii. $CH_3COO^-(aq) + H_2O(l) \rightarrow$ ____________________________
   b. Which reaction produces the most amount of OH^-? Explain why.

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