

IB Chemistry HL - R3.1

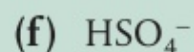
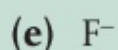
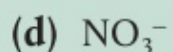
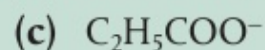
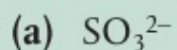
Proton transfer reactions

Exercises + Practice questions

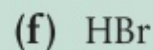
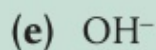
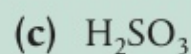
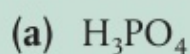
Official answers appended at the end

Exercise

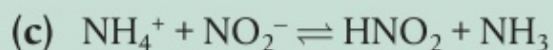
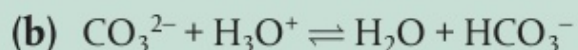
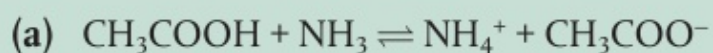
Q1. Deduce the formula of the conjugate acid of each of the following:



Q2. Deduce the formula of the conjugate base of each of the following:



Q3. For each of the following reactions, identify the Brønsted–Lowry acids and bases and the conjugate acid–base pairs:



Exercise

- Q4.** Show by means of equations how the anion in K_2HPO_4 is amphoteric.
- Q5.** (a) Explain with an equation why normal rainwater is acidic because it dissolves CO_2 from the atmosphere.
- (b) Formulate equations to show how sulfur dioxide released into the atmosphere can be oxidized to sulfur trioxide, which then dissolves in water to form sulfuric acid.
- (c) Suggest why adding lime, calcium oxide, to stream water may help to reduce the effects of acid rain.
- Q6.** Suggest why the elimination of burning coal as a fuel is an important goal of many countries and international organizations.

Exercise

- Q7.** What happens to the pH of an acid when 10 cm^3 of the acid is added to 90 cm^3 of water?
- Q8.** Beer has a hydrogen ion concentration of $1.9 \times 10^{-5}\text{ mol dm}^{-3}$. What is its pH?
- Q9.** What is the pH of a 0.01 mol dm^{-3} solution of HCl which dissociates fully?
- $$\text{HCl(aq)} \rightarrow \text{H}^{\text{+}}\text{(aq)} + \text{Cl}^{-}\text{(aq)}$$
- Q10.** Lake water was found to have a concentration of $\text{H}^{\text{+}}$ ions of $3.2 \times 10^{-5}\text{ mol dm}^{-3}$. Calculate the pH and determine if the lake water is acidic, basic, or neutral at 298 K.
- Q11.** Soil water found in a limestone area has a pH of 8.3. What is its concentration of $\text{H}^{\text{+}}$ ions?
- Q12.** Suggest why it is more convenient to express acidity in pH values rather than by concentration of hydrogen ions.

Exercise

- Q13.** A sample of pure water is found to have a pH of 7.3. What can you deduce about the temperature at which the measurement was made?
- Q14.** An aqueous solution of baking soda, NaHCO_3 , has a concentration of OH^- ions of $7.8 \times 10^{-6} \text{ mol dm}^{-3}$ at 298 K. Determine its concentration of hydrogen ions.
- Q15.** At body temperature, 37°C , the value of K_w is 2.4×10^{-14} . Determine the concentration of H^+ ions and the pH of pure water at this temperature.
- Q16.** An aqueous solution has a pH of 9 at 25°C . What are its concentrations of H^+ and OH^- ions?
- Q17.** For each of the following aqueous solutions at 298 K, calculate $[\text{OH}^-]$ from $[\text{H}^+]$ or $[\text{H}^+]$ from $[\text{OH}^-]$. Classify each solution as acidic, basic, or neutral.
- (a) $[\text{H}^+] = 3.4 \times 10^{-9} \text{ mol dm}^{-3}$
 - (b) $[\text{OH}^-] = 0.010 \text{ mol dm}^{-3}$
 - (c) $[\text{OH}^-] = 1.0 \times 10^{-10} \text{ mol dm}^{-3}$
 - (d) $[\text{H}^+] = 8.6 \times 10^{-5} \text{ mol dm}^{-3}$
- Q18.** A sample of blood has $[\text{H}^+] = 4.6 \times 10^{-8} \text{ mol dm}^{-3}$ at 298 K. Determine its concentration of OH^- ions and state whether the sample is acidic, basic or neutral.
- Q19.** For each of the following biological fluids, calculate the pH from the given concentration of H^+ or OH^- ions at 298 K.
- (a) bile: $[\text{OH}^-] = 8 \times 10^{-8} \text{ mol dm}^{-3}$
 - (b) gastric juice: $[\text{H}^+] = 10^{-2} \text{ mol dm}^{-3}$
 - (c) urine: $[\text{OH}^-] = 6 \times 10^{-10} \text{ mol dm}^{-3}$

Exercise

Q20. Ammonia, NH_3 , acts as a weak Brønsted–Lowry base when dissolved in water.

Write an equation for this reaction and outline what is meant by the term ‘weak’ in the context of the equilibrium position of this reaction.

Q21. Which of the following 1 mol dm^{-3} solutions will be the poorest conductor of electricity?

- A** HCl
- B** CH_3COOH
- C** NaOH
- D** NaCl

Q22. Which methods will distinguish between equimolar solutions of a strong base and a strong acid?

- I.** Add magnesium to each solution and look for the formation of gas bubbles.
- II.** Add aqueous sodium hydroxide to each solution and measure the temperature change.
- III.** Use each solution in a circuit with a battery and lamp and see how brightly the lamp glows.

- A** I and II only
- B** I and III only
- C** II and II only
- D** I, II and III

Q23. Which acid in each of the following pairs has the stronger conjugate base?

- (a) H_2CO_3 or H_2SO_4 (b) HCl or HCOOH