



IB Chemistry – SL

Topic 8 Questions

- An aqueous solution of which of the following reacts with magnesium metal?
 - Ammonia
 - Hydrogen chloride
 - Potassium hydroxide
 - Sodium hydrogencarbonate
- Which of the following is/are formed when a metal oxide reacts with a dilute acid?
 - A metal salt
 - Water
 - Hydrogen gas
 - I only
 - I and II only
 - II and III only
 - I, II and III
- Four aqueous solutions, I, II, III and IV, are listed below.
 - $0.100 \text{ mol dm}^{-3} \text{ HCl}$
 - $0.010 \text{ mol dm}^{-3} \text{ HCl}$
 - $0.100 \text{ mol dm}^{-3} \text{ NaOH}$
 - $0.010 \text{ mol dm}^{-3} \text{ NaOH}$

What is the correct order of **increasing** pH of these solutions?

- I, II, III, IV
 - I, II, IV, III
 - II, I, III, IV
 - II, I, IV, III
- Which substance can be dissolved in water to give a 0.1 mol dm^{-3} solution with a high pH and a high electrical conductivity?
 - HCl
 - NaCl



- C. NH_3
- D. NaOH
5. The pH of a solution is 2. If its pH is increased to 6, how many times greater is the $[\text{H}^+]$ of the original solution?
- A. 3
- B. 4
- C. 1000
- D. 10 000
6. The pH of solution **X** is 1 and that of **Y** is 2. Which statement is correct about the hydrogen ion concentrations in the two solutions?
- A. $[\text{H}^+]$ in **X** is half that in **Y**.
- B. $[\text{H}^+]$ in **X** is twice that in **Y**.
- C. $[\text{H}^+]$ in **X** is one tenth of that in **Y**.
- D. $[\text{H}^+]$ in **X** is ten times that in **Y**.
7. Lime was added to a sample of soil and the pH changed from 4 to 6. What was the corresponding change in the hydrogen ion concentration?
- A. increased by a factor of 2
- B. increased by a factor of 100
- C. decreased by a factor of 2
- D. decreased by a factor of 100
8. When the following 1.0 mol dm^{-3} solutions are listed in increasing order of pH (lowest first), what is the correct order?
- A. $\text{HNO}_3 < \text{H}_2 \text{CO}_3 < \text{NH}_3 < \text{Ba}(\text{OH})_2$
- B. $\text{NH}_3 < \text{Ba}(\text{OH})_2 < \text{H}_2 \text{CO}_3 < \text{HNO}_3$
- C. $\text{Ba}(\text{OH})_2 < \text{H}_2 \text{CO}_3 < \text{NH}_3 < \text{HNO}_3$
- D. $\text{HNO}_3 < \text{H}_2 \text{CO}_3 < \text{Ba}(\text{OH})_2 < \text{NH}_3$
9. Which change in $[\text{H}^+]$ causes the biggest increase in pH?
- A. A change in $[\text{H}^+(\text{aq})]$ from 1×10^{-3} to $1 \times 10^{-2} \text{ mol dm}^{-3}$



- B. A change in $[H^+(aq)]$ from 1×10^{-3} to 1×10^{-4} mol dm⁻³
- C. A change in $[H^+(aq)]$ from 1×10^{-4} to 1×10^{-2} mol dm⁻³
- D. A change in $[H^+(aq)]$ from 1×10^{-4} to 1×10^{-6} mol dm⁻³
10. Which methods can distinguish between solutions of a strong monoprotic acid and a weak monoprotic acid of the same concentration?
- Add magnesium to each solution and measure the rate of the formation of gas bubbles.
 - Add aqueous sodium hydroxide to each solution and measure the temperature change.
 - Use each solution in a circuit with a battery and lamp and see how bright the lamp glows.
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III
11. Which species are a conjugate pair according to the Brønsted-Lowry theory?
- A. CH_3COOH and CH_3CHO
- B. NH_3 and BF_3
- C. $H_2NO_3^+$ and NO_3^-
- D. H_2SO_4 and HSO_4^-
12. Which is **not** a strong acid?
- A. Nitric acid
- B. Sulfuric acid
- C. Carbonic acid
- D. Hydrochloric acid
13. Lime is added to a lake to neutralize the effects of acid rain. The pH value of the lake water rises from 4 to 7. What is the change in concentration of H^+ ions in the lake water?
- A. An increase by a factor of 3
- B. An increase by a factor of 1000
- C. A decrease by a factor of 3
- D. A decrease by a factor of 1000



14. Which is a Brønsted-Lowry acid-base pair?
- A. H_2O and O^{2-}
 - B. CH_3COOH and CH_3COO^-
 - C. NH_4^+ and NH_2^-
 - D. H_2SO_4 and SO_4^{2-}
15. Solutions of hydrochloric acid ($\text{HCl}(\text{aq})$) and ethanoic acid ($\text{CH}_3\text{COOH}(\text{aq})$) of the same concentration reacted completely with 5.0 g of calcium carbonate in separate containers. Which statement is correct?
- A. $\text{CH}_3\text{COOH}(\text{aq})$ reacted slower because it has a lower pH than $\text{HCl}(\text{aq})$.
 - B. A smaller volume of $\text{CO}_2(\text{g})$ was produced with $\text{CH}_3\text{COOH}(\text{aq})$ than with $\text{HCl}(\text{aq})$.
 - C. A greater volume of $\text{CO}_2(\text{g})$ was produced with $\text{CH}_3\text{COOH}(\text{aq})$ than with $\text{HCl}(\text{aq})$.
 - D. The same volume of $\text{CO}_2(\text{g})$ was produced with both $\text{CH}_3\text{COOH}(\text{aq})$ and $\text{HCl}(\text{aq})$.
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 - D. The same volume of $\text{CO}_2(\text{g})$ was produced with both $\text{CH}_3\text{COOH}(\text{aq})$ and $\text{HCl}(\text{aq})$.
17. Which acids are strong?
- I. $\text{HCl}(\text{aq})$
 - II. $\text{HNO}_3(\text{aq})$
 - III. $\text{H}_2\text{SO}_4(\text{aq})$
- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III
18. The pH of a solution changes from pH = 1 to pH = 3. What happens to the $[\text{H}^+]$ during this pH change?
- A. It increases by a factor of 100.



- B. It decreases by a factor of 100.
- C. It increases by a factor of 1000.
- D. It decreases by a factor of 1000.
19. What is the conjugate base of the $\text{HSO}_4^-(\text{aq})$ ion?
- A. $\text{H}_2\text{SO}_4(\text{aq})$
- B. $\text{SO}_4^{2-}(\text{aq})$
- C. $\text{H}_2\text{O}(\text{l})$
- D. $\text{H}_3\text{O}^+(\text{aq})$
20. Which species can act as a Lewis acid?
- A. BF_3
- B. OH^-
- C. H_2O
- D. NH_3
21. Which substance, when dissolved in water, to give a 0.1 mol dm^{-3} solution, has the highest pH?
- A. HCl
- B. NaCl
- C. NH_3
- D. NaOH
22. 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 bright the lamp glows.
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III



23. (a) Aqueous XO_4^{3-} ions form a precipitate with aqueous silver ions, Ag^+ . Write a balanced equation for the reaction, including state symbols.

..... (2)

- (b) When 41.18 cm^3 of a solution of aqueous silver ions with a concentration of $0.2040 \text{ mol dm}^{-3}$ is added to a solution of XO_4^{3-} ions, 1.172 g of the precipitate is formed.

- (i) Calculate the amount (in moles) of Ag^+ ions used in the reaction. (1)

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- (ii) Calculate the amount (in moles) of the precipitate formed. (1)

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- (iii) Calculate the molar mass of the precipitate.

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- (iv) Determine the relative atomic mass of X and identify the element. (2)

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(2)
(Total 8 marks)

24. (a) (i) A solution of hydrochloric acid has a concentration of 0.10 mol dm^{-3} and a pH value of 1. The solution is diluted by a factor of 100. Determine the concentration of the acid **and** the pH value in the diluted solution.

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(2)

- (ii) Explain why 0.10 mol dm^{-3} ethanoic acid solution and the diluted solution in (a) (i) have similar $[\text{H}^+]$ values.

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(3)

- (b) Suggest **one** method, other than measuring pH, which could be used to distinguish between solutions of a strong acid and a weak acid of the same concentration. State the expected results.

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(2)

(Total 7 marks)

25. Define the terms *strong acid* and *weak acid*. Using hydrochloric and ethanoic acid as examples, write equations to show the dissociation of each acid in aqueous solution.

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(Total 4 marks)

26. (i) Calcium carbonate is added to separate solutions of hydrochloric acid and ethanoic acid of the same concentration. State **one** similarity and **one** difference in the observations you could make.

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(2)

- (ii) Write an equation for the reaction between hydrochloric acid and calcium carbonate.

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..... (2)

- (iii) Determine the volume of 1.50 mol dm^{-3} hydrochloric acid that would react with exactly 1.25 g of calcium carbonate.

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..... (3)

- (iv) Calculate the volume of carbon dioxide, measured at 273 K and $1.01 \times 10^5 \text{ Pa}$, which would be produced when 1.25 g of calcium carbonate reacts completely with the hydrochloric acid.

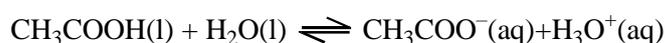
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..... (2)
(Total 9 marks)

27. The pH values of solutions of three organic acids of the same concentration were measured.

acid X	pH = 5
acid Y	pH = 2
acid Z	pH = 3

- (i) Identify which solution is the least acidic. (1)
- (ii) Deduce how the $[\text{H}^+]$ values compare in solutions of acids Y and Z. (2)
- (iii) Arrange the solutions of the three acids in decreasing order of electrical conductivity, starting with the greatest conductivity, giving a reason for your choice. (2)
- (Total 5 marks)

28. The equilibrium reached when ethanoic acid is added to water can be represented by the following equation:



Define the terms Brønsted-Lowry acid and Lewis base, and identify two examples of each of these species in the equation.

(Total 4 marks)

29. Identify **one** example of a strong acid and **one** example of a weak acid. Outline **three** different



methods to distinguish between equimolar solutions of these acids in the laboratory. State how the results would differ for each acid.

(Total 5 marks)

30. Vinegar has a pH of approximately 3 and some detergents have a pH of approximately 8. State and explain which of these has the higher concentration of H^+ and by what factor.

(Total 1 mark)

31. Define the terms *Brønsted-Lowry acid* and *Lewis acid*. For each type of acid, identify one example other than water and write an equation to illustrate the definition.

(Total 5 marks)

32. The pH values of three acidic solutions, X, Y and Z, are shown in the following table:

Solution	Acid	pH
X	HCl(aq)	2
Y	HCl(aq)	4
Z	CH ₃ COOH(aq)	4

- (i) Solutions X and Z have the same acid concentration. Explain, by reference to both acids, why they have different pH values.

(2)

- (ii) Deduce by what factor the values of $[H^+]$ in solutions X and Y differ.

(1)

(Total 3 marks)

33. State and explain **two** methods, other than measuring pH, which could be used to distinguish between 1.0 mol dm^{-3} solutions of nitric acid and ethanoic acid.

(Total 4 marks)

34. Propanoic acid is classified as a weak acid.

- (a) State the meaning of the term *weak acid*.

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(1)

- (b) State, giving a reason in each case, **two** methods other than measuring pH, that could be used to distinguish between $0.100 \text{ mol dm}^{-3}$ propanoic acid and $0.100 \text{ mol dm}^{-3}$ nitric acid.

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(2)
(Total 3 marks)

35. State an equation for the reaction of propanoic acid with water. Identify **one** conjugate *Brønsted-Lowry* pair.

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(Total 2 marks)