

Acids, bases and salts

30 questions: 15 multiple choice, 15 structured.

1

Core

The characteristic properties of acids and bases

[1]

A student adds a few drops of three different indicators to separate samples of dilute nitric acid.

Which row shows the colour of each indicator in the dilute nitric acid?

	litmus	thymolphthalein	methyl orange
A	red	colourless	red
B	blue	blue	yellow
C	red	blue	red
D	red	colourless	yellow

2**Core**

The characteristic properties of acids and bases

[4]

Dilute sulfuric acid and aqueous sodium hydroxide are both used in a school laboratory.

- (a) Give the formula of the ion that is present in all aqueous solutions of acids. [1]

- (b) Give the formula of the ion that is present in all aqueous solutions of alkalis. [1]

- (c) Copper(II) oxide is a base, but it is not an alkali. Explain why. [2]

3**Core**

The characteristic properties of acids and bases

[1]

Four solutions, W, X, Y and Z, are tested with universal indicator paper. The pH values are shown.

solution	W	X	Y	Z
pH	12	6	2	8

Which list shows the solutions in order of **increasing** hydrogen ion concentration?

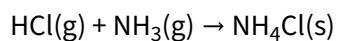
- A Y, X, Z, W
B W, Z, X, Y
C W, X, Z, Y
D Z, X, W, Y

4**Supplement**

The characteristic properties of acids and bases

[1]

Hydrogen chloride gas reacts with ammonia gas to form a white solid.



Which statement about this reaction is correct?

- A HCl acts as a base because it accepts a proton.
 - B NH₃ acts as an acid because it donates a proton.
 - C NH₃ acts as a base because it accepts a proton.
 - D HCl acts as an acid because it accepts a proton.
-

5**Core**

Oxides

[1]

Element E is a shiny solid. It conducts electricity and is malleable.

Which row describes element E and the type of oxide it is most likely to form?

	type of element	type of oxide
A	metal	basic
B	metal	acidic
C	non-metal	basic
D	non-metal	acidic

6

Core

The characteristic properties of acids and bases

[7]

A student adds a piece of magnesium ribbon to some dilute hydrochloric acid in a test-tube.

- (a) Name the gas produced and the salt formed in this reaction.

[2]

- (b) Write the balanced symbol equation for the reaction between magnesium and hydrochloric acid.

[2]

- (c) In a second experiment, the student adds zinc carbonate powder to dilute hydrochloric acid.

Complete the word equation for this reaction.

zinc carbonate + hydrochloric acid → + +

[2]

- (d) State **one** observation the student would make during the reaction in (c).

[1]

7

Supplement

The characteristic properties of acids and bases

[7]

Hydrochloric acid is a strong acid. Ethanoic acid is a weak acid.

(a) Define the terms *strong acid* and *weak acid*.

[2]

(b) Write the equation for the dissociation of ethanoic acid in water. Include state symbols.

[2]

(c) A student has a solution of hydrochloric acid and a solution of ethanoic acid. Both solutions have the same concentration. Using universal indicator paper, the student finds that one solution has pH 1 and the other has pH 3.

Identify which acid has pH 3. Explain your answer.

[3]

8

Core

The characteristic properties of acids and bases

[6]

Ammonium sulfate is used as a fertiliser. Calcium hydroxide (slaked lime) is a base that gardeners sometimes add to soil.

When ammonium sulfate is warmed with calcium hydroxide, a gas is given off.

- (a) Name the gas given off. [1]

- (b) The gas is alkaline. State the colour change seen when damp red litmus paper is held in the gas. [1]

- (c) Complete the word equation for the reaction.
ammonium sulfate + calcium hydroxide → + + water [2]

- (d) Suggest why a gardener should **not** spread calcium hydroxide on the soil at the same time as ammonium sulfate fertiliser. [2]

A student prepares crystals of copper(II) sulfate. The student adds copper(II) oxide, a little at a time, to warm dilute sulfuric acid and stirs. The student stops adding copper(II) oxide when some black solid remains unreacted.

- (a) Write the balanced symbol equation for the reaction between copper(II) oxide and sulfuric acid.

[1]

- (b) Explain why the student adds copper(II) oxide until some remains unreacted.

[2]

- (c) Name the method used to remove the unreacted copper(II) oxide from the mixture.

[1]

- (d) Describe how the student can obtain pure, dry crystals of copper(II) sulfate from the solution left after (c).

[3]

10

Core

Preparation of salts

[1]

Which pair of salts are **both** insoluble in water?

- A calcium chloride and lead(II) nitrate
- B sodium carbonate and barium sulfate
- C copper(II) carbonate and potassium sulfate
- D barium sulfate and silver chloride

11

Core

The characteristic properties of acids and bases

[1]

A few drops of thymolphthalein are added to a colourless solution. The solution turns blue.

Which row shows the colour of litmus and of methyl orange in separate samples of the same solution?

	litmus	methyl orange
A	blue	red
B	red	yellow
C	blue	yellow
D	red	red

Indigestion is caused by too much hydrochloric acid in the stomach. Some indigestion tablets contain magnesium hydroxide, which is a base.

- (a) Name the salt formed when magnesium hydroxide reacts with hydrochloric acid. [1]

- (b) Write the balanced symbol equation for the reaction between magnesium hydroxide and hydrochloric acid. [2]

- (c) Other indigestion tablets contain calcium carbonate instead of magnesium hydroxide.
Name the gas produced when calcium carbonate reacts with hydrochloric acid. Suggest one reason why producing this gas could be a disadvantage for a person taking the tablets. [2]

- (d) State the name of the type of reaction that happens between an acid and a base. [1]

13 **Core** The characteristic properties of acids and bases

[1]

Dilute nitric acid is added to aqueous potassium hydroxide until the solution is exactly neutral.

Which ions are present in the neutral solution in the largest amounts?

- A K^+ and NO_3^-
- B H^+ and OH^-
- C H^+ and NO_3^-
- D K^+ and OH^-

14 **Supplement** The characteristic properties of acids and bases

[1]

P and Q are two different acids. Aqueous solutions of P and Q are made with the same concentration.

The solution of P has pH 1. The solution of Q has pH 4.

Which statement is correct?

- A P is partially dissociated in aqueous solution.
- B The solution of Q has a higher concentration of H^+ ions than the solution of P.
- C Q is partially dissociated in aqueous solution.
- D P and Q are both strong acids because both solutions have a pH below 7.

15 **Supplement** Oxides

[1]

Oxide X reacts with dilute hydrochloric acid. Oxide X also reacts with aqueous sodium hydroxide. A salt and water are formed in both reactions.

What is oxide X?

- A calcium oxide
- B carbon dioxide
- C zinc oxide
- D copper(II) oxide

16**Supplement**

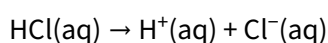
The characteristic properties of acids and bases

[6]

- (a) Define an *acid* and a *base* in terms of protons.

[2]

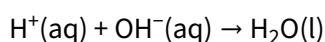
- (b) The dissociation of hydrochloric acid is shown by the equation.



State what the single, one-way arrow shows about hydrochloric acid.

[1]

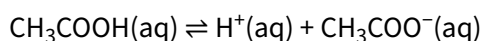
- (c) When hydrochloric acid neutralises aqueous sodium hydroxide, the reaction is



Identify the species that acts as a base in this reaction. Explain your answer.

[2]

- (d) Ethanoic acid dissociates in water.



In the reverse reaction, H^+ ions and CH_3COO^- ions join to form CH_3COOH .

Identify the species that acts as a base in the reverse reaction.

[1]

A student is given four oxides: calcium oxide, CaO, copper(II) oxide, CuO, carbon dioxide, CO₂, and sulfur dioxide, SO₂.

- (a) Classify each of the four oxides as acidic or basic. [2]

- (b) State how the type of oxide an element forms is related to whether the element is a metal or a non-metal. [2]

- (c) Copper(II) oxide does not dissolve in water, so it has no effect on the pH of water. Suggest how the student could show by an experiment that copper(II) oxide is a basic oxide. Include the result the student would expect. [2]

Barium sulfate is an insoluble salt. It is used in hospitals to help X-ray images of the stomach show up clearly. It can be made in the laboratory by precipitation.

- (a) Name **two** aqueous solutions that could be mixed to make a precipitate of barium sulfate. [2]

- (b) Write the ionic equation for the formation of barium sulfate. Include state symbols. [2]

- (c) Describe how a pure, dry sample of barium sulfate could be obtained from the mixture after precipitation. [3]

Which statement defines an *anhydrous* substance?

- A a substance that contains no water
- B a substance that is chemically combined with water
- C a substance that has been dissolved in water
- D a substance that absorbs water vapour from the air

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A student tests five household solutions with universal indicator paper. The results are shown.

solution	pH
drain cleaner	13
vinegar	3
salt solution	7
baking soda solution	9
rainwater	5

- (a) Identify the solution that is neutral. [1]

- (b) Identify the solution with the highest concentration of hydroxide ions. [1]

- (c) Put vinegar, rainwater and salt solution in order of **increasing** hydrogen ion concentration. [1]

- (d) Describe how the student used universal indicator paper to find the pH of one of the solutions. [2]

21 **Core** The characteristic properties of acids and bases

[1]

Which substance reacts with dilute sulfuric acid to form a salt, water **and** a gas?

- A copper
 - B sodium carbonate
 - C magnesium
 - D zinc oxide
-

22 **Supplement** The characteristic properties of acids and bases

[1]

Which equation shows how ethanoic acid behaves as a weak acid in water?

- A $\text{CH}_3\text{COOH}(\text{aq}) \rightarrow \text{H}^+(\text{aq}) + \text{CH}_3\text{COO}^-(\text{aq})$
 - B $\text{CH}_3\text{COOH}(\text{aq}) \rightleftharpoons \text{CH}_3\text{COO}^+(\text{aq}) + \text{H}^-(\text{aq})$
 - C $\text{CH}_3\text{COOH}(\text{aq}) \rightleftharpoons \text{CH}_3\text{CO}^+(\text{aq}) + \text{OH}^-(\text{aq})$
 - D $\text{CH}_3\text{COOH}(\text{aq}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{CH}_3\text{COO}^-(\text{aq})$
-

23 **Core** Preparation of salts

[1]

A student wants to make pure crystals of potassium nitrate.

Which method is the most suitable?

- A Add excess potassium metal to dilute nitric acid, filter, then crystallise the filtrate.
 - B Add excess aqueous potassium hydroxide to dilute nitric acid, filter, then crystallise the filtrate.
 - C Add excess solid potassium carbonate to dilute hydrochloric acid, filter, then crystallise the filtrate.
 - D Find the volume of dilute nitric acid needed to neutralise aqueous potassium hydroxide by titration with an indicator, repeat using the same volumes without the indicator, then crystallise the solution.
-

24 **Supplement** Preparation of salts

[1]

Blue crystals of hydrated copper(II) sulfate have the formula $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$.

Which statement about these crystals is correct?

- A The crystals are a mixture of copper(II) sulfate and liquid water, and the water can be removed by filtration.
- B The $5\text{H}_2\text{O}$ represents water of crystallisation: water molecules present in the hydrated crystals.
- C The crystals contain no water once they have been dried with filter paper.
- D The crystals are anhydrous because the water is chemically combined.

Which substance is an alkali?

- A copper(II) oxide
- B potassium hydroxide
- C iron(III) hydroxide
- D magnesium carbonate

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26**Core**

The characteristic properties of acids and bases

[6]

A student puts 25.0 cm^3 of aqueous sodium hydroxide in a conical flask and adds a few drops of thymolphthalein. Dilute hydrochloric acid is then added from a burette until the indicator changes colour.

- (a) State the colour of the thymolphthalein in the flask at the start. [1]

- (b) State the colour of the thymolphthalein when a slight excess of hydrochloric acid has been added. [1]

- (c) Write the ionic equation for the neutralisation reaction. Include state symbols. [2]

- (d) Name the salt formed, and state the pH of the solution in the flask when the sodium hydroxide has been exactly neutralised. [2]

A student has two white powders, P and Q. One is aluminium oxide and the other is magnesium oxide. Each powder is warmed with dilute hydrochloric acid, and a fresh sample of each is warmed with aqueous sodium hydroxide. The results are shown.

powder	warmed with dilute hydrochloric acid	warmed with aqueous sodium hydroxide
P	reacts; a colourless solution forms	reacts; a colourless solution forms
Q	reacts; a colourless solution forms	no reaction

- (a) Identify which powder is aluminium oxide. Explain your answer.

[2]

- (b) Describe what is meant by an *amphoteric oxide*.

[2]

- (c) Suggest the name of another oxide that would give the same results as P.

[1]

- (d) Classify powder Q as acidic, basic or amphoteric. Explain your answer in terms of the element it contains.

[2]

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Three bottles contain colourless solutions labelled J, K and L. One is dilute hydrochloric acid, one is aqueous sodium hydroxide and one is aqueous sodium chloride. A student does three tests on each solution. The results are shown.

test	J	K	L
add a piece of magnesium ribbon	bubbles of gas	no change	no change
add a few drops of thymolphthalein	colourless	blue	colourless
warm with solid ammonium chloride	no gas	gas given off that turns damp red litmus paper blue	no gas

(a) Identify solutions J, K and L.

[3]

(b) Name the gas given off in the magnesium test with J, and the gas given off when K is warmed with ammonium chloride.

[2]

(c) Solution K is added to a sample of J until the mixture is exactly neutral. A piece of magnesium ribbon is then added to this neutral mixture.

Predict what would be seen. Explain your answer.

[2]

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Epsom salts are crystals of hydrated magnesium sulfate, $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$. A student heats some Epsom salts strongly in an evaporating basin. The student weighs the basin and contents several times and stops heating when the mass no longer decreases. A white powder remains.

- (a) Define the term *hydrated substance*. [1]

- (b) State the name given to the water molecules shown as $7\text{H}_2\text{O}$ in the formula $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$. [1]

- (c) Give the formula of the white powder that remains. State whether it is hydrated or anhydrous. [2]

- (d) Explain why the mass decreases during heating, and why the student heats until the mass no longer decreases. [2]

A student wants to make three sulfate salts: lead(II) sulfate, potassium sulfate and zinc sulfate.

The student can choose from these three methods.

- method 1: titration of an acid with an alkali
- method 2: adding an excess of an insoluble solid (a metal, an insoluble base or an insoluble carbonate) to an acid, then filtering
- method 3: precipitation by mixing two solutions

(a) State the most suitable method (1, 2 or 3) for making each salt. [3]

(b) Name **two** aqueous solutions that could be mixed to make lead(II) sulfate. [2]

(c) Name **one** solid that could be added in excess to dilute sulfuric acid to make zinc sulfate. [1]

(d) Explain why potassium sulfate is made by titration rather than by adding an excess of a solid potassium compound to the acid. [2]

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