

Experimental techniques and chemical analysis

30 questions: 15 multiple choice, 15 structured.

1 Core Experimental design [1]

Which piece of apparatus is used to add a liquid a little at a time and to measure the volume added to the nearest 0.05 cm^3 ?

- A gas syringe
- B measuring cylinder
- C burette
- D volumetric pipette

2 Core Experimental design [1]

Which statement describes a saturated solution?

- A a solution containing more solute than solvent
- B a solution containing the maximum concentration of a solute dissolved in the solvent at a specified temperature
- C a solution containing the maximum concentration of a solute dissolved in the solvent at any temperature
- D a solution in which the mass of solute is equal to the mass of solvent

3 Core Acid-base titrations [1]

A student adds aqueous sodium hydroxide from a burette to dilute hydrochloric acid in a conical flask. The acid contains a few drops of methyl orange indicator.

What colour change in the flask shows the end-point?

- A blue to colourless
- B colourless to blue
- C yellow to orange
- D red to orange

4**Core**

Chromatography

[1]

In paper chromatography, the baseline is drawn in pencil and not in ink.

Why is pencil used?

- A Pencil lines are easier to see than ink lines after the solvent has evaporated.
 - B Pencil does not dissolve in the solvent, so the line does not move up the paper and mix with the spots.
 - C Pencil makes the solvent rise up the paper more quickly.
 - D Pencil reacts with the substances being separated so that they can be seen.
-

5**Supplement**

Chromatography

[1]

A mixture of colourless substances is separated by paper chromatography using a suitable solvent.

Which extra step allows the positions of the separated substances to be seen?

- A Add more of the mixture to the baseline so that the spots are larger.
 - B Draw the baseline in ink instead of pencil.
 - C After the chromatogram has dried, spray it with a locating agent.
 - D Use a solvent in which the substances are insoluble.
-

6**Core**

Separation and purification

[1]

Ethanol and water mix completely. Ethanol boils at 78 °C and water boils at 100 °C.

Which method is used to separate ethanol from a mixture of ethanol and water?

- A chromatography
- B crystallisation
- C filtration
- D fractional distillation

A solid compound gives a light green colour in a flame test.

Which cation is present in the compound?

- A barium, Ba^{2+}
- B calcium, Ca^{2+}
- C copper(II), Cu^{2+}
- D lithium, Li^{+}

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A student investigates how quickly hydrogen gas is produced when zinc granules react with dilute sulfuric acid in a conical flask. The gas passes along a tube into a piece of apparatus that measures its volume. The student records the volume of gas every 20 seconds.

- (a) Name a piece of apparatus that can be used to measure the volume of the hydrogen gas. [1]

- (b) Name the piece of apparatus used to measure the time. [1]

- (c) Name the piece of apparatus used to measure the mass of the zinc granules. [1]

- (d) The student measures 50 cm³ of dilute sulfuric acid using the markings on the side of a beaker. Suggest one disadvantage of using a beaker to measure the volume of the acid. [1]

- (e) Another student suggests counting the bubbles of gas instead of measuring the volume of gas. Suggest one advantage of measuring the volume of gas rather than counting bubbles. [1]

A food scientist wants to find out which dyes are in a food colouring, E. She uses paper chromatography to compare E with four known dyes, P, Q, R and S. All five samples are placed on the same piece of chromatography paper and run with the same solvent.

- (a) Describe how the scientist should set up and run the chromatogram. [3]

- (b) The results are shown in the table.

Sample	Distance of each spot from the baseline / cm
E	2.1 and 5.4
P	2.1
Q	3.8
R	5.4
S	2.1 and 6.7

- (i) Deduce which of the known dyes P, Q, R and S are present in E. Explain your answer. [2]

- (ii) State which one of the known dyes P, Q, R and S is not a pure substance. [1]

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A technician tests three aqueous solutions, X, Y and Z. Each solution contains one cation. Aqueous sodium hydroxide is added dropwise and then in excess to one sample of each solution. Aqueous ammonia is added dropwise and then in excess to a second sample.

Solution	Aqueous sodium hydroxide	Aqueous ammonia
X	green precipitate, dissolves in excess	green precipitate, does not dissolve in excess
Y	light blue precipitate, does not dissolve in excess	light blue precipitate, dissolves in excess to give a dark blue solution
Z	green precipitate, does not dissolve in excess; the precipitate turns brown near the surface on standing	green precipitate, does not dissolve in excess; the precipitate turns brown near the surface on standing

- (a) Identify the cation in each of the solutions X, Y and Z.

[3]

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- (b) A fourth solution, W, gives a red-brown precipitate with aqueous sodium hydroxide and with aqueous ammonia. The precipitate does not dissolve in excess of either reagent. Identify the cation in W.

[1]

- (c) Describe a test for ammonium ions, NH_4^+ , in an aqueous solution. Give the positive result.

[2]

11 **Core** Acid–base titrations

[1]

During a titration, the conical flask is placed on a white tile.

What is the reason for this?

- A to make the colour change of the indicator easier to see
- B to keep the contents of the flask at a constant temperature
- C to neutralise any acid that is spilled
- D to make the reaction in the flask faster

12 **Core** Chromatography

[1]

A black ink is tested by paper chromatography. After the solvent has risen up the paper, one spot remains on the baseline and two separate spots have moved up the paper.

Which conclusion is correct?

- A The ink contains only two substances.
- B The ink is a pure substance.
- C The ink contains at least three substances, and one of them is insoluble in the solvent.
- D The ink contains three substances, and all of them are soluble in the solvent.

13 **Core** Separation and purification

[1]

A pure sample of a white solid melts at 122 °C. A student makes a sample of the same solid, but the sample contains an impurity.

How does the student's impure sample melt?

- A sharply, at 122 °C
- B sharply, at a temperature above 122 °C
- C over a range of temperatures above 122 °C
- D over a range of temperatures below 122 °C

An aqueous solution of a sodium salt is acidified with dilute nitric acid. Aqueous silver nitrate is then added. A yellow precipitate forms.

Which anion is present in the salt?

- A iodide, I^-
- B bromide, Br^-
- C chloride, Cl^-
- D sulfate, SO_4^{2-}

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A student wants to find the volume of dilute hydrochloric acid needed to neutralise exactly 25.0 cm^3 of aqueous potassium hydroxide. She uses methyl orange as the indicator.

- (a) Describe how the student should carry out the titration. In your answer, name the apparatus she should use.

[4]

- (b) State the colour of methyl orange in the aqueous potassium hydroxide at the start of the titration.

[1]

- (c) Suggest why the acid should be added drop by drop when the end-point is close.

[1]

A garden supplier has a powdered mixture of potassium nitrate and zinc oxide. Potassium nitrate is soluble in water. Zinc oxide is insoluble in water.

- (a) Describe how a pure, dry sample of zinc oxide can be obtained from the mixture. [3]

- (b) Describe how pure, dry crystals of potassium nitrate can be obtained from the solution produced in (a). [3]

A student is given two salts, T and V. Each salt contains one cation and one anion.

Salt T gives a lilac colour in a flame test. An aqueous solution of T is acidified with dilute nitric acid, and aqueous barium nitrate is added. A white precipitate forms.

- (a) Identify the cation in T. [1]

- (b) Identify the anion in T. [1]

- (c) An aqueous solution of V is tested. The results are shown in the table.

Test	Observation
add aqueous sodium hydroxide dropwise, then in excess	white precipitate, does not dissolve in excess
add aqueous ammonia dropwise, then in excess	no precipitate
acidify with dilute nitric acid, then add aqueous silver nitrate	cream precipitate

- Name salt V. [2]

- (d) Describe how the student should carry out a flame test on a solid salt. [2]

- (e) Explain why the solution of V is acidified with dilute nitric acid, and not with dilute hydrochloric acid, before aqueous silver nitrate is added. [1]

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Sugars are colourless. A student uses paper chromatography to find out which sugars are present in a sample of fruit juice. After the solvent has risen up the paper, the chromatogram is dried and treated so that the spots can be seen.

- (a) Explain why the spots of sugar cannot be seen on the chromatogram as soon as it has dried. [1]

- (b) Describe how a locating agent is used to show the positions of the sugars on the dried chromatogram. [2]

- (c) The solvent front travelled 9.6 cm from the baseline. The fruit juice gave two spots, at 2.4 cm and 7.2 cm from the baseline.

The table shows the R_f values of four sugars in the solvent used.

Sugar	R_f value
lactose	0.15
sucrose	0.25
glucose	0.50
fructose	0.75

- (i) Calculate the R_f value of each spot from the fruit juice. [2]

(ii) Identify the two sugars in the fruit juice. [1]

(d) Suggest why the R_f values of the spots must be compared with R_f values measured using the same solvent. [1]

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A student adds blue copper(II) sulfate crystals to 50 cm³ of water at 25 °C and stirs. The crystals dissolve to form a blue solution.

(a) Name:

(i) the solvent

[1]

(ii) the solute.

[1]

(b) The student keeps adding crystals until some crystals stay at the bottom of the beaker, however long the mixture is stirred. State the term used to describe the solution now.

[1]

(c) The student filters the mixture from (b).

(i) State the term used for the solid left on the filter paper.

[1]

(ii) State the term used for the solution that passes through the filter paper.

[1]

(d) Suggest why the temperature must be stated when describing the solution in (b).

[1]

20 **Core** Separation and purification [6]

(a) Suggest the most suitable method for each of the following.

(i) obtaining sand from a mixture of sand and sea water [1]

(ii) obtaining pure water from sea water [1]

(iii) obtaining crystals of magnesium sulfate from aqueous magnesium sulfate [1]

(iv) separating petroleum (crude oil) into fractions [1]

(b) Explain how the method you gave in (a)(ii) produces pure water from sea water. [2]

21 **Core** Experimental design

[1]

A student uses a measuring cylinder instead of a burette to add acid to an alkali in a titration.

What is the main disadvantage of using the measuring cylinder?

- A A much larger volume of acid is needed to reach the end-point.
 - B The volume of acid added cannot be measured as precisely.
 - C A measuring cylinder cannot be used to hold acids.
 - D The measuring cylinder changes the colour of the indicator.
-

22 **Supplement** Chromatography

[1]

In a paper chromatography experiment, the solvent front travels 7.5 cm from the baseline. Substance Z has an R_f value of 0.60 in this solvent.

How far does substance Z travel from the baseline?

- A 0.08 cm
 - B 3.0 cm
 - C 4.5 cm
 - D 12.5 cm
-

23 **Core** Separation and purification

[1]

The table gives information about two solids, Q and R.

Solid	Solubility in water	Solubility in ethanol
Q	insoluble	soluble
R	insoluble	insoluble

Which method gives a sample of solid Q from a mixture of Q and R?

- A Add water, stir, filter and dry the residue.
- B Add ethanol, stir, filter and evaporate the ethanol from the filtrate.
- C Add ethanol, stir, filter and dry the residue.
- D Add water, stir, filter and evaporate the water from the filtrate.

Which reagent, added dropwise and then in excess, can be used to tell the difference between aqueous zinc sulfate and aqueous aluminium sulfate?

- A aqueous ammonia
- B aqueous sodium hydroxide
- C dilute nitric acid followed by aqueous barium nitrate
- D dilute nitric acid followed by aqueous silver nitrate

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A student investigates the rate of the reaction between marble chips (calcium carbonate) and dilute hydrochloric acid. Carbon dioxide gas is given off. She compares two methods.

Method 1: the flask containing the acid and the marble chips stands on a balance. A loose plug of cotton wool is placed in the neck of the flask. The mass is recorded every 30 seconds.

Method 2: the flask is connected to a gas syringe. The volume of gas in the syringe is recorded every 30 seconds.

- (a) Name a piece of apparatus that could be used to measure 50 cm³ of the dilute hydrochloric acid. [1]

- (b) Suggest why a loose plug of cotton wool is placed in the neck of the flask in Method 1. [1]

- (c) Suggest one advantage of Method 2 compared with Method 1. [1]

- (d) Suggest one disadvantage of Method 2 compared with Method 1. [1]

- (e) The student wants to use Method 1 to measure the rate of the reaction between magnesium ribbon and dilute hydrochloric acid, which produces hydrogen gas. Explain why Method 1 is not suitable for this reaction. [2]

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Liquid J and liquid K mix completely. Liquid J boils at 81 °C and liquid K boils at 111 °C. A chemist separates a mixture of J and K using a flask, a fractionating column with a thermometer at the top, and a condenser.

- (a) Name this method of separation. [1]

- (b) Explain how this method separates liquid J from liquid K. [3]

- (c) The thermometer reads 81 °C while the first liquid is collected. Suggest how the chemist can tell when all of liquid J has been collected. [1]

- (d) Describe how the boiling point of the first liquid collected can be used to show whether it is pure J. [2]

Gases are produced in many laboratory reactions.

(a) When a small piece of calcium is added to cold water, bubbles of a gas are given off.

(i) Name the gas. [1]

(ii) Describe a test for this gas. Give the positive result. [2]

(b) When manganese(IV) oxide is added to hydrogen peroxide solution, a gas is given off that relights a glowing splint. Name the gas. [1]

(c) Describe a test for chlorine gas. Give the positive result. [2]

(d) A gas turns acidified aqueous potassium manganate(VII) from purple to colourless. Identify the gas. [1]

(e) A gas turns damp red litmus paper blue. Identify the gas.

[1]

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A quality-control technician tests three different products for anions.

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- (a) A liquid fertiliser is thought to contain nitrate ions, NO_3^- . Describe a test for nitrate ions. Give the positive result. [3]

- (b) A powdered rock is thought to contain carbonate ions, CO_3^{2-} . Describe a test for carbonate ions. Give the positive result. [2]

- (c) A food preservative solution is thought to contain sulfite ions, SO_3^{2-} . Describe a test for sulfite ions. Give the positive result. [2]

- (d) The fertiliser contains sodium nitrate and the preservative contains sodium sulfite. Explain why a flame test cannot be used to tell these two compounds apart. [1]

A student titrates 25.0 cm^3 of aqueous sodium hydroxide with dilute sulfuric acid, using thymolphthalein as the indicator. The sodium hydroxide is in the conical flask and the acid is in the burette. She does one rough titration and then three accurate titrations.

	Rough	Run 1	Run 2	Run 3
final burette reading / cm^3	24.60	24.30	24.55	24.50
initial burette reading / cm^3	0.00	0.50	0.20	0.60
titre / cm^3				

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- (a) Calculate the titre for each titration. [2]

- (b) Titres within 0.10 cm^3 of each other are concordant. Identify the concordant accurate titres and use them to calculate the mean titre. [2]

- (c) Suggest why the student does a rough titration first. [1]

- (d) State the colour change of the thymolphthalein at the end-point. [1]

A student tests a green dye using paper chromatography. She repeats the experiment three times, each time with a different solvent.

Solvent	Result
water	one spot, which stays on the baseline
ethanol	two spots, 1.6 cm and 4.4 cm from the baseline; the solvent front is 8.0 cm from the baseline
propanone	one spot, which moves just behind the solvent front

- (a) Suggest why the spot does not move from the baseline when water is the solvent. [1]

- (b) State which solvent is the most suitable for separating the substances in the green dye. Explain your answer. [2]

- (c) Calculate the R_f value of each of the two spots obtained with ethanol. [2]

- (d) A second student looks only at the result with propanone and says that the green dye is a pure substance. Explain why this conclusion is not correct. [1]

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