PEARSON EDEXCEL IGCSE CHEMISTRY · 4CH1

CHEMISTRY



EXAM QUESTION PACK

SECTION 2: INORGANIC CHEMISTRY (PACK 3)

SCORE	PERCENTAGE
/116	%

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Q1.

(a) Two substances are needed to cause iron to rust.

Name these two substances.

(2)

1 .....

2 .....

(b) The box gives the names of some substances.

calcium	copper	gold
iodine	methane	zinc

Use words from the box to answer these questions.

(i) Give the name of a non-metallic element.

(1)

.....

(ii) Give the name of a compound.

(1)

.....

(iii) Give the name of the metal that is lowest in the reactivity series.

(1)

.....

(Total for question = 5 marks)

Q2.

Sulfur dioxide (SO_2) and hydrogen sulfide (H_2S) are both gases.

The two gases react together to form solid sulfur and water.

(a) (i) Complete the chemical equation for the reaction.

(2)

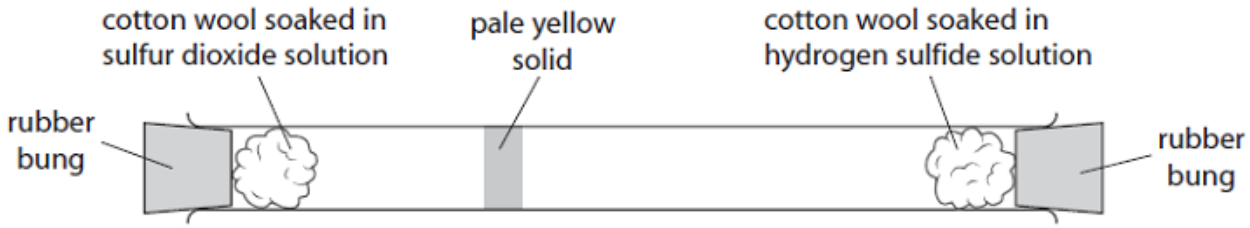
$$2H_2S(\ldots\ldots) + SO_2(\ldots\ldots) \rightarrow \ldots\ldots S(s) + \ldots\ldots H_2O(\ldots\ldots)$$

(ii) State why the sulfur dioxide is reduced in the reaction.

(1)

.....

(b) The diagram shows apparatus used to compare the speed at which particles of the two gases diffuse.



The two pieces of cotton wool and rubber bungs are put in position at the same time.

A pale yellow solid soon forms.

(i) Explain how the diagram shows that hydrogen sulfide gas diffuses more quickly than sulfur dioxide gas.

(2)

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(ii) Deduce a relationship between the relative formula mass (M_r) of a gas and the speed at which a gas diffuses.

Use the *A*r values to help you.

[A_r values: H = 1 S = 32 O = 16]

(3)

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(Total for question = 8 marks)

Q3.

Ammonia is manufactured on a large scale and is used to make fertilisers such as ammonium nitrate (NH_4NO_3).

(a) The first stage in the manufacture of ammonium nitrate is to react ammonia gas with oxygen gas.

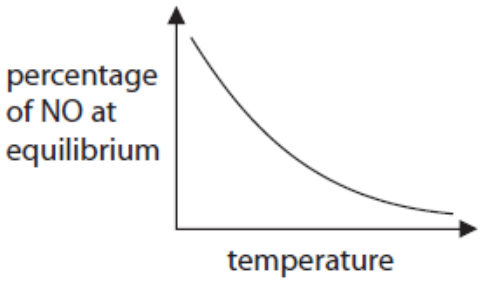
$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g) \qquad \Delta H = -907\,kJ/mol$$

The reaction is carried out at a pressure of about 10 atm and at a temperature of 800 °C, in the presence of a catalyst.

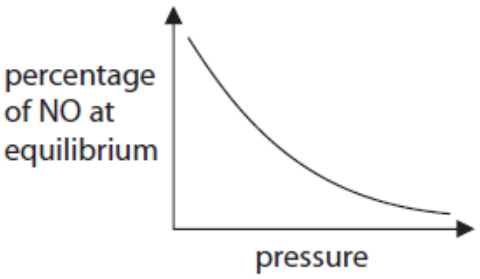
If the mixture is left for long enough in a sealed container, the reaction reaches a position of dynamic equilibrium.

Graph A shows how the percentage of nitrogen monoxide (NO) in the equilibrium mixture varies with temperature at constant pressure.

Graph B shows how the percentage of nitrogen monoxide (NO) in the equilibrium mixture varies with pressure at constant temperature.



graph A



graph B

(i) Explain why the percentage of NO at equilibrium decreases in each case.

(4)

Graph A .....

.....

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Graph B .....

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(ii) Explain why the use of a catalyst has no effect on the position of equilibrium in a reversible reaction.

(2)

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(b) The second stage in the manufacture of ammonium nitrate is to convert the nitrogen monoxide into nitric acid. The nitric acid is then reacted with concentrated aqueous ammonia as shown in this equation.

$$HNO_3(aq) + NH_3(aq) \rightarrow NH_4NO_3(aq)$$

(i) State, in terms of proton transfer, why this reaction is classified as an acid-base reaction.

(1)

.....

.....

(ii) Calculate the volume of 14.8 mol / dm^3 aqueous ammonia that is required to exactly neutralise 150 dm^3 of a solution of nitric acid of concentration 15.8 mol / dm^3.

(2)

volume of aqueous ammonia = ... dm^3

(Total for question = 9 marks)

Q4.

Use the Periodic Table to help you answer this question.

(a) Identify the element with atomic number 7

(1)

.....

(b) Identify a solid non-metallic element in Period 3

(1)

.....

(c) Name an element in Group 7 that is a liquid at room temperature.

(1)

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(d) State the relative atomic mass of the element that is in Group 4 and Period 4

(1)

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(e) Which row shows the most reactive element in Group 1 and Group 7?

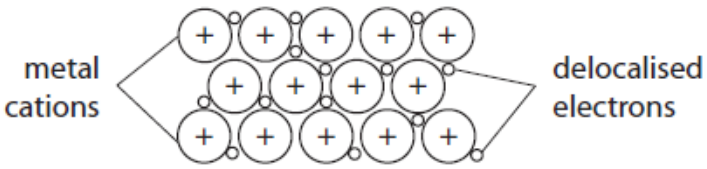
(1)

	Most reactive element in Group 1	Most reactive element in Group 7
☒ **A**	lithium	fluorine
☒ **B**	francium	astatine
☒ **C**	lithium	astatine
☒ **D**	francium	fluorine

(Total for question = 5 marks)

Q5.

(a) The diagram represents the structure of copper metal.



Explain **three** properties of copper that make it a suitable metal to use in electrical wiring.

(5)

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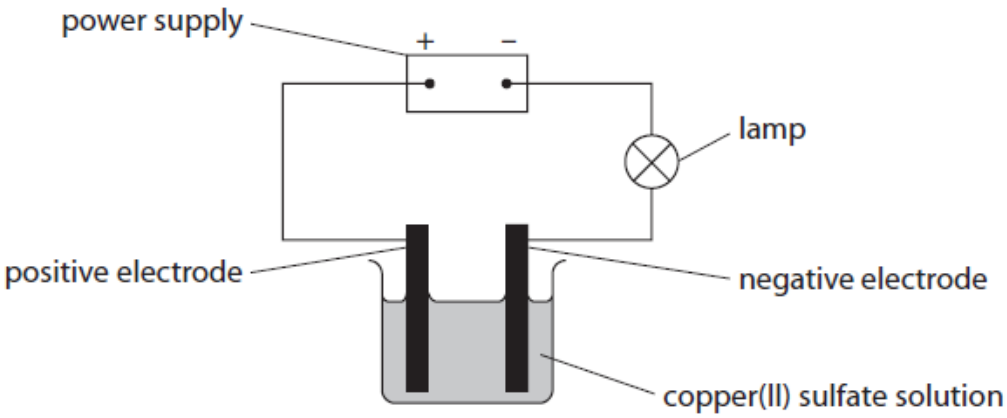
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(b) The diagram shows the electrolysis of copper(II) sulfate solution, using graphite electrodes.



Copper forms at the negative electrode and oxygen forms at the positive electrode.

(i) Give the formula of the copper ion and the formula of the sulfate ion in copper(II) sulfate.

(1)

copper ion

.....

sulfate ion

.....

(ii) State what would be seen at the positive electrode.

(1)

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.....

(iii) Give a test for oxygen.

(1)

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(iv) Give an ionic half-equation for the formation of oxygen at the positive electrode.

(2)

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(v) Suggest why the copper(II) sulfate solution contains some OH^- ions.

(1)

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(Total for question = 11 marks)

Q6.

Titanium is an important metal in industry.

Titanium dioxide (TiO_2) can be converted into titanium metal in two stages.

Stage 1 titanium dioxide is converted into titanium(IV) chloride ($TiCl_4$)

Stage 2 titanium(IV) chloride is converted into titanium

(a) This is the equation for the reaction in stage 1.

$$TiO_2 + 2Cl_2 + C \rightarrow TiCl_4 + CO_2$$

Calculate the volume, in dm^3, of chlorine gas at rtp needed to react completely with 20 tonnes of titanium dioxide.

Give your answer in standard form.

[1 tonne = 10^6 g M_r of TiO_2 = 80]

[molar volume of chlorine gas at rtp = 24 dm^3]

(4)

volume of chlorine gas = ... dm^3

(b) In stage 2, titanium(IV) chloride vapour is passed through molten magnesium in a container filled with argon.

This is the equation for the reaction in stage 2.

$$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$$

Explain why the container is filled with argon rather than air.

(2)

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(c) Aeroplanes are made of an alloy containing aluminium and titanium.

Explain why the alloy is stronger than pure titanium metal.

You may include diagrams in your answer.

(3)

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(Total for question = 9 marks)

Q7.

A student uses this method to do a titration.

- use a measuring cylinder to obtain 25 cm^3 of sodium hydroxide solution
- transfer the solution to a conical flask
- add a few drops of universal indicator to the flask
- fill a burette with dilute sulfuric acid and record the initial burette reading
- add the acid to the flask, swirling the flask continuously
- add the acid slowly near the end-point
- record the final burette reading at the end-point

The student repeats the titration until at least two concordant results are obtained.

(a) State what is meant by concordant results.

(1)

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(b) Explain two improvements to the student's method so that more accurate results are obtained.

(4)

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(c) The student makes the improvements and repeats the titration.

The sulfuric acid has a concentration of 0.600 mol/dm^3.

The sodium hydroxide solution has a concentration of 1.50 mol/dm^3.

This is the equation for the reaction.

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the volume, in cm^3, of sulfuric acid that the student needs to completely react with 25.0 cm^3 of the sodium hydroxide solution.

(3)

volume of sulfuric acid = ... cm^3

(d) The student plans to obtain pure dry crystals of hydrated sodium sulfate.

They add the calculated volume of sulfuric acid to 25.0 cm^3 of the sodium hydroxide solution to form sodium sulfate solution.

Describe what the student should do to obtain pure dry crystals of hydrated sodium sulfate from the solution.

(4)

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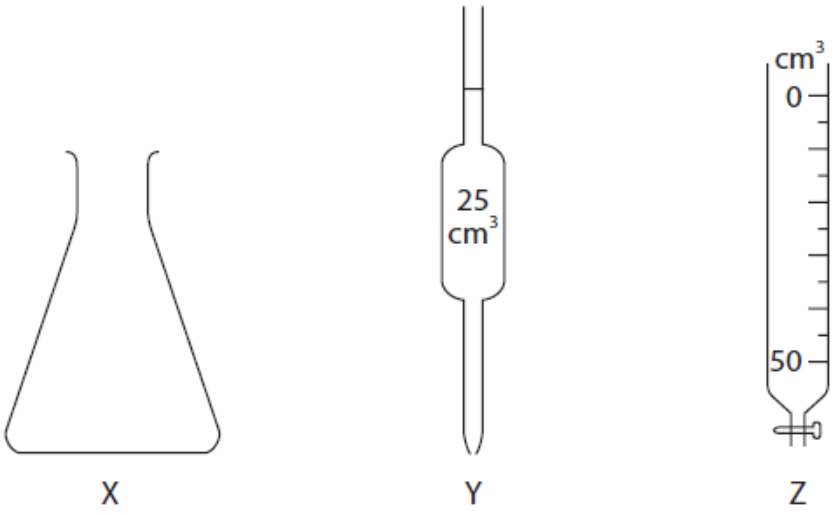
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(Total for question = 12 marks)

Q8.

A student does a titration to find the concentration of a solution of phosphoric acid.

He uses these pieces of apparatus X, Y and Z in his titration.



Diagrams are not to scale.

(a) Give the names of X, Y and Z.

(3)

X .....

Y .....

Z .....

(b) What is the colour of phenolphthalein in phosphoric acid?

(1)

☒ **A** blue

☒ **B** colourless

☒ **C** pink

☒ **D** red

(c) The student titrates 25.0 cm^3 of phosphoric acid with a solution of sodium hydroxide (NaOH).

Table 1 shows the student's results.

titration number	1	2	3	4
volume of NaOH added in cm^3	30.35	30.25	30.00	30.30
concordant results				

Table 1

Concordant results are those within 0.20 cm^3 of each other.

(i) Add ticks (✓) to table 1 to show the concordant results.

(1)

(ii) Use your ticked results to calculate the mean (average) volume of NaOH added.

(2)

mean volume = ... cm^3

(d) Table 2 shows the titration results of another student.

volume of phosphoric acid used in cm^3	25.0
concentration of sodium hydroxide solution in mol/dm^3	0.525
mean volume of sodium hydroxide added in cm^3	30.40

Table 2

The equation for the reaction is

$$3NaOH + H_3PO_4 \rightarrow Na_3PO_4 + 3H_2O$$

(i) Calculate the amount, in moles, of NaOH in 30.40 cm^3 of sodium hydroxide solution.

(2)

amount = ... mol

(ii) Calculate the amount, in moles, of H_3PO_4 in 25.0 cm^3 of phosphoric acid.

(1)

amount = ... mol

(iii) Calculate the concentration, in mol/dm^3, of the phosphoric acid.

(2)

concentration = ... mol/dm^3

(Total for question = 12 marks)

Q9.

A student does a titration using dilute sulfuric acid to find the concentration of a solution of

potassium hydroxide.

The student adds 25.0 cm^3 of the potassium hydroxide solution to a conical flask. He then adds a few drops of methyl orange indicator.

The student does the titration four times.

(a) (i) Name the piece of apparatus the student should use to add the potassium hydroxide solution.

(1)

.....

(ii) What is the colour of methyl orange in an alkaline solution?

(1)

☒ **A** blue

☒ **B** orange

☒ **C** red

☒ **D** yellow

(b) The table shows the student's results.

titration	1	2	3	4
volume of acid added in cm^3	20.65	20.60	20.90	20.55
concordant results				

Concordant results are those within 0.20 cm^3 of each other.

(i) Place ticks (✓) in the table to show which results are concordant.

(1)

(ii) Use the concordant results to calculate the mean (average) volume of acid added.

(2)

mean volume = ... cm^3

(c) This table shows the student's results for another titration.

volume of potassium hydroxide solution used in cm^3	25.0
concentration of potassium hydroxide solution in mol/dm^3	0.0370
mean volume of sulfuric acid added in cm^3	21.20

The equation for the reaction is

$$2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$$

(i) Calculate the amount, in moles, of KOH in 25.0 cm^3 of the potassium hydroxide solution.

(2)

amount of KOH = ... mol

(ii) Calculate the amount, in moles, of H_2SO_4 in 21.20 cm^3 of sulfuric acid.

(1)

amount of H_2SO_4 = ... mol

(iii) Calculate the concentration, in mol/dm^3, of the sulfuric acid.

(2)

concentration of sulfuric acid = ... mol/dm^3

(Total for question = 10 marks)

Q10.

A student wants to prepare sodium chloride crystals from sodium hydroxide solution and dilute hydrochloric acid.

He does a titration to find the volume of dilute hydrochloric acid needed to neutralise the sodium hydroxide solution.

This is his method.

- add 25.0 cm^3 of sodium hydroxide solution to a conical flask
- add a few drops of phenolphthalein indicator to the conical flask
- titrate the solution with the hydrochloric acid

(a) Name a suitable piece of apparatus that the student should use to measure 25.0 cm^3 of sodium hydroxide solution.

(1)

.....

(b) (i) Give the colour of the phenolphthalein indicator in sodium hydroxide solution and in hydrochloric acid.

(2)

colour in sodium hydroxide solution
.....

colour in hydrochloric acid
.....

(ii) Suggest why universal indicator is never used in a titration.

(1)

.....

.....

(c) The student finds that 21.50 cm^3 of hydrochloric acid is needed to neutralise 25.0 cm^3 of sodium hydroxide solution.

(i) Describe what the student should do next to prepare a pure solution of sodium chloride.

(2)

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(ii) Describe how the student could obtain dry crystals of sodium chloride from the pure sodium chloride solution.

(4)

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(d) The student needs 21.50 cm^3 of hydrochloric acid to neutralise 25.0 cm^3 of sodium hydroxide solution of
concentration 0.800 mol/dm^3.

The equation for the reaction is

$$NaOH + HCl \rightarrow NaCl + H_2O$$

Calculate the concentration, in mol/dm^3, of the hydrochloric acid.

(3)

concentration = ... mol/dm^3

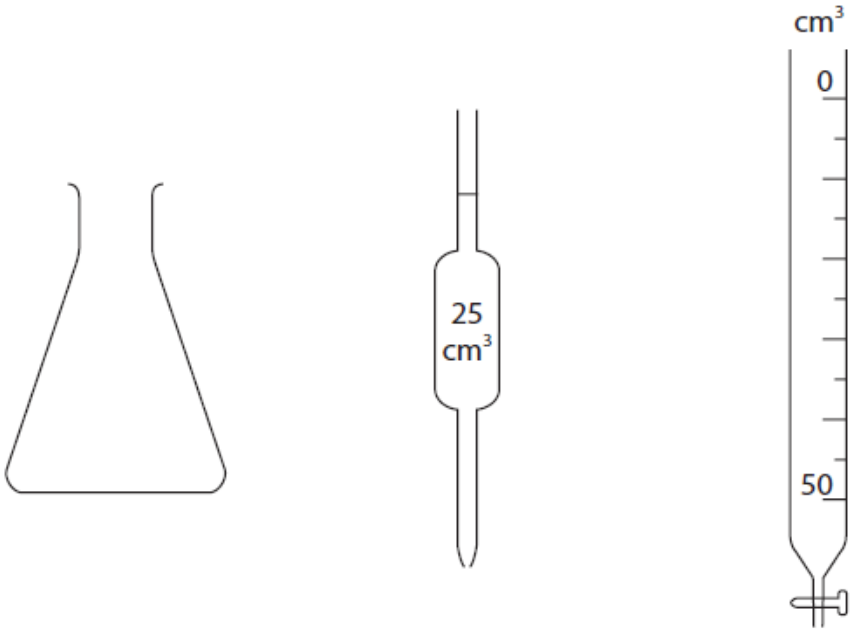
(Total for question = 13 marks)

Q11.

A student does a titration to find the concentration of a solution of dilute sulfuric acid.

The student uses these solutions and this apparatus.

- dilute sulfuric acid
- potassium hydroxide solution of concentration 0.240 mol / dm^3
- methyl orange indicator



(a) The student wants to find the volume of sulfuric acid needed to neutralise 25.0 cm^3 of the potassium hydroxide solution.

Describe how the student should do this titration.

Assume that all pieces of apparatus are clean and dry.

(6)

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(b) The student needs 15.00 cm^3 of sulfuric acid to neutralise 25.0 cm^3 of the potassium hydroxide solution.

This is the equation for the reaction.

$$2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$$

(i) Calculate the amount, in moles, of KOH in 25.0 cm^3 of potassium hydroxide solution of concentration 0.240 mol / dm^3.

(2)

amount of KOH = ... mol

(ii) Calculate the amount, in moles, of H_2SO_4 in 15.00 cm^3 of the sulfuric acid.

(1)

amount of H_2SO_4 = ... mol

(iii) Calculate the concentration, in mol / dm^3, of the sulfuric acid.

(2)

concentration of sulfuric acid = ... mol / dm^3

(Total for question = 11 marks)

Q12.

A student is provided with a bottle containing a colourless solution X.

Solution X is thought to be dilute sulfuric acid of concentration 0.10 mol/dm^3.

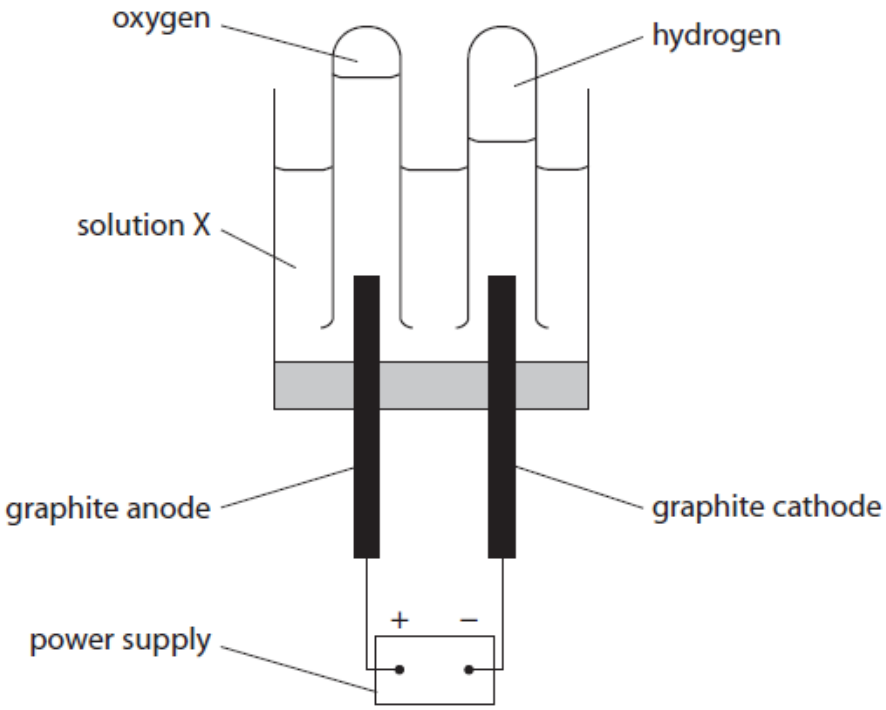
The student does some experiments on samples of solution X to try to show that it is dilute sulfuric acid.

The student adds a few drops of litmus to a sample of solution X.

The litmus turns red.

(a) The student knows that the products of the electrolysis of dilute sulfuric acid are hydrogen and oxygen.

She carries out the electrolysis using this apparatus.



(i) Suggest why the student does not use zinc electrodes in her experiment.

(1)

.....

.....

(ii) State what is observed at both the anode and the cathode during the electrolysis.

(1)

.....

(iii) Which of these tests shows that the gas formed at the cathode is hydrogen?

(1)

☒ **A** a glowing splint relights

☒ **B** a burning splint gives a squeaky pop

☒ **C** a burning splint goes out

☒ **D** limewater turns cloudy

(b) Describe a test to show that solution X contains sulfate ions.

(2)

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(c) The student then does a titration to see if the concentration of the dilute sulfuric acid is 0.10 mol/dm^3.

She measures 25.0 cm^3 of potassium hydroxide solution into a conical flask, and then adds a few drops of indicator solution.

(i) Name the piece of apparatus the student should use to measure 25.0 cm^3 of the potassium hydroxide solution.

(1)

.....

(ii) The concentration of potassium hydroxide in the solution is 0.125 mol/dm^3.

Calculate the amount, in mol, of KOH in 25.0 cm^3 of this solution.

(2)

amount = ... mol

(iii) The equation for the reaction in the titration is

$$H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$$

Calculate the volume, in cm^3, of 0.10 mol/dm^3 sulfuric acid needed to neutralise 25.0 cm^3 of the potassium hydroxide solution.

(3)

volume of sulfuric acid = ... cm^3

(Total for question = 11 marks)