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Answer ALL questions.

Some questions must be answered with a cross \boxtimes . If you change your mind about an answer, put a line through the box \boxtimes and then mark your new answer with a cross \boxtimes .

- 1 The table shows the composition of five species that are either atoms or ions.

Species	Number of protons	Number of neutrons	Number of electrons
A	1	0	1
B	3	3	3
C	3	4	3
D	9	10	10
E	13	14	13

- (a) Use the table to answer these questions.

You may use each letter once, more than once, or not at all.

- (i) Give the letter of the species that is a negative ion. (1)

- (ii) Give the letter of the species that has a full outer shell of electrons. (1)

- (iii) Give the letter of the species that has an atomic number equal to its mass number. (1)

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(b) Explain why species B and C are atoms of the same element with identical chemical properties.

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(c) A proton has a mass of 1.6726×10^{-24} g.

A neutron has a mass of 1.6740×10^{-24} g.

Calculate the mass, in grams, of the nucleus of an atom of species C.

(2)

mass = g

(Total for Question 1 = 7 marks)

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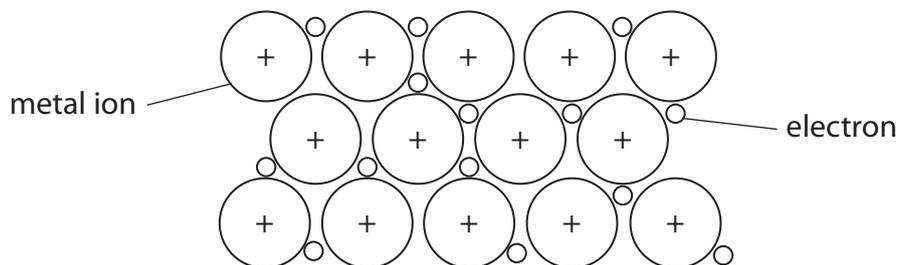
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2 This question is about metals and metal compounds.

(a) All metals are malleable and good conductors of electricity.

The diagram shows the structure of a metal.



(i) Explain why metals are malleable.

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(ii) Explain why metals are good conductors of electricity.

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- (b) Two methods of obtaining a metal from a compound are electrolysis and extraction using carbon.

Explain, without giving practical details, which method is most suitable for extracting iron from iron(III) oxide.

(2)

- (c) A student has a solution of iron(II) sulfate and a solution of iron(III) sulfate.

Describe a chemical test the student could use to identify which solution is iron(II) sulfate.

(2)

(Total for Question 2 = 8 marks)

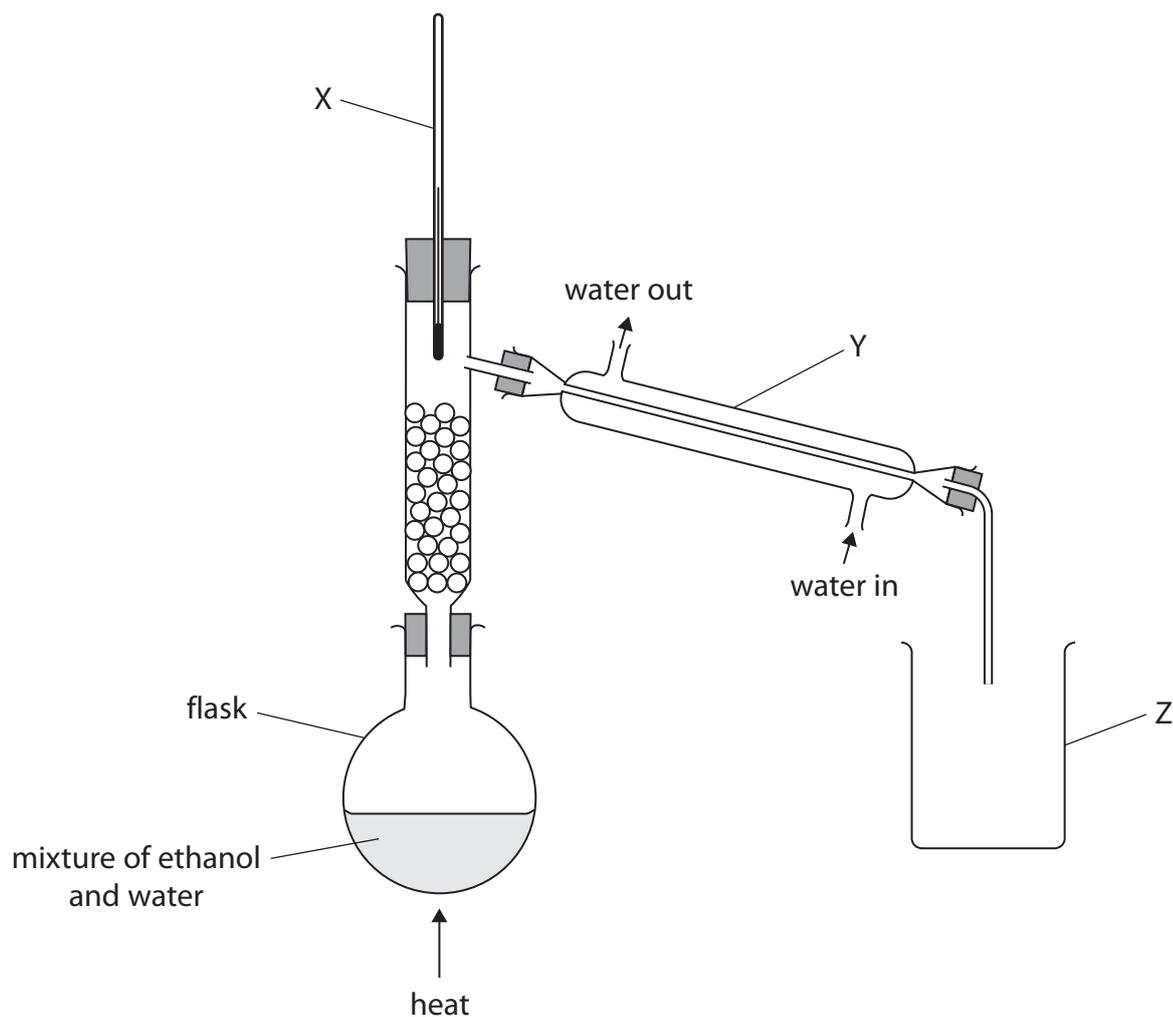
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3 A teacher uses this apparatus to separate a mixture of ethanol and water.



(a) Give the name of this method of separation.

(1)

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



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(b) Name the pieces of apparatus labelled X, Y and Z.

(3)

X

Y

Z

(c) Give a physical test that the teacher could do to find out if the ethanol produced is pure.

(2)

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(Total for Question 3 = 6 marks)

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4 A teacher adds a small piece of lithium to water and collects the gas produced.

(a) (i) Give two observations when lithium is added to water.

(2)

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(ii) The teacher adds a few drops of universal indicator to the solution at the end of the reaction.

Explain the final colour of the universal indicator.

(2)

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(b) This is the equation for the reaction between lithium and water.



The teacher collects 550 cm³ of hydrogen at rtp.

Calculate the mass, in grams, of lithium that the teacher added to the water.

[one mole of gas at rtp has a volume of 24 000 cm³]

[for lithium, $A_r = 7$]

[for carbon $A_r = 12$ for hydrogen, $A_r = 1$ for oxygen $A_r = 16$]

(3)

mass = g



- 5 A student does some titrations to find the volume of dilute nitric acid needed to exactly neutralise 25.0 cm^3 of sodium hydroxide solution.

This is the student's method.

Step 1 add 25.0 cm^3 of sodium hydroxide solution to a conical flask

Step 2 add three drops of methyl orange indicator

Step 3 fill a burette with the acid

Step 4 add acid from the burette until the indicator changes colour

Step 5 record the volume of acid added

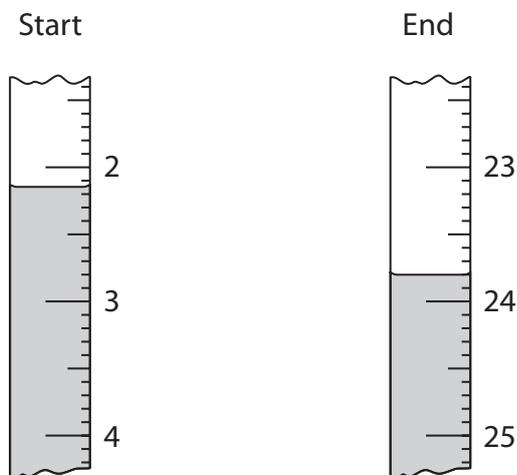
- (a) (i) Give the name of the apparatus that the student should use to measure the volume of sodium hydroxide solution in step 1. (1)

- (ii) Give the colour change seen in step 4. (1)

- (iii) Give a reason why the student does not use universal indicator in this titration. (1)

- (b) The student completes a rough titration and four accurate titrations.

The diagram shows the burette readings from the rough titration.



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The table shows the student's results.

	Rough titration	Titration 1	Titration 2	Titration 3	Titration 4
Burette reading at end in cm^3		21.80	22.85	21.75	24.10
Burette reading at start in cm^3		0.50	0.15	0.25	0.10
Volume added in cm^3		21.30	22.70	21.50	24.00

- (i) Complete the table by adding the results from the rough titration.

Record the volumes to the nearest 0.05 cm^3

(2)

- (ii) Concordant results are results within 0.20 cm^3 of each other.

Use the concordant results from the table to calculate the mean volume of acid added.

(3)

mean volume of acid = cm^3

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6 This question is about crude oil.

(a) Describe how crude oil is separated into fractions by fractional distillation.

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(b) Some of the long-chain alkanes obtained from fractional distillation are cracked, producing shorter-chain alkanes and ethene.

(i) Give the conditions necessary for cracking to occur.

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(ii) Explain why shorter-chain alkanes are more useful than longer-chain alkanes.

(2)

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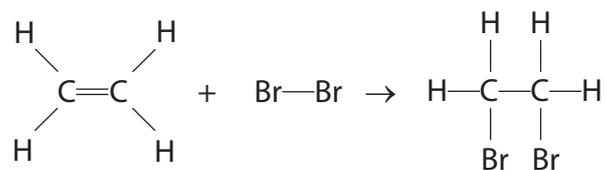
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(iii) Ethene reacts with bromine.

The equation shows the displayed formulae of the reactants and product.



The table shows some bond energies.

Bond	Bond energy in kJ/mol
C=C	612
C—C	348
C—H	414
Br—Br	193
C—Br	276

Show that the molar enthalpy change, ΔH , for this reaction is about -100 kJ/mol.

(3)

$\Delta H = \dots\dots\dots$ kJ/mol

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(iv) Explain why the reaction between ethene and bromine is exothermic.

Refer to bond energies in your answer.

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(Total for Question 6 = 13 marks)

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7 This question is about alcohols and carboxylic acids.

(a) These are the structural formulae of alcohol A and carboxylic acid B.

Alcohol A $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

Carboxylic acid B $\text{CH}_3(\text{CH}_2)_n\text{COOH}$

(i) Name alcohol A.

(1)

(ii) Draw the displayed formula of alcohol A.

(1)

(iii) Carboxylic acid B has a chain of carbon atoms with no branches.

The number of CH_2 units is represented by the letter n .

Calculate the value of n .

[for carboxylic acid B, $M_r = 242$]

(3)

$n = \dots\dots\dots$

(iv) Alcohol A and carboxylic acid B react together to form an ester.

Give the other product of the reaction.

(1)

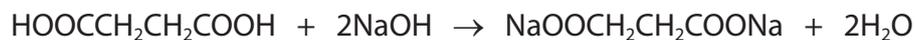


(b) These are the structural formulae of dicarboxylic acid C and diol D.

Dicarboxylic acid C $\text{HOOCCH}_2\text{CH}_2\text{COOH}$

Diol D $\text{HOCH}_2\text{CH}_2\text{OH}$

(i) This is the equation for the reaction between dicarboxylic acid C and sodium hydroxide solution.



25.0 cm³ of 0.150 mol/dm³ sodium hydroxide solution is completely neutralised by 17.5 cm³ of a solution of dicarboxylic acid C.

Calculate the concentration, in mol/dm³, of the solution of dicarboxylic acid C.

Give your answer to three significant figures.

(4)

concentration = mol/dm³

(ii) Dicarboxylic acid C and diol D react to form a polyester.

Draw the displayed formula of the repeat unit of this polyester.

(2)

(Total for Question 7 = 12 marks)

TOTAL FOR PAPER = 70 MARKS

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