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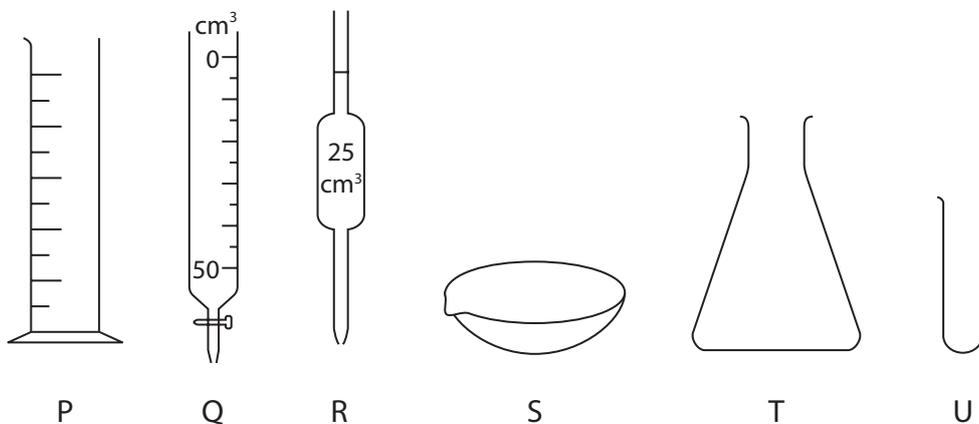
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Answer ALL questions.

- 1 The diagram shows some pieces of apparatus that can be used for different processes.
The pieces of apparatus are not to scale.



- (a) Complete the table by placing ticks (✓) in each column to show if a piece of apparatus can be used for a process.

One tick has been done for you.

Each piece of apparatus can be used for one process, more than one process, or not at all.

(5)

Letter	Process		
	titration	measures different volumes	evaporates solvent to produce crystals
P			
Q	✓		
R			
S			
T			
U			

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(b) Give the letter for the piece of apparatus that is a burette.

(1)

(c) Name the piece of apparatus labelled R.

(1)

(Total for Question 1 = 7 marks)



2 This question is about the halogens.

(a) The table lists some halogens and their properties.

Complete the table by giving the missing information.

(3)

Halogen	State at 25°C	Colour
fluorine		pale yellow
chlorine	gas	
bromine		brown
iodine	solid	dark grey

(b) Suggest the state of astatine at 25 °C.

(1)

(c) A sample of bromine atoms contains 42.0% bromine-79 and 58.0% bromine-81.

Calculate the relative atomic mass of this sample of bromine atoms.

Give your answer to three significant figures.

(3)

relative atomic mass =

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(d) A sample of chlorine contains 0.75 mol of ^{35}Cl atoms and 0.25 mol of ^{37}Cl atoms.

The table gives the relative molecular masses (M_r) of the different diatomic molecules of chlorine.

The table also gives the probability of having a molecule of $^{37}\text{Cl}^{37}\text{Cl}$ in this sample.

Molecule	$^{35}\text{Cl}^{35}\text{Cl}$	$^{35}\text{Cl}^{37}\text{Cl}$ and $^{37}\text{Cl}^{35}\text{Cl}$	$^{37}\text{Cl}^{37}\text{Cl}$
M_r	70	72	74
Probability			$0.25 \times 0.25 = 0.0625$

(i) Calculate the probability of having a molecule with an M_r of 70

(1)

probability =

(ii) Explain why the probability of a molecule having an M_r of 72 is not 0.1875

(2)

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3 (a) Paint can be used to coat iron, which protects iron from rusting.

(i) Give the chemical name for rust.

(1)

(ii) Explain how painting prevents iron from rusting.

(2)

(b) Steel is made from iron and carbon.

Explain how the difference in malleability of pure iron and high-carbon steel affects the uses of these materials.

(6)

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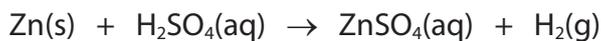
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(c) Zinc reacts with dilute sulfuric acid to produce zinc sulfate and hydrogen.

This is the equation for the reaction.



A mass of 16 g of zinc reacts with an excess of sulfuric acid.

Calculate the maximum volume, at rtp, of hydrogen produced.

[for hydrogen at rtp, molar volume = 24 dm³]

(2)

volume of hydrogen = dm³

(d) A solution of zinc sulfate is electrolysed to form zinc on the negative electrode.

(i) The ionic half-equation at the negative electrode is

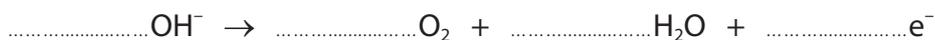


Give a reason why this half-equation shows reduction.

(1)

(ii) Complete the ionic half-equation for the reaction that could occur at the positive electrode.

(1)



(iii) A sample of the solution surrounding the positive electrode is tested with universal indicator.

Explain the final colour of the universal indicator.

(2)

(Total for Question 3 = 15 marks)

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4 (a) Steam can be used to manufacture ethanol.

(i) Give the other reactant needed for this reaction.

(1)

(ii) State the pressure and catalyst used for this reaction to manufacture ethanol.

(2)

pressure

catalyst

(b) The glucose in grapes can be fermented to make ethanol.

(i) State the condition needed to prevent the formation of ethanoic acid.

(1)

(ii) Explain why fermentation needs to happen in the range of 30 °C to 40 °C.

(2)

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(c) Grapes also contain esters.

This is the structural formula of an ester.



(i) Draw the displayed formula of this ester.

(2)

(ii) Deduce the name of the carboxylic acid and the name of the alcohol that react to form this ester.

(2)

carboxylic acid

alcohol

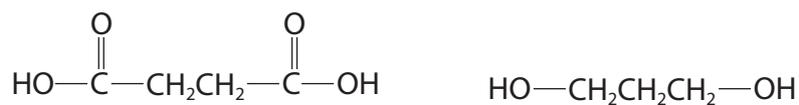
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- (d) These are the structural formulae of two monomers that are used to make a polyester.



- (i) Give the name of this type of polymerisation. (1)

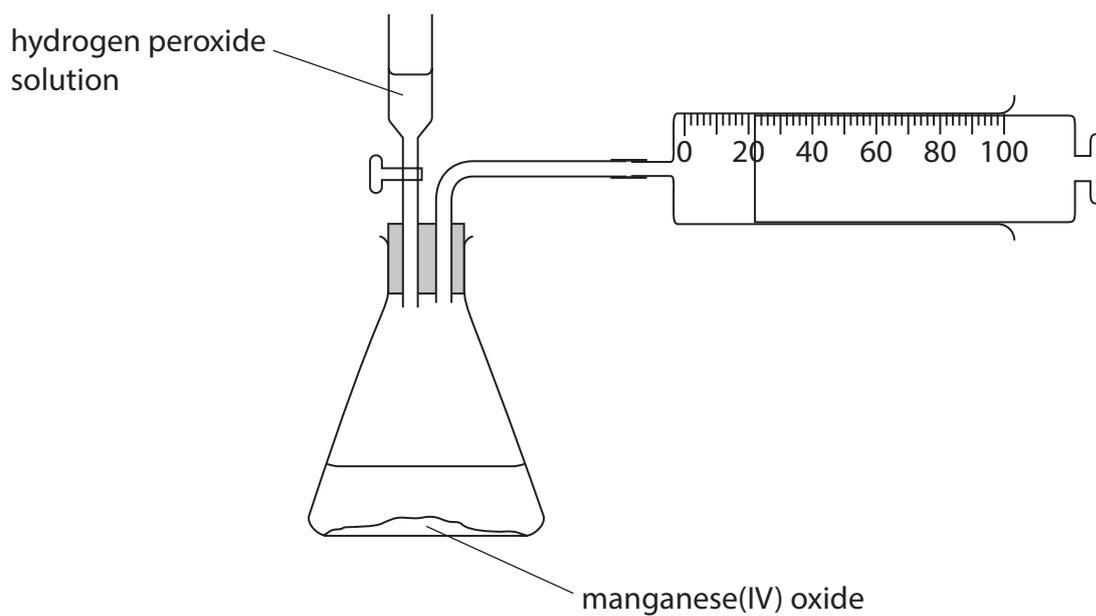
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- (ii) Draw the structure of the repeat unit of the polyester formed from the two monomers. (2)

- (iii) Identify the small molecule formed when these two monomers react together. (1)

(Total for Question 4 = 14 marks)



- 5 A student uses this apparatus to investigate the decomposition of hydrogen peroxide solution.



This is the equation for the reaction.



- (a) Give a chemical test for the presence of water.

(2)

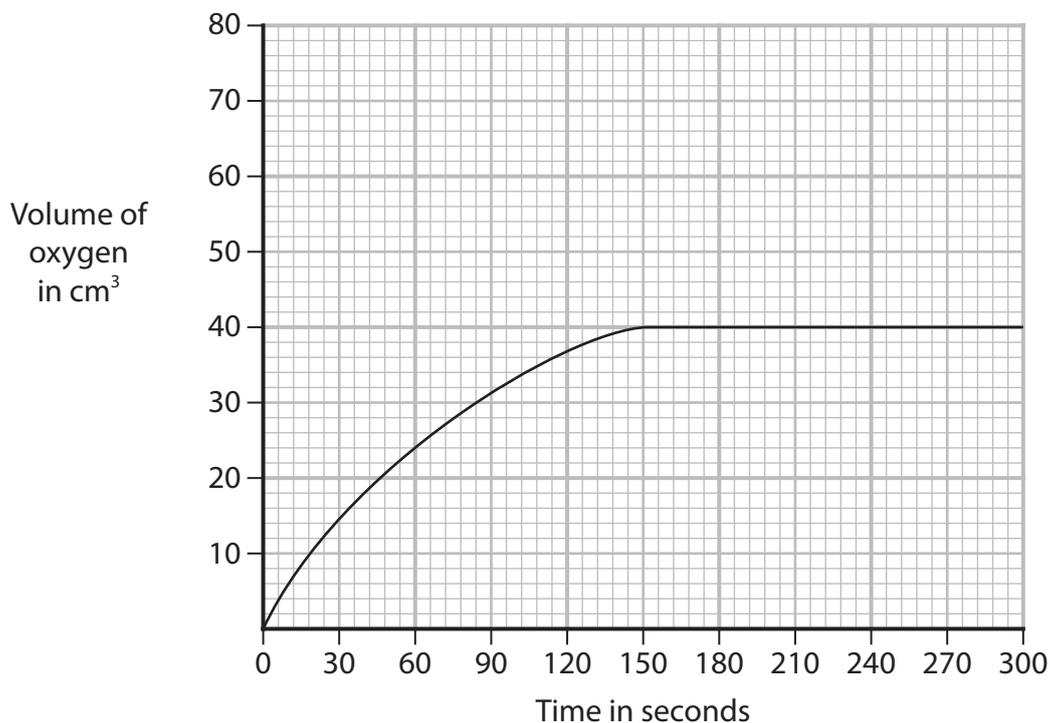
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- (b) In the first experiment the student uses hydrogen peroxide solution with a concentration of 0.020 mol/dm^3 .

The graph shows the student's results.



In a second experiment, the student uses hydrogen peroxide solution with a concentration of 0.025 mol/dm^3 .

All other conditions remain the same.

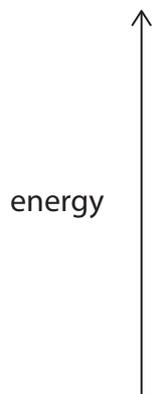
- (i) On the grid, draw the curve you would expect the student to obtain from the second experiment. (2)
- (ii) On the grid, draw the curve you would expect the student to obtain for the second experiment carried out at a lower temperature. (2)

- 6 The equation shows one of the possible substitution reactions that occurs during the reaction between methane and chlorine.



- (a) Complete the reaction profile diagram to show the levels of the reactants, the products and the activation energy, E_a .

(3)



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(b) The table gives some bond energies.

Bond	C—H	Cl—Cl	H—Cl
Bond energy in kJ/mol	414	242	431

Using information from the equation and the table, calculate the bond energy of the C—Cl bond.

(5)

C—Cl bond energy = kJ/mol

(Total for Question 6 = 8 marks)

TOTAL FOR PAPER = 70 MARKS

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