

The Periodic Table of the Elements

| | | | | | | | | |
|---|-------------------------------------|-------------------------------------|---------------------------------------|---|--|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | |
| 7 Li lithium 3 | 9 Be beryllium 4 | 11 Na sodium 11 | 12 C carbon 6 | 13 Al aluminium 13 | 14 N nitrogen 7 | 15 O oxygen 8 | 16 F fluorine 9 | 17 Ne neon 10 |
| 19 K potassium 19 | 20 Ca calcium 20 | 23 V vanadium 23 | 24 Cr chromium 24 | 25 Mn manganese 25 | 26 Fe iron 26 | 27 Co cobalt 27 | 28 Ni nickel 28 | 29 Cu copper 29 |
| 37 Rb rubidium 37 | 38 Sr strontium 38 | 40 Zr zirconium 40 | 41 Nb niobium 41 | 42 Mo molybdenum 42 | 43 Tc technetium 43 | 44 Ru ruthenium 44 | 45 Rh rhodium 45 | 46 Pd palladium 46 |
| 55 Cs caesium 55 | 56 Ba barium 56 | 57 La* lanthanum 57 | 58 Ce cerium 58 | 59 Pr praseodymium 59 | 60 Nd neodymium 60 | 61 Pm promethium 61 | 62 Sm samarium 62 | 63 Eu europium 63 |
| 87 Fr francium 87 | 88 Ra radium 88 | 89 Ac* actinium 89 | 90 Th thorium 90 | 91 Pa protactinium 91 | 92 U uranium 92 | 93 Np neptunium 93 | 94 Pu plutonium 94 | 95 Am americium 95 |
| 133 Bi bismuth 133 | 134 Po polonium 134 | 135 At astatine 135 | 136 Rn radon 136 | 137 Fr francium 137 | 138 Ra radium 138 | 139 Ac actinium 139 | 140 Th thorium 140 | 141 Pa protactinium 141 |
| 209 Po polonium 209 | 210 At astatine 210 | 211 Rn radon 211 | 212 Fr francium 212 | 213 Ra radium 213 | 214 Ac actinium 214 | 215 Th thorium 215 | 216 Pa protactinium 216 | 217 U uranium 217 |
| 204 Pb lead 204 | 205 Bi bismuth 205 | 206 Po polonium 206 | 207 At astatine 207 | 208 Rn radon 208 | 209 Fr francium 209 | 210 Ra radium 210 | 211 Ac actinium 211 | 212 Th thorium 212 |
| 201 Hg mercury 201 | 202 Tl thallium 202 | 203 Pb lead 203 | 204 Bi bismuth 204 | 205 Po polonium 205 | 206 At astatine 206 | 207 Rn radon 207 | 208 Fr francium 208 | 209 Ra radium 209 |
| 112 Cd cadmium 112 | 113 In indium 113 | 114 Sn tin 114 | 115 Sb antimony 115 | 116 Te tellurium 116 | 117 I iodine 117 | 118 Xe xenon 118 | 119 Fr francium 119 | 120 Ra radium 120 |
| 65 Zn zinc 65 | 66 Ga gallium 66 | 67 Ge germanium 67 | 68 As arsenic 68 | 69 Se selenium 69 | 70 Br bromine 70 | 71 Kr krypton 71 | 72 Rb rubidium 72 | 73 Sr strontium 73 |
| 108 Ag silver 108 | 109 Cd cadmium 109 | 110 In indium 110 | 111 Sb antimony 111 | 112 Te tellurium 112 | 113 I iodine 113 | 114 Xe xenon 114 | 115 Fr francium 115 | 116 Ra radium 116 |
| 197 Au gold 197 | 198 Hg mercury 198 | 199 Tl thallium 199 | 200 Pb lead 200 | 201 Bi bismuth 201 | 202 Po polonium 202 | 203 At astatine 203 | 204 Rn radon 204 | 205 Fr francium 205 |
| 106 Ds darmstadtium 106 | 107 Bh bohrium 107 | 108 Hs hassium 108 | 109 Mt meitnerium 109 | 110 Ds darmstadtium 110 | 111 Rg roentgenium 111 | Elements with atomic numbers 112-116 have been reported but not fully authenticated | | |

1
H
hydrogen
1

Key
relative atomic mass
atomic symbol
name
atomic (proton) number

* The Lanthanides (atomic numbers 58-71) and the Actinides (atomic numbers 90-103) have been omitted.

Cu and Cl have not been rounded to the nearest whole number.



P 7 8 7 6 7 R A 0 2 2 0



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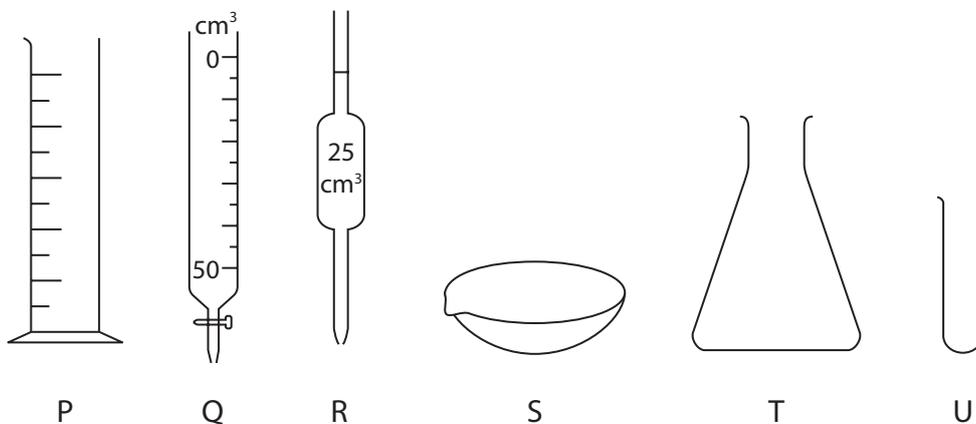
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P 7 8 7 6 7 R A 0 3 2 0

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 =



(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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(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

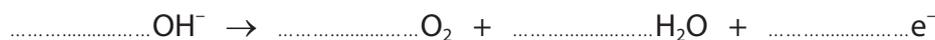


Give a reason why this half-equation shows reduction.

(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)



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)

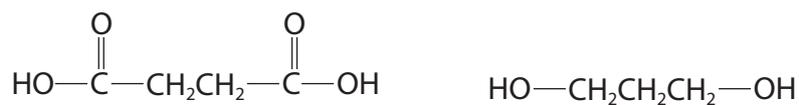
(ii) Deduce the name of the carboxylic acid and the name of the alcohol that react to form this ester. (2)

carboxylic acid

alcohol



- (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)

-
- (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)

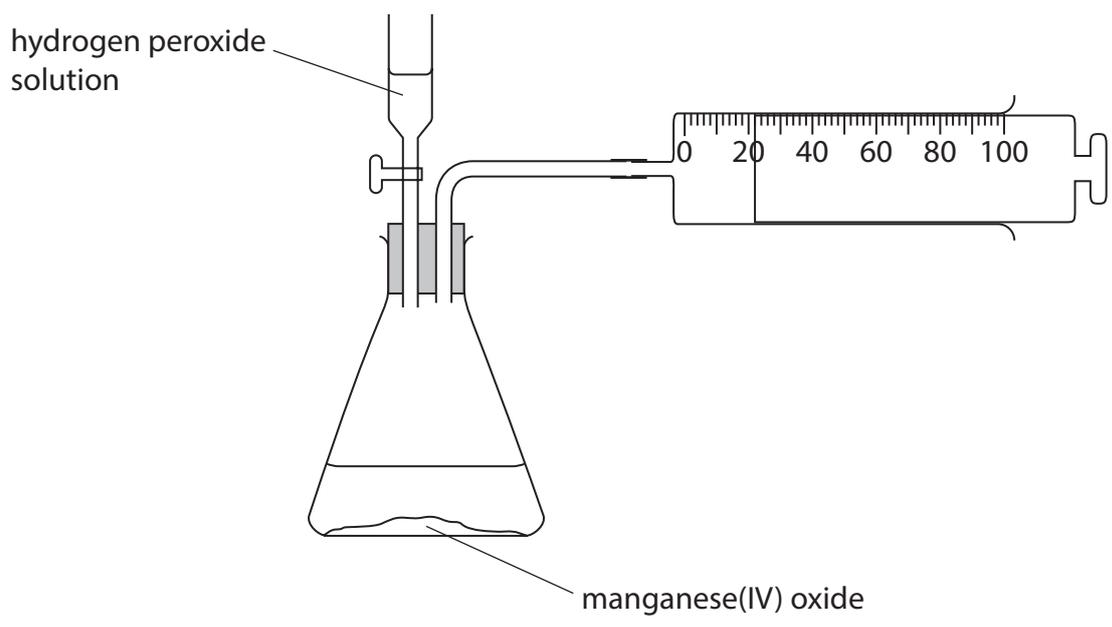


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5 A student uses this apparatus to investigate the decomposition of hydrogen peroxide solution.



This is the equation for the reaction.



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

(2)

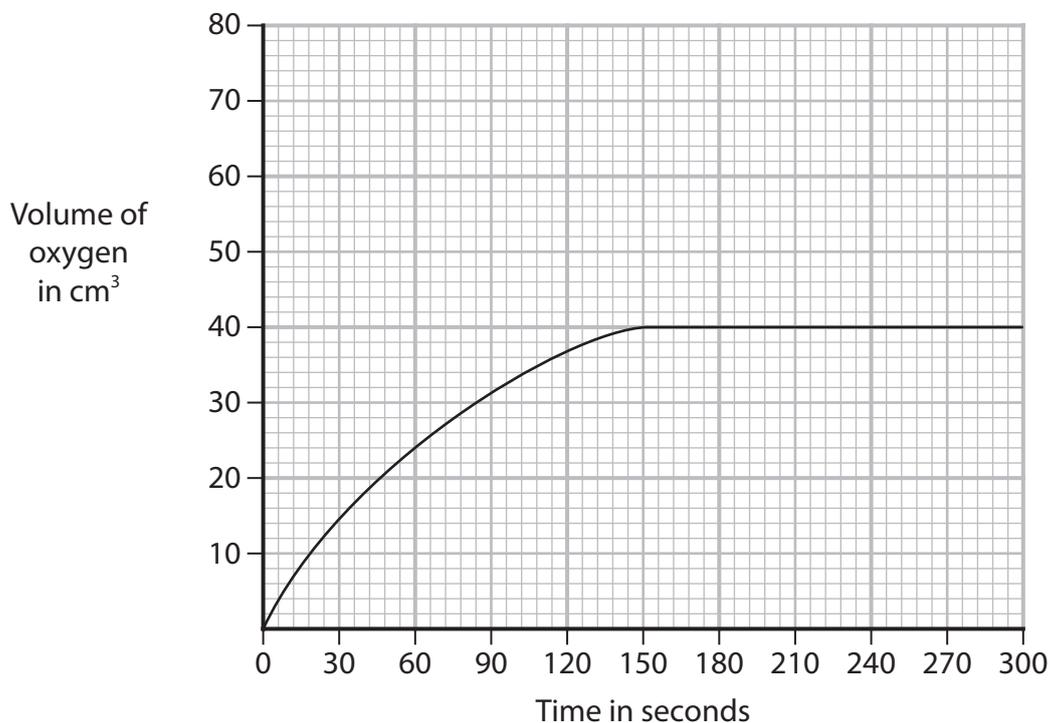
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- (b) In the first experiment the student uses hydrogen peroxide solution with a concentration of 0.020 mol/dm^3 .

The graph shows the student's results.



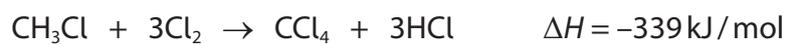
In a second experiment, the student uses hydrogen peroxide solution with a concentration of 0.025 mol/dm^3 .

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)

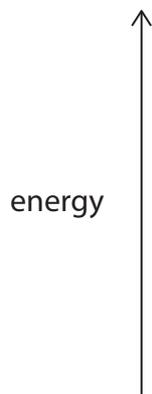


- 6 The equation shows one of the possible substitution reactions that occurs during the reaction between methane and chlorine.



- (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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