Please check the examination details below before entering your candidate information

| Candidate surname | Other names |
|---|---|
| | |

Centre Number | Candidate Number

# Pearson Edexcel Level 1/Level 2 GCSE (9–1)

**Time** 1 hour 45 minutes

**Paper reference** **1CH0/2H**

# Chemistry

## PAPER 2

## Higher Tier

**You must have:**
Calculator, ruler

Total Marks

## Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

## Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.
- There is a periodic table on the back cover of the paper.

## Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

*Turn over* ▶

P69487A



Q:1/1/1/1/1/

P 6 9 4 8 7 A 0 1 3 2

Pearson

**Answer ALL questions. Write your answers in the spaces provided.**

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

**1** (a) Titanium dioxide nanoparticles are used in some sunscreens.

(i) State one property of titanium dioxide nanoparticles that make them suitable for use in sunscreens.

**(1)**

Color less

(ii) Suggest one possible risk associated with using nanoparticles.

**(1)**

long term effects not known

(b) Figure 1 shows the surface area to volume ratio for different diameters of spherical nanoparticles.

| diameter of nanoparticle in nm | surface area : volume ratio |
|---|---|
| 10 | 3 : 5 |
| 20 | 3 : 10 |
| 30 | 3 : 15 |
| 40 | 3 : 20 |
| 50 | 3 : 25 |

**Figure 1**

(i) State the trend shown by the data in Figure 1.

**(1)**

as the diameter of the nanoparticle increases the surface area
volume ratio decreases

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(ii) What is the surface area : volume ratio for a spherical nanoparticle with a diameter of 80 nm?

**(1)**

☒ **A** 3 : 35

☒ **B** 3 : 40

☒ **C** 3 : 45

☒ **D** 3 : 50

(c) A different nanoparticle is cube shaped, as shown in Figure 2.

The length of one side of this cube is 60 nm.

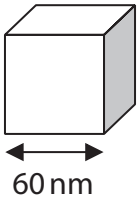


**Figure 2**

Show that the surface area : volume ratio for this cube is 1 : 10.

**(3)**

calculate surface area

60 x 60 x 6 (= 21 600 ) (1)

calculate volume

60 x 60 x 60 (= 216 000 ) (1)

s.a : vol ratio

216000 (1) (= 10)

21600

**(Total for Question 1 = 7 marks)**

**2** A student used the apparatus in Figure 3 to investigate the rate of the reaction between a metal and dilute hydrochloric acid.

Pieces of the metal were placed in dilute hydrochloric acid in the flask, and the total volume of gas produced was measured every minute.

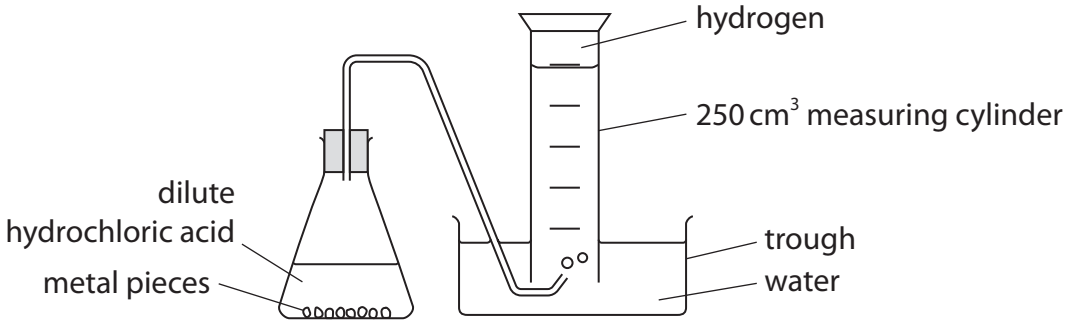


**Figure 3**

(a) Figure 4 shows a graph of the student's results.

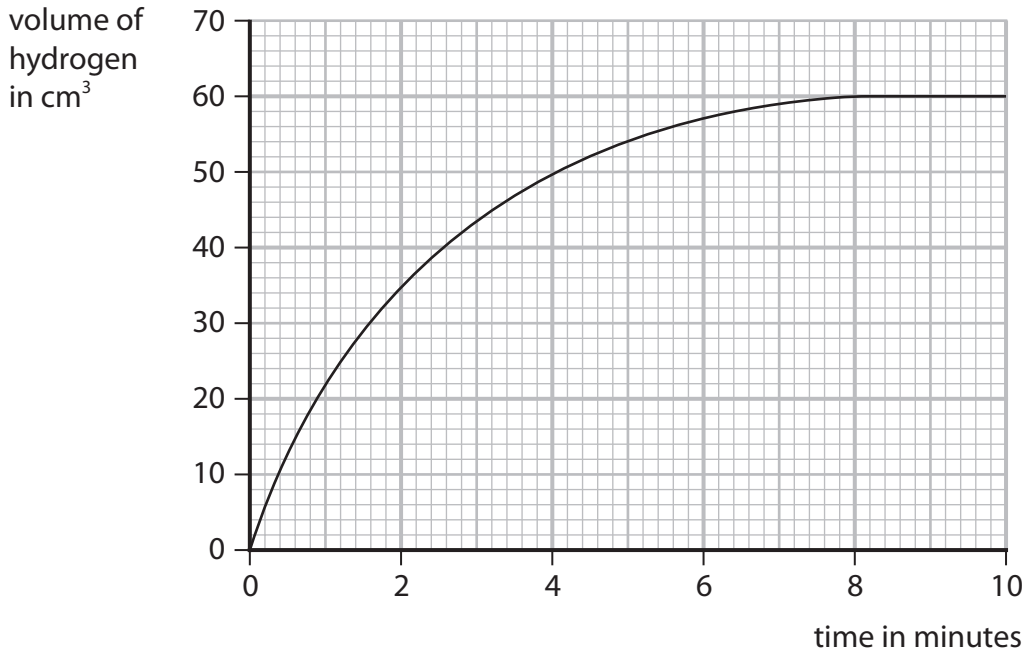


**Figure 4**

(i) Name a piece of apparatus that would be better to measure the volume of gas produced, instead of the 250 $cm^3$ measuring cylinder.

Give a reason for your answer.

**(2)**

name of apparatus

• 100 cm3 measuring cylinder/ (gas) syringe

•

reason

which has smaller gradations

(ii) Calculate the mean rate of production of hydrogen over the first 90 seconds, in $cm^3$ per second.

**(3)**

volume read at 90s = 29 cm3

• rate = volume
90

• = 0.3222…. (cm3 per second)

rate = 0.32222 $cm^3$ per second

(iii) The student measured the volume of gas for 10 minutes.

State why the measurements could have been stopped at 9 minutes.

**(1)**

Volume Was

(b) The experiment was repeated, but with acid of a higher concentration.

The rate of reaction was faster.

(i) Explain why the rate of reaction increases when the concentration of acid is increased.

**(2)**

more particles present (in same volume)

so more frequent collisions/ more chance of collision

(ii) Another student suggests four other ways of increasing the rate of this reaction.

Which one is correct?

**(1)**

- ☒ **A** use the same acid but at a lower temperature
- ☒ **B** use a larger trough
- ☒ **C** use a smaller flask
- ☒ **D** use the same metal but in a powdered form

**(Total for Question 2 = 9 marks)**

**3** This question is about gases.

(a) When sodium is added to water, hydrogen gas is produced.

Which observation shows that a gas has been produced?

**(1)**

- ☒ **A** a white precipitate forms
- ☒ **B** effervescence is seen
- ☒ **C** the sodium sinks in the water
- ☒ **D** the water changes to a pink colour

(b) Some damp litmus paper is placed in a gas.
The litmus paper is bleached.

Which gas bleaches damp litmus paper?

**(1)**

- ☒ **A** carbon dioxide
- ☒ **B** chlorine
- ☒ **C** hydrogen
- ☒ **D** oxygen

(c) When calcium carbonate is heated it decomposes.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

When 5.000 g of calcium carbonate is heated, the mass of solid remaining is 2.800 g.

Calculate the mass of carbon dioxide that has been released.

Give your answer to three significant figures.

**(2)**

2.20 with or without working scores
• 5(.000) – 2.8(00) = 2.2(00)
• = 2.20

mass of carbon dioxide = ..... g

(d) A diagram of an atom of helium is shown in Figure 5.

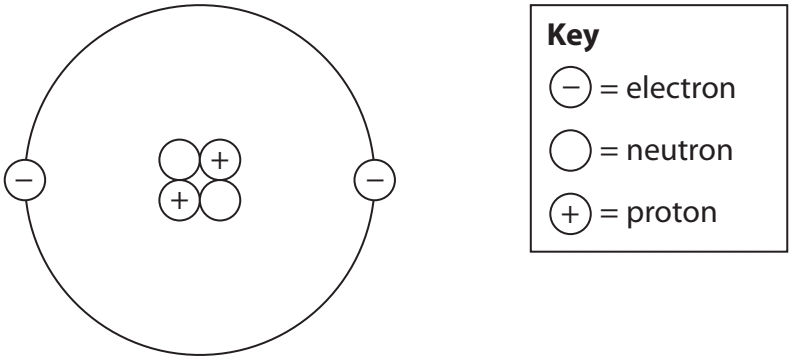


**Figure 5**

(i) Explain, using Figure 5, why helium is inert.

**(2)**

it has two electrons in outer shell/ it has a full outer shell / OWTTE
• so does not {gain/ lose/ transfer/ share} electrons

(ii) Helium is used to fill balloons.

State one property of helium, apart from it being inert, that makes it suitable for filling balloons.

**(1)**

Less denser than air

(e) Oxygen gas has the formula $O_2$.

Calculate the number of oxygen **atoms** in 3.50 mol of oxygen gas.

(Avogadro constant = $6.02 \times 10^{23}$)

**(2)**

4.214 x 1024 with or without working scores
2 x 3.5 (1) (= 7(.0))
7(.0) x 6.02 x 1023 (1) (= 4.214 x 1024)

number of oxygen atoms = .....

**(Total for Question 3 = 9 marks)**

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

**4** (a) Some acids are used in tests for ions.

A bottle of one acid is shown in Figure 6.

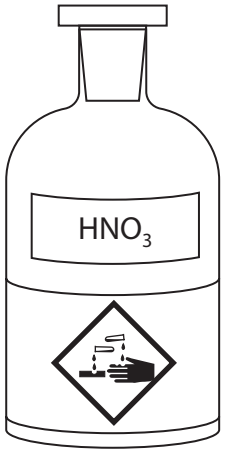


**Figure 6**

(i) The acid in Figure 6 can be used in the test for carbonate ions.

Explain, giving the name of the hazard symbol shown, what safety precautions should be taken when using this acid.

**(2)**

Corrosiveness

So wear goggles

(ii) Give the name of the acid shown in Figure 6.

**(1)**

Nitric acid

(iii) State a property of glass that makes it a suitable material to make the container for an acid.

**(1)**

Inert

(b) A teacher conducts a flame test to identify the metal ions in some unknown solids.

**step 1** dip a flame test wire into hydrochloric acid

**step 2** dip the flame test wire into the unknown solid

**step 3** hold the flame test wire above a Bunsen burner flame

(i) This method did not work well.

Explain an improvement that needs to be made to **step 3** to enable a bright flame colour to be produced.

**(2)**

• hold the wire in the flame / at the tip of the (blue) cone
• (as) it is hotter

(ii) Figure 7 shows the results of the flame tests on three compounds, **P**, **Q** and **R**.

| compound | flame colour |
|---|---|
| **P** | red |
| **Q** | lilac |
| **R** | blue-green |

**Figure 7**

Use Figure 7 to identify the metal ions in compounds **P**, **Q** and **R**.

**(3)**

**P** Lithium

**Q** Potassium

**R** Copper

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

(c) A flame photometer was used to analyse samples of a solution of metal ions.

Each sample was treated with 5.00 $cm^3$ of dilute hydrochloric acid.
1.00 $dm^3$ of the acid contained 219 g of hydrogen chloride.

Calculate the mass of hydrogen chloride in the acid used to test 20 samples.

**(2)**

20 x 5/1000 x 219 (2) (= 21.9 g)
• 5/1000 (= 0.005) (1)
• 20 x 0.005 x 219 (1) (= 21.9 g)

mass = ..... g

**(Total for Question 4 = 11 marks)**

**BLANK PAGE**

**5** (a) Figure 8 shows some information about the composition of pollutant exhaust gases from the engines of two different vehicles.

| pollutant | mass of pollutant given out in g per kilometre driven | |
|---|---|---|
| | petrol engine | diesel engine |
| carbon dioxide | 210 | 180 |
| carbon monoxide | 1.5 | 0.10 |
| unburnt hydrocarbons | 0.13 | 0.020 |
| nitrogen oxides | 0.36 | 2.0 |
| particulates | 0.0060 | 0.046 |
| sulfur dioxide | 0.0089 | 0.0037 |

**Figure 8**

(i) Give **two** ways in which the data in Figure 8 shows that the diesel engine is **more** damaging to the environment than the petrol engine.

**(2)**

diesel releases more (nitrogen oxides / NOx) (per km driven) / ORA
diesel releases more particulates (per km driven) / ORA

(ii) Explain, using information from Figure 8, **one** way in which the diesel engine is **less** damaging to the environment than the petrol engine.

**(2)**

diesel releases less carbon dioxide
which is a greenhouse gas/contributes to global warming

(b) (i) Which statement about the members of the alkane homologous series is correct?

**(1)**

☒ **A** they show a trend in chemical properties

☒ **B** their boiling point decreases as the molecules get larger

☒ **C** the molecular formula of neighbouring compounds differs by $CH_3$

☒ **D** their viscosity increases as the molecules get larger

(ii) Which one of the following hydrocarbons belongs to the same homologous series as octane, $C_8H_{18}$?

**(1)**

☒ **A** $C_4H_6$

☒ **B** $C_4H_8$

☒ **C** $C_4H_{10}$

☒ **D** $C_4H_{12}$

(iii) Write the balanced equation for the complete combustion of octane, $C_8H_{18}$.

**(3)**

$2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$

LHS formulae →

→ RHS formulae

balancing correct formulae

**(Total for Question 5 = 9 marks)**

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

**6** The elements in group 7 of the periodic table are known as the halogens.

(a) Name the halogen that is in period 4 of the periodic table.

**(1)**

Bromine

(b) Explain why chlorine is more reactive than iodine.

**(3)**

• outer {shell / electron(s)} is further from nucleus in iodine/ORA
• {force / attraction} between nucleus and (electrons in) outer shell is less in iodine/ORA
• iodine does not gain (an) electron(s) as readily/ORA

(c) A piece of burning sodium is placed into a gas jar containing chlorine gas, as shown in Figure 9.

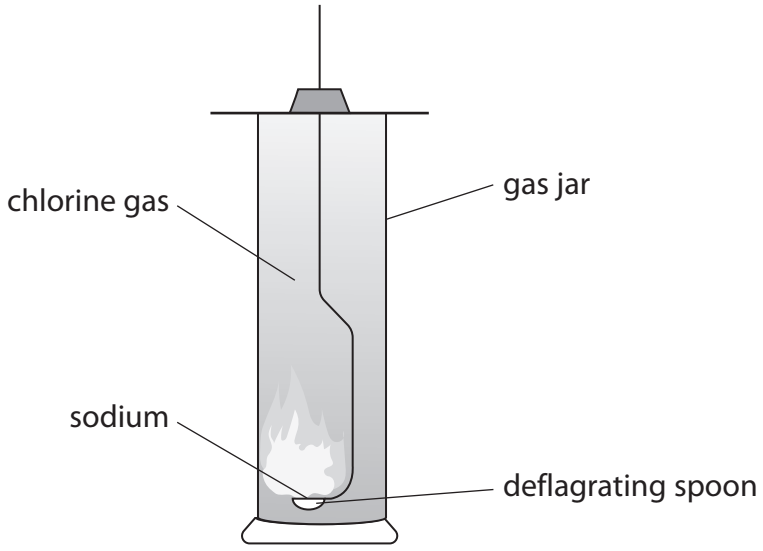


**Figure 9**

At the end of the reaction, the inside of the gas jar is coated with white crystals.

Identify the white crystals.

**(1)**

(d) Sodium also reacts with bromine.

(i) Write the balanced equation for the reaction between sodium and bromine.

**(2)**

Sodium chloride

(ii) In another experiment, a student adds colourless sodium bromide solution to chlorine water.

State what you would **see** in this reaction.

**(1)**

Turns yellow

(iii) The ionic equation for the reaction between sodium bromide and chlorine is:

$$2Br^- + Cl_2 \rightarrow 2Cl^- + Br_2$$

Explain which species has been oxidised in this reaction.

**(2)**

2Na + Br2 → 2NaBr

1 mark for correct formulae

1 mark for balancing correct formulae

**(Total for Question 6 = 10 marks)**

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

**7** This question is about oxygen.

(a) The percentage of oxygen in today's atmosphere is greater than the percentage of oxygen in the Earth's early atmosphere.

Explain what caused this change to happen.

**(2)**

Plants

Photosynthesis

(b) Magnesium reacts with oxygen from the air to form magnesium oxide.

A student carries out an investigation to determine the mass of magnesium oxide formed when a known mass of magnesium reacts completely with oxygen.

This is the method the student used.

**step 1** find the mass of a crucible and lid

**step 2** put a known mass of magnesium into the crucible and put the lid on

**step 3** heat for five minutes using a roaring Bunsen burner flame

**step 4** let the crucible, lid and contents cool down

**step 5** find the final mass of the crucible, lid and contents

Explain how the student could check that the magnesium had reacted completely with oxygen.

**(2)**

Reheat

Untill mass remains constant

(c) In another experiment, it was found that 1.24 g of phosphorus reacted completely with 1.60 g of oxygen to form phosphorus oxide.

The relative formula mass of this phosphorus oxide is 284.

Deduce the molecular formula of this phosphorus oxide.

You must show your working.

(relative atomic masses: O = 16, P = 31)

**(4)**

1.24 P (= 0.04) and 1.6 O (= 0.1)
31 16
ratio = 2:5 OR empirical formula = $P_2O_5$
relative formula mass $P_2O_5$ = 142
molecular formula = $P_4O_{10}$

molecular formula = .....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(d) A student uses the apparatus shown in Figure 10 to investigate the percentage of oxygen in the atmosphere.

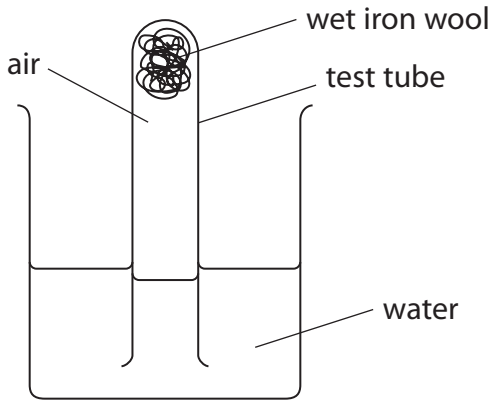


**Figure 10**

The apparatus was left for a few days.

(i) Explain one change the student would see after a few days.

**(2)**

Water level in test tube rises

(ii) Explain one change that can be made to the apparatus in Figure 10 to allow the student to calculate the percentage of oxygen in the atmosphere.

**(2)**

replace test tube with a measuring cylinder

to measure the {volume / amount} of oxygen used up

**(Total for Question 7 = 12 marks)**

**8** (a) A precipitate is produced when an alkaline solution is added to a solution containing some metal ions.

(i) Which of these is evidence of a precipitate being produced?

**(1)**

☒ **A** fizzing

☒ **B** solid forms in the solution ✖

☒ **C** the solution turns purple

☒ **D** the solution gets hot

(ii) You are given two solutions, one containing $Ca^{2+}$ ions and the other containing $Al^{3+}$ ions.

Devise a plan to identify which solution is which.

**(4)**

add named alkaline solution / sodium hydroxide (solution) / potassium hydroxide (solution)
• white precipitate forms (in both)
• white precipitate dissolves with excess (alkali) indicates Al3+
• white precipitate does not dissolve in excess (alkali) indicates Ca2+

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

*(b) A scientist carries out some tests on solid **V** and on a solution of **V**.

The tests and results are shown in Figure 11.

| test | result |
|---|---|
| appearance of **V** | white solid |
| see whether solid **V** conducts electricity | the solid does not conduct electricity |
| see whether a solution of **V** conducts electricity | the solution conducts electricity |
| heat solid **V** to 400 °C | the solid does not melt |
| add some sodium hydroxide solution to solid **V** and warm | a pungent gas, **W**, is released which turns damp litmus paper blue |
| add some dilute nitric acid, followed by drops of silver nitrate solution, to a solution of **V** | a cream precipitate, **X**, is produced |

**Figure 11**

Use the data in Figure 11 to deduce information about **V**, **W** and **X**, explaining your deductions.

**(6)**

V
• does not contain transition metal
• because it is white
• has ionic bonding
• because does not have low melting point, is soluble in water and only conducts when dissolved
W
• it is alkaline gas as litmus turned blue
• pungent and alkaline so is ammonia
X
• X is insoluble
• it contains bromide ions as a cream ppt formed
• which is silver bromide
Identity of V
• V contains ammonium ions
• V contains bromide ions
• V is ammonium bromide

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

**(Total for Question 8 = 11 marks)**

**9** (a) In some chemical reactions, bonds are broken in the reactant molecules and new bonds are formed to make the product molecules.

(i) Which row is correct about the energy changes for these processes?

**(1)**

| | | energy change | |
|---|---|---|---|
| | | **breaking a bond** | **making a bond** |
| ☒ | **A** | energy is released | energy is released |
| ☒ | **B** | energy is released | energy is absorbed |
| ☒ | **C** | energy is absorbed | energy is released |
| ☒ | **D** | energy is absorbed | energy is absorbed |

(ii) Hydrogen reacts with fluorine.

$$H_2 + F_2 \rightarrow 2HF$$

Figure 12 shows the bond energies for the bonds in the three molecules in the equation.

| bond | bond energy in kJ mol$^{-1}$ |
|---|---|
| H—H | 436 |
| F—F | 158 |
| H—F | 562 |

**Figure 12**

Calculate the energy change for this reaction.

**(4)**

- energy change in reactants = 436 + 158 (= 594)
- energy change in products = 2 x 562 (= 1124)
- overall energy change = 594 – 1124
- = -530 (1) (kJ mol-1)

energy change = ..... kJ mol$^{-1}$

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

*(b) The reaction profile for an uncatalysed exothermic reaction is shown in Figure 13.

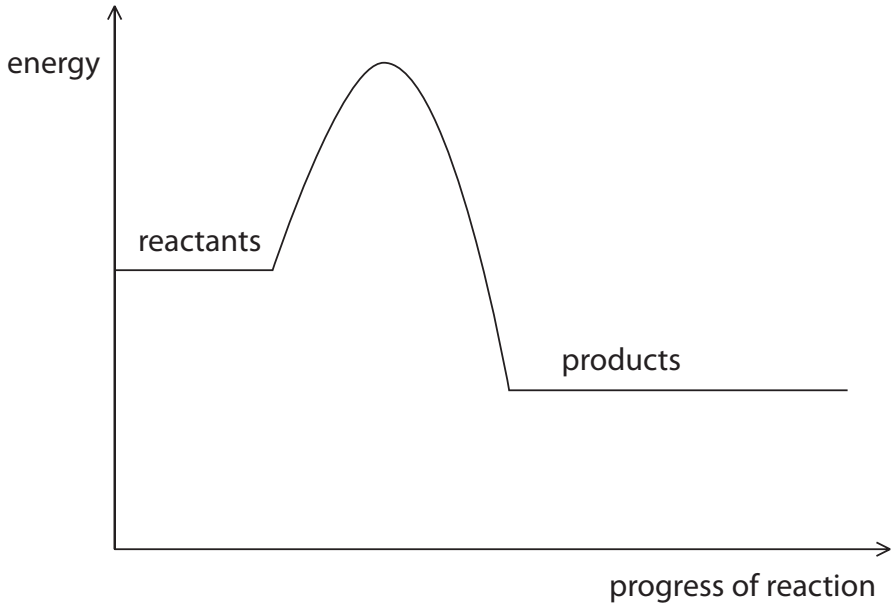


**Figure 13**

Using some examples of catalysts you have met in chemistry, discuss what catalysts do and their effect on the activation energy of a reaction.

You can use Figure 13 to illustrate your answer.

**(6)**

DESCRIPTION
- increases the rate of reaction
- does not alter products of reaction
- is chemically unchanged by reaction
- does not get used up
- so catalyst mass does not change

FUNCTION
- particles must have minimum energy for reactions to occur
- this is called activation energy
- reaction proceeds by an alternative route
- which reduces activation energy
- so a greater proportion of collisions are successful

DIAGRAM
- reaction profile with catalyst has start and end energies the same
- because reactants and products the same (label or in text)
- new profile has lower peak
- this represents lower activation energy (label or in text)

EXAMPLES
- Haber process to make ammonia uses iron catalyst
- cracking to make smaller alkanes uses catalyst
- (fermentation) to make alcoholic drinks uses (yeast which contains) an enzyme
- hydrogen peroxide decomposition uses catalysts
- used in catalytic converters
- use of enzymes as biological catalysts

**(Total for Question 9 = 11 marks)**

**10** (a) Figure 14 shows the structure of a molecule of hydrocarbon **Z**, $C_4H_8$.

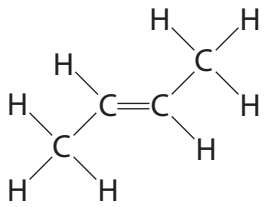

**Figure 14**

(i) Give the name of hydrocarbon **Z** shown in Figure 14.

**(1)**

but-2-ene

(ii) Complete the balanced equation for the reaction of hydrocarbon **Z**, $C_4H_8$, with bromine.

**(2)**

$C_4H_8$ + ~~Br2~~ → ~~C4H8Br2~~

(iii) Draw the repeating unit of the addition polymer formed when hydrocarbon **Z** undergoes polymerisation.

**(2)**

2 neighbouring carbon atoms with single bond and continuation bonds shown
rest of repeating unit correct

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(b) Figure 15 shows the arrangement of atoms in a molecule of an alcohol.

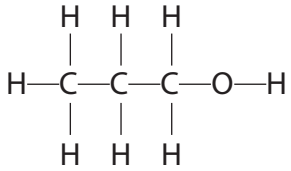

**Figure 15**

(i) Give the name of the carbon-containing product formed when the alcohol in Figure 15 undergoes dehydration.

**(1)**

Propene

(ii) Give the formula of the functional group of the product formed when the alcohol in Figure 15 undergoes oxidation.

**(1)**

-COOH / COOH /

(iii) A student wants to investigate the amount of energy released when 1.00 g of the alcohol is burned.

They set up the apparatus shown in Figure 16 to measure the temperature rise of the water.

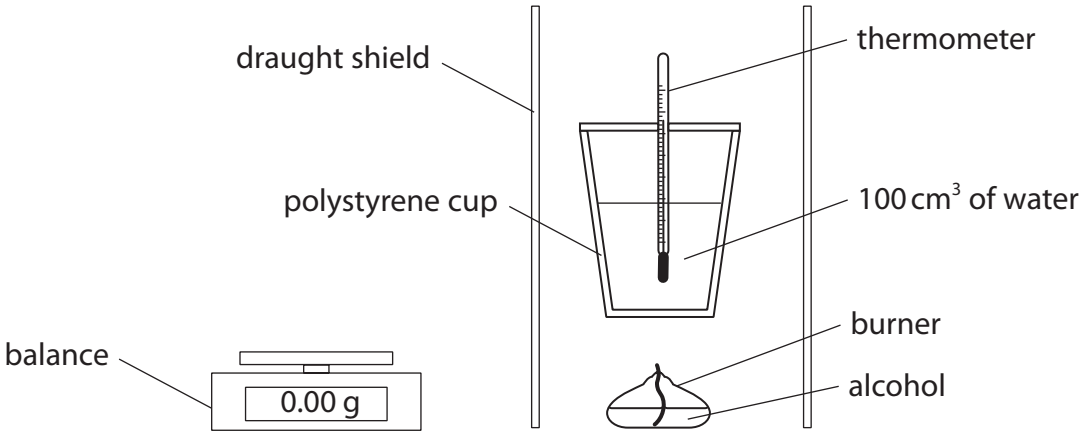


**Figure 16**

State why this apparatus is not suitable for use in this experiment.

**(1)**

the polystyrene cup {is a poor conductor of heat

(c) Some alcohols can react with some carboxylic acids to form polyesters, which are condensation polymers.

Figure 17 shows the repeating unit of the polyester molecule formed in a reaction between a carboxylic acid and an alcohol.

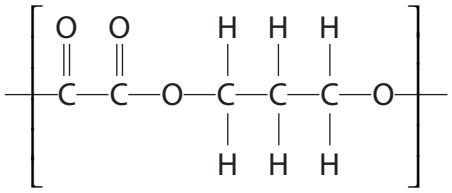

**Figure 17**

(i) Give the formula of the other product formed in this reaction.

**(1)**

H2O

(ii) Draw the structure of one molecule of the alcohol used to produce the polyester shown in Figure 17, showing all covalent bonds.

**(2)**

**(Total for Question 10 = 11 marks)**

**TOTAL FOR PAPER = 100 MARKS**

**BLANK PAGE**

# The periodic table of the elements

| 1 | 2 | | | | | | | | | | | 3 | 4 | 5 | 6 | 7 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1 **H** hydrogen 1 | | | | | | | | | | 4 **He** helium 2 |
| 7 **Li** lithium 3 | 9 **Be** beryllium 4 | | | | | | | | | | | 11 **B** boron 5 | 12 **C** carbon 6 | 14 **N** nitrogen 7 | 16 **O** oxygen 8 | 19 **F** fluorine 9 | 20 **Ne** neon 10 |
| 23 **Na** sodium 11 | 24 **Mg** magnesium 12 | | | | | | | | | | | 27 **Al** aluminium 13 | 28 **Si** silicon 14 | 31 **P** phosphorus 15 | 32 **S** sulfur 16 | 35.5 **Cl** chlorine 17 | 40 **Ar** argon 18 |
| 39 **K** potassium 19 | 40 **Ca** calcium 20 | 45 **Sc** scandium 21 | 48 **Ti** titanium 22 | 51 **V** vanadium 23 | 52 **Cr** chromium 24 | 55 **Mn** manganese 25 | 56 **Fe** iron 26 | 59 **Co** cobalt 27 | 59 **Ni** nickel 28 | 63.5 **Cu** copper 29 | 65 **Zn** zinc 30 | 70 **Ga** gallium 31 | 73 **Ge** germanium 32 | 75 **As** arsenic 33 | 79 **Se** selenium 34 | 80 **Br** bromine 35 | 84 **Kr** krypton 36 |
| 85 **Rb** rubidium 37 | 88 **Sr** strontium 38 | 89 **Y** yttrium 39 | 91 **Zr** zirconium 40 | 93 **Nb** niobium 41 | 96 **Mo** molybdenum 42 | [98] **Tc** technetium 43 | 101 **Ru** ruthenium 44 | 103 **Rh** rhodium 45 | 106 **Pd** palladium 46 | 108 **Ag** silver 47 | 112 **Cd** cadmium 48 | 115 **In** indium 49 | 119 **Sn** tin 50 | 122 **Sb** antimony 51 | 128 **Te** tellurium 52 | 127 **I** iodine 53 | 131 **Xe** xenon 54 |
| 133 **Cs** caesium 55 | 137 **Ba** barium 56 | 139 **La*** lanthanum 57 | 178 **Hf** hafnium 72 | 181 **Ta** tantalum 73 | 184 **W** tungsten 74 | 186 **Re** rhenium 75 | 190 **Os** osmium 76 | 192 **Ir** iridium 77 | 195 **Pt** platinum 78 | 197 **Au** gold 79 | 201 **Hg** mercury 80 | 204 **Tl** thallium 81 | 207 **Pb** lead 82 | 209 **Bi** bismuth 83 | [209] **Po** polonium 84 | [210] **At** astatine 85 | [222] **Rn** radon 86 |

**Key**

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

**** The elements with atomic numbers from 58 to 71 are omitted from this part of the periodic table.***

***The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.***