Please check the examination details below before entering your candidate information

Candidate surname	Other names

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

Centre Number	Candidate Number

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.
- Good luck with your examination.

Turn over ▶

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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) Figure 1 shows a list of particles.

ethene molecule
nanoparticle
sodium atom
starch molecule

Figure 1

In the spaces below, write the names of these particles in order of increasing particle size.

(2)

smallest particle - sodium atom

ethene molecule

starch molecule

largest particle nanoparticle

(b) Explain a possible risk associated with nanoparticulate materials.

(2)

• do not know the risks fully / long term risk not yet known (1)

• because they have not been used for a long time / are new technology / no long term research (1)

(c) Explain the advantage of using catalysts made of nanoparticles rather than larger particles.

(2)

An explanation linking two from

• catalyst particles have much larger surface area (when made from nanoparticles) (1)

• leads to increased reaction rate (1)

(Total for Question 1 = 6 marks)

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2 (a) The concentration of a solution can be calculated using the equation

$$\text{concentration of solution} = \frac{\text{mass of solid}}{\text{volume of solution}}$$

A student dissolved 9.25 g of ammonium chloride in water and made up the solution to a volume of 200 cm^3.

Use the equation to calculate the concentration of this solution in g dm^{-3}.

(2)

$\frac{9.25}{200}$ = (0.04625) (1)

0.04625 x 1000 = 46.25 (1)

concentration = 46.25 g dm^{-3}

(b) Dissolving ammonium chloride in water is an endothermic process.
Figure 2 shows part of the reaction profile for this process.

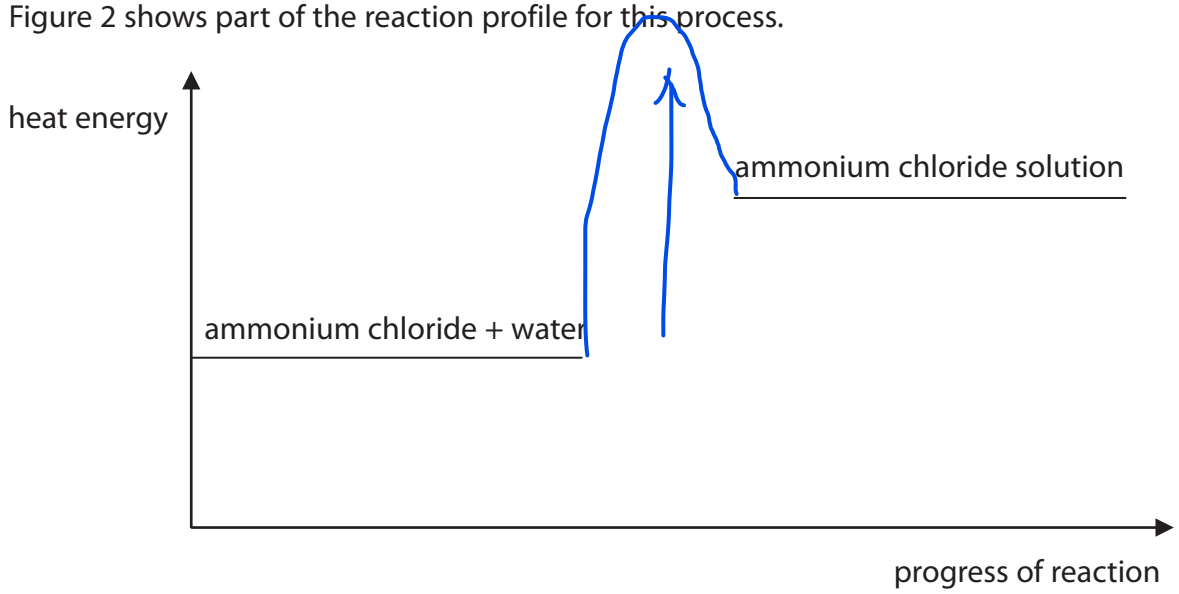

Figure 2

(i) Explain how Figure 2 shows that dissolving ammonium chloride in water is an endothermic process.

(2)

an explanation linking two of:

• {ammonium chloride solution/product} has more energy than {ammonium chloride solid and water/reactant} / ora (1)

• heat (energy) has increased / energy change is positive (1)

• (therefore) heat energy has been {absorbed/taken in} (1)

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(ii) Complete the reaction profile in Figure 2 and label the activation energy.

(2)

(c) A student used the equipment in Figure 3 to investigate whether electricity can pass through solid ammonium chloride and through ammonium chloride solution.

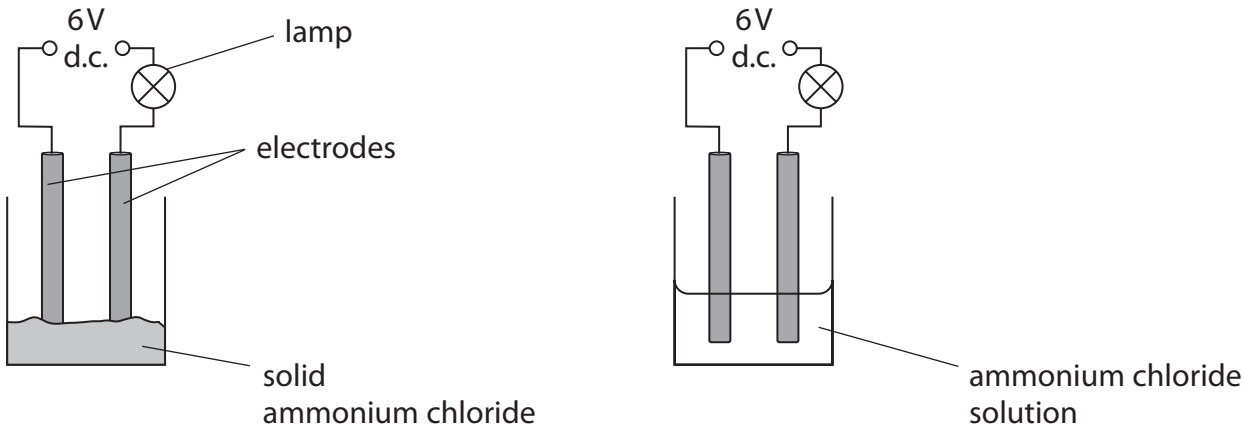

Figure 3

If an electrical current flows in the circuit, the lamp will light up.

Figure 4 shows the results of the investigation.

substance	lamp
solid ammonium chloride	did not light up
ammonium chloride solution	lit up brightly

Figure 4

Explain the results of the investigation.

(3)

An explanation linking

• ammonium chloride solution conducts electricity and solid ammonium chloride does not conduct electricity (1)

• ammonium chloride contains ions (1)

• in solution ions can move / in solid ions cannot move (1)

(Total for Question 2 = 9 marks)

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3 Diesel oil is a mixture of hydrocarbons that can be obtained from crude oil.

(a) State the name of the process used to separate diesel oil from crude oil.

(1)

fractional distillation / fractionation (1)

(b) Diesel oil contains alkanes.
These alkanes are part of an homologous series.

Which statement about compounds in this homologous series is true?

(1)

- ☒ **A** they have the same chemical formula
- ☒ **B** they have the same empirical formula
- ☒ **C** they have the same general formula
- ☒ **D** they have the same molecular formula

(c) When fuels such as diesel oil are burned, the high temperatures produced can cause nitrogen and oxygen in the air to form the pollutant nitrogen dioxide.

Complete the balanced equation for the reaction.

(2)

$N_2 + 2O_2 \rightarrow$ 2NO2 (2)

(d) Explain how the greenhouse effect is caused by the gases produced by the complete combustion of diesel oil.

(3)

An explanation linking

• {carbon dioxide / water} produced (1)

• (the gases) absorb heat radiated from earth (1)

• re-radiate heat back into the atmosphere (1)

(Total for Question 3 = 7 marks)

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4 This question is about polymers.

(a) (i) State a problem with **recycling** polymers.

(1)

need to sort polymers into different types

(ii) Describe a problem associated with the **disposal** of polymers.

(2)

polymers persist in landfill / landfill site fills up too quickly

• polymers degrade very slowly

or

• combustion produces gases

(b) Poly(chloroethene) is a polymer made from chloroethene.
A molecule of chloroethene is shown in Figure 5.

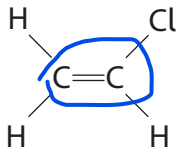


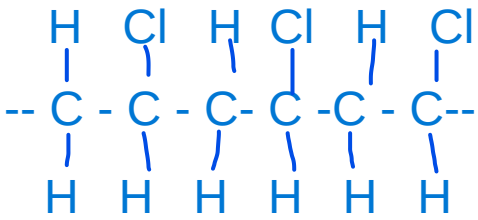
Figure 5

(i) On Figure 5, draw a circle around the functional group in this molecule.

(1)

(ii) Draw a section of a poly(chloroethene) molecule containing three repeating units, showing all bonds.

(3)



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(iii) What type of polymer is poly(chloroethene)?

(1)

addition (polymer)

(iv) Calculate the relative formula mass of a poly(chloroethene) molecule made from 2850 chloroethene molecules, C_2H_3Cl.

(relative atomic masses: H = 1.00, C = 12.0, Cl = 35.5)

Give your answer to three significant figures.

Show your working.

(3)

relative formula mass C2H3Cl = 62.5 (1)

2850 x 62.5 (1) (=178125)

178000 (to 3 sig figs) (1)

relative formula mass = ...

(Total for Question 4 = 11 marks)

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5 This question is about potassium and zinc.

(a) Which of the following temperatures is most likely to be the melting point of potassium?

(1)

- ☒ **A** –63 °C
- ☒ **B** 6.3 °C
- ☒ **C** 63 °C
- ☒ **D** 630 °C

(b) Explain how the electronic configuration of an atom of potassium is related to its position in the periodic table.

(2)

An explanation linking
• number of electrons on outer shell gives the group number / 1 electron on outer shell so group 1 (1)

• number of electron shells gives the period number / 4 electron shells so period 4 (1)

(c) Potassium reacts with oxygen to form potassium oxide.

(i) Describe the test to show that a gas is oxygen.

(2)

A description to include

• use of glowing splint (1)
• (glowing splint) relights (1)

(ii) Potassium oxide is ionic.

Write the electronic configurations for the ions in potassium oxide, K_2O.

(2)

potassium ion: 2.8.8 (1)

oxide ion: 2.8 (1)

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(d) Figure 6 shows two gas syringes connected by a glass tube.

Inside the glass tube there are some pieces of zinc.
Zinc reacts with oxygen at a temperature of over 225 °C.
Not all the oxygen reacts at once, the oxygen reacts only when in contact with the zinc.

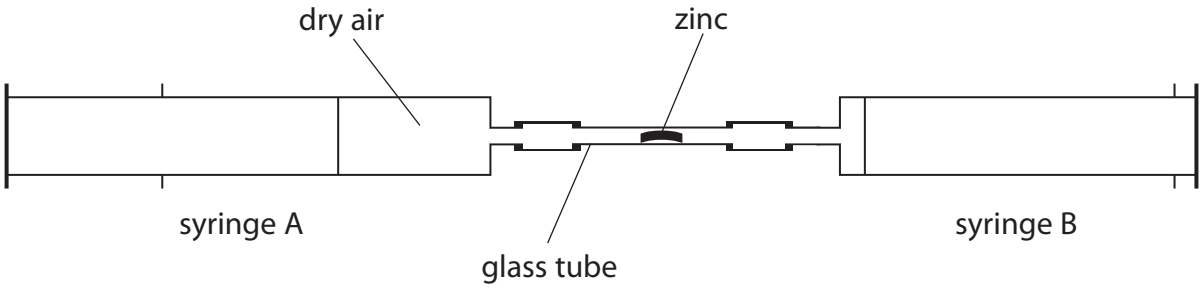


Figure 6

Devise a plan to find the volume of oxygen contained in a known volume of air, using the apparatus shown in Figure 6.

(4)

A plan to include

- heating tube where zinc is (1)
- pass {gas / air} over (heated) zinc (1)
- until no further change in volume (1)
- measuring volume of gas after experiment / calculate difference in volume (1)

(Total for Question 5 = 11 marks)

6 This question is about the rate of reaction between calcium carbonate and dilute hydrochloric acid.

The word equation for this reaction is

calcium carbonate + hydrochloric acid → calcium chloride + water + carbon dioxide

(a) Which of the following is the formula for calcium carbonate?

(1)

- ☒ **A** $CaCO_2$
- ☒ **B** $CaCO_3$
- ☒ **C** $Ca(CO)_3$
- ☒ **D** $Ca(CO_3)_2$

(b) Some pieces of calcium carbonate were added to dilute hydrochloric acid in a conical flask and the volume of carbon dioxide produced was measured.

Complete the diagram in Figure 7 to show the apparatus to collect the gas produced and measure its volume.

(2)

diagram of
• delivery tube with bung in flask connected to (1)
• gas syringe / gas syringe labelled (1)

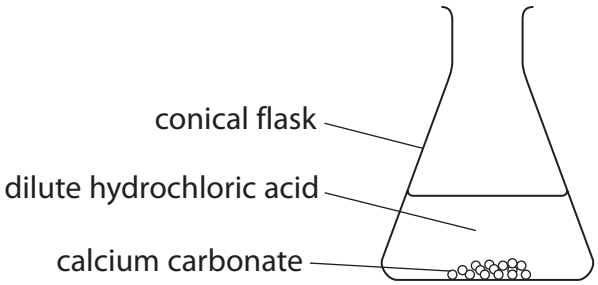


Figure 7

(c) The reaction between calcium carbonate and dilute hydrochloric acid was investigated at different temperatures.

(i) State what could be used to keep the temperature of the conical flask and its contents at a temperature of 45 °C throughout the reaction.

(1)

conical flask in water bath

[could be shown on diagram]

(ii) Figure 8 shows a graph of volume of gas collected in this investigation.

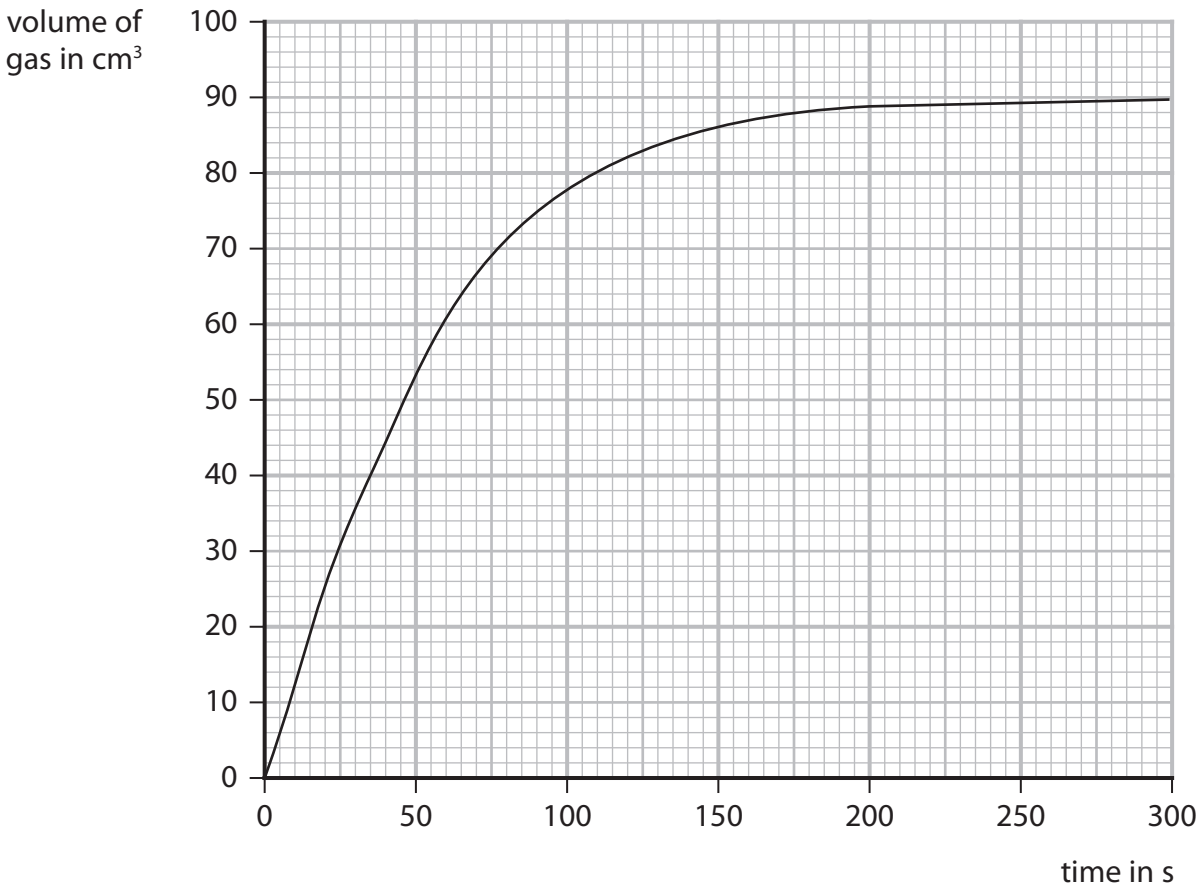


Figure 8

Draw a tangent at 100 seconds on Figure 8.
Use this tangent to calculate the rate of reaction at this time.

(2)

.....

.....

rate of reaction = ... $cm^3 s^{-1}$

Using tangent drawn on graph eg vertical difference (100 – 52) (1)
horizontal difference 180 (1)
(= 0.267) (cm3 s-1)

calculation will depend on final graph
2 marks for rate being within a range eg 0.250 – 0.290
1 mark for rate being in range 0.230 – 0.249 or 0.291 – 0.310

(iii) The temperature of the acid was kept at 45 °C.

State **one** other variable that needs to be controlled during this investigation.

(1)

particle size / concentration of acid / volume of acid / mass of calcium carbonate

(iv) Explain, in terms of particles, how decreasing the temperature affects the rate of this reaction.

(3)

An explanation linking

• fewer successful collisions (between acid and calcium carbonate particles) / fewer collisions with activation energy (1)

and any two from

• (because) decreasing temperature (of the acid) particles have lower energy (1)

• (because) the particles move slower (1)

• (so) rate of reaction decreases (1)

(Total for Question 6 = 10 marks)

7 (a) A technician was asked to find the concentration of potassium ions in a dilute solution using a flame photometer.

(i) The technician first produced a calibration curve using solutions with known concentrations of potassium ions.
Figure 9 contains the data for the calibration curve.

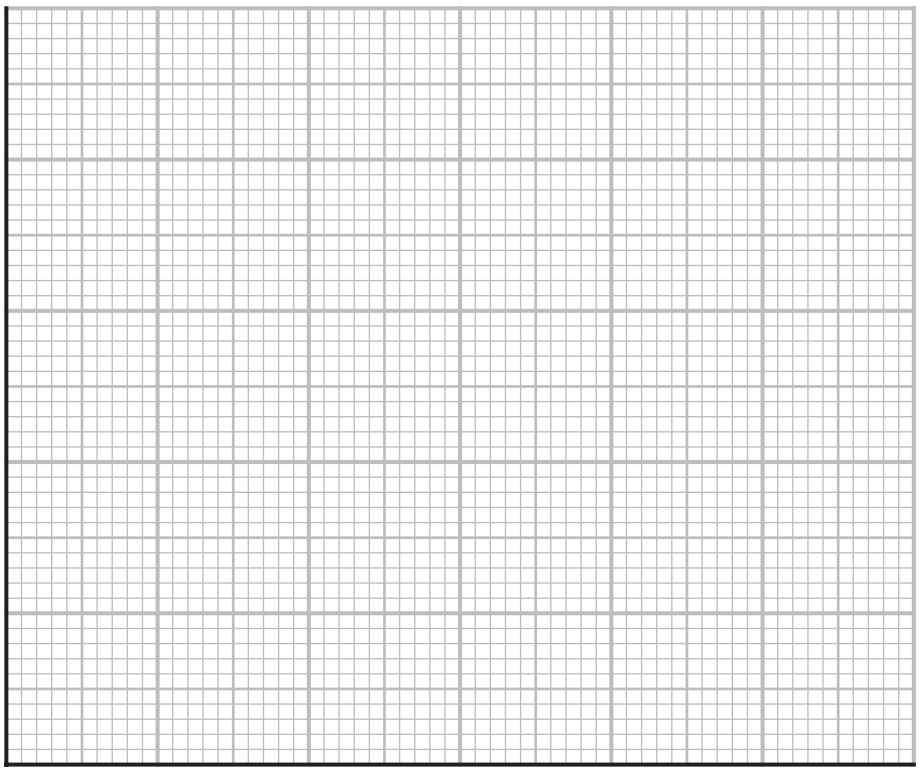
concentration of potassium ions in mol dm^{-3}	display reading
0.025	180
0.050	280
0.100	440
0.200	580
0.500	900

Figure 9

Use the information in Figure 9 to plot the calibration curve on the grid below.

(3)

display reading



concentration of potassium ions in mol dm^{-3}

suitable scale on axes using more than half axis in both directions (1)
correctly plotted points (1)
best fit curve (1)

(ii) The technician then obtained a reading of 360 for a dilute solution containing potassium ions.

Use the calibration curve to find the concentration of the potassium ions in this solution.

reading of concentration from graph (1)
(about 0.070 - 0.080 mol dm-3) **(1)**

concentration = ... mol dm^{-3}

(b) In the test for chloride ions, silver nitrate solution is added to a solution containing chloride ions.
A white precipitate forms.

Write the ionic equation for this reaction.

(2)

Ag+ + Cl- ----> AgCl (2)

*(c) A student was given a container of ammonium iron(II) sulfate, $(NH_4)_2Fe(SO_4)_2$.
The student was also given a dilute solution of sodium hydroxide and access to other laboratory reagents.

Describe the tests the student should carry out to identify the ions in the ammonium iron(II) sulfate, including appropriate equations for the reactions involved.

(6)

ions present – NH4+, Fe2+, SO42-

• dissolve solid in (distilled / deionised) water
• add drops of sodium hydroxide solution

• green / grey-green / dirty green
• precipitate shows Fe2+ ion

• precipitate is iron(II) hydroxide
• Fe2+ + 2OH- ----> Fe(OH)2

• warm mixture of salt solution and sodium hydroxide solution
• hold damp (red litmus / universal / pH indicator) paper above

mixture

indicator paper turns (blue / purple)

- test shows ammonia gas formed
- ammonia gas comes from NH4+ ions present

- NH4+ + OH- -----> NH3 + H2O

- to second portion of salt solution add drops of dilute hydrochloric acid
- add drops of barium chloride solution (or lead nitrate solution)
- white
- precipitate forms

- precipitate is barium sulfate (or lead sulfate)

- Ba2+(or Pb2+) + SO42- -----> Ba(or Pb)SO4

(Total for Question 7 = 12 marks)

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8 This question is about some of the elements in group 7 of the periodic table.

(a) Which row in the table correctly shows the colours and physical states of the elements at room temperature?

(1)

☒ **A**	iodine: purple gas	bromine: yellow liquid
☒ **B**	chlorine: pale green gas	iodine: brown solid
☒ **C**	bromine: red-brown liquid	chlorine: yellow liquid
☒ **D**	iodine: dark grey solid	bromine: red-brown liquid

(b) The compound phosphorus oxychloride has the formula $POCl_3$.

Calculate the percentage by mass of chlorine in phosphorus oxychloride.

(relative atomic masses: O = 16.0, P = 31.0, Cl = 35.5)

(2)

Formula mass $POCl_3$ = (31+16+3x35.5) (1)
(= 153.5)

$$\% \text{ Cl} = \frac{3 \times 35.5}{153.5} \times 100 \text{ (1) (= 69.4\%)}$$

percentage by mass of chlorine = 69.4

(c) When iron reacts with chlorine, iron chloride is formed.

Two possible equations for this reaction are

A $Fe + Cl_2 \rightarrow FeCl_2$

B $2Fe + 3Cl_2 \rightarrow 2FeCl_3$

In an experiment, 8.40 g iron reacts with chlorine to form 19.05 g iron chloride.

Show, using a calculation, which reaction, **A** or **B**, is taking place.

You must show your working.

(relative atomic masses: Cl = 35.5, Fe = 56.0)

(3)

mass of chlorine = 19.05 – 8.40 (1) (= 10.65 g)

EITHER

moles iron = $\frac{8.40}{56}$ (= 0.15) and moles chlorine = $\frac{10.65}{35.5 \times 2}$ (= 0.15) (1)

ratio 1:1 so equation A represents reaction (1)

*(d) Group 1 metals react with the elements from group 7 to form salts.

Some examples of these reactions are shown in Figure 10.

reaction	word equation
W	lithium + chlorine → lithium chloride
X	potassium + fluorine → potassium fluoride
Y	rubidium + iodine → rubidium iodide
Z	potassium + bromine → potassium bromide

Figure 10

You will find the position of these elements in their groups on the periodic table.

Explain, in terms of their electronic configurations and the relative reactivity of these elements, which of the reactions shown in Figure 10 would be the most violent.

(6)

group 1 metals form positive ions
• outer electron lost
• further down the group outer electron more easily lost
• due to electron shell further from nucleus OR greater electron shielding
• so lower nuclear attraction
• group 1 metal becomes more reactive
• order of reactivity Li < K < Rb
• group 7 elements form negative ions
• gains electron to complete outer shell
• further down the group electron is less easily gained
• due to outer electron shell further from nucleus OR greater electron shielding
• so lower nuclear attraction
• group 7 element becomes less reactive
• order of reactivity F > Br > I
• most reactive pair likely to be potassium + fluorine with suitable justification (K low in group 1 and F is at the top of group 7)
• allow rubidium +iodine with justification (Rb lower in group 1 than K and so more reactive)

(Total for Question 8 = 12 marks)

9 Pentadecane, $C_{15}H_{32}$, is a hydrocarbon and is used as a fuel.

(a) The incomplete combustion of pentadecane produces carbon monoxide. Carbon monoxide is a toxic gas.

(i) Explain why the incomplete combustion of pentadecane can produce carbon monoxide as one of the products.

(2)

An explanation linking

• insufficient oxygen (1)
• to oxidise all carbon to carbon dioxide (1)

(ii) Explain how carbon monoxide behaves as a toxic gas.

An explanation linking **(2)**

• carbon monoxide reacts with {haemoglobin (in blood) / blood / red blood cells} (1)
• stops oxygen being carried by {haemoglobin / blood / red blood cells} / so less oxygen reaches brain (1)

(b) 1 mole of pentadecane can be cracked to form 1 mole of octane, C_8H_{18}, and 1 mole of propene, C_3H_6, and 2 moles of another product.

Complete the balanced equation for this reaction by adding the formula of the missing product.

(1)

$$C_{15}H_{32} \rightarrow C_8H_{18} + C_3H_6 + 2\ C2H4$$

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(c) Figure 11 shows the reaction of propene, C_3H_6, with water.

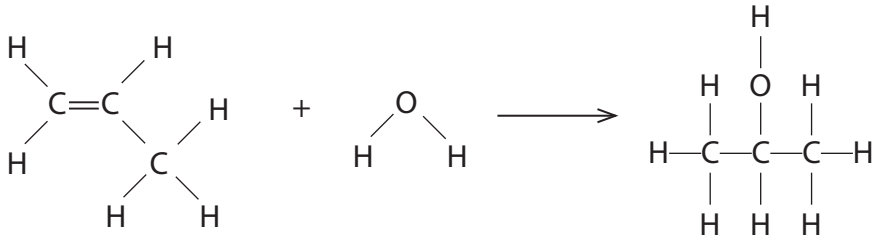

Figure 11

Figure 12 shows some bond energies.

bond	bond energy in kJ mol^{-1}
C—C	347
C—O	358
C—H	413
O—H	464
C=C	612

Figure 12

Use the bond energies in Figure 12 to calculate the energy change of the reaction in Figure 11.

(4)

bonds broken = C=C + O-H
= 612 + 464 (1)
(= 1076 (kJ mol-1))

bonds formed = C-C + C-O + C-H
= 347 + 358 + 413 (1)
(= 1118 (kJ mol-1))

energy change of reaction = 1076 – 1118 (1)
= - (1) (42 (kJ mol-1))

energy change of reaction = ... kJ mol^{-1}

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(d) Methane gas, CH_4, was burned using the apparatus shown in Figure 13.

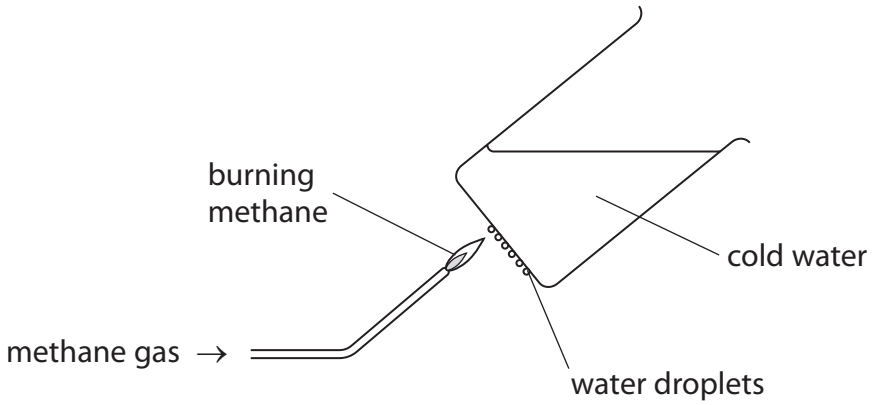

Figure 13

Explain why water droplets form on the bottom of the beaker of cold water.

(2)

An explanation to include

• water vapour forms during combustion (1)

• (water vapour) condenses on cold surface (1)

(Total for Question 9 = 11 marks)

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10 (a) Propanol, C_3H_7OH, can undergo reactions to form compounds **Y** and **Z** shown in Figure 14.

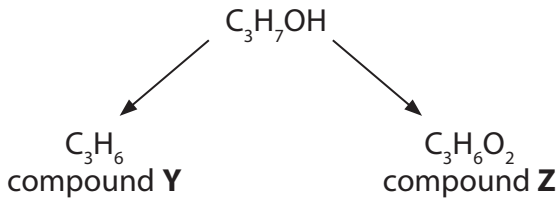

Figure 14

(i) What happens to propanol when it forms compound **Y**?

(1)

☒ **A** propanol undergoes an addition reaction

☒ **B** propanol is dehydrated

☒ **C** propanol is hydrated

☒ **D** propanol is oxidised

(ii) Compound **Y** can also be formed in the following reaction

$$\underset{\text{compound X}}{C_3H_8} \rightarrow \underset{\text{compound Y}}{C_3H_6} + H_2$$

Explain how bromine water can be used to distinguish between compound **X** and compound **Y**.

(3)

bromine water is yellow (1)

• with compound X, yellow colour remains / no change of colour (1)

• with compound Y, bromine water turns colourless (1)

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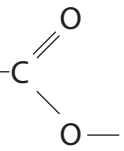
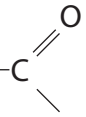
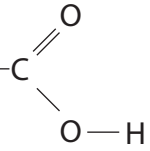
(iii) Compound **Z** is a carboxylic acid.

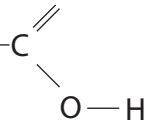
Which of the following shows the functional group of a carboxylic acid?

(1)

☒ **A** 

☒ **B** 

☒ **C** 

☒ **D** 

(iv) Compound **Z** is an acid and turns litmus and universal indicator papers red.
Compound **Z** also shows other acidic properties.

Devise an experiment that would show another acidic property of compound **Z**.

(2)

Any suitable reaction and result such as

- add a piece of magnesium ribbon (1)
- bubbles of gas form (1)

- add a (metal) carbonate (1)
- bubbles of gas form (1)

(b) The balanced equation for the production of ethanol from the carbohydrate sucrose is

$$\underset{\text{sucrose}}{C_{12}H_{22}O_{11}} + H_2O \rightarrow 4C_2H_5OH + 4CO_2$$

Calculate the minimum mass of sucrose needed to produce 26.9 g of ethanol.

(relative formula masses: $C_2H_5OH = 46$, $C_{12}H_{22}O_{11} = 342$)

(2)

moles of sucrose = $\frac{\text{moles of ethanol}}{4}$ (1) (= $\frac{26.9}{4 \times 46}$ = 0.146)

mass of sucrose = $\frac{\text{moles of ethanol}}{4}$ x 342 (1) (= $\frac{26.9 \times 342}{4 \times 46}$ = 49.999 g)

minimum mass of sucrose = 50 g

(c) Calculate the total number of atoms in 10.0 g of sucrose, $C_{12}H_{22}O_{11}$.

(relative formula mass: $C_{12}H_{22}O_{11} = 342$; Avogadro constant = 6.02×10^{23})

(2)

moles sucrose = $\frac{10.0}{342}$ (1) (=0.029)

number of atoms = 10.0 x 45 x 6.02×10^{23} (1)

number of atoms = ...

(Total for Question 10 = 11 marks)

TOTAL FOR PAPER = 100 MARKS

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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.