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0620/31

May/June 2018

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

A copy of the Periodic Table is printed on page 16.

You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **15** printed pages and **1** blank page.

1 The names of eight gases are given.

ammonia
argon
carbon dioxide
helium
hydrogen
methane
neon
sulfur dioxide

(a) Answer the following questions about these gases.
Each gas may be used once, more than once or not at all.
State which gas:

(i) turns damp red litmus paper blue

..... [1]

(ii) contributes to the formation of acid rain

..... [1]

(iii) is a hydrocarbon which contributes to climate change

..... [1]

(iv) is a product of the reaction of copper(II) carbonate with hydrochloric acid

..... [1]

(v) is a monatomic gas which has atoms with the electronic structure 2,8,8.

..... [1]

(b) (i) Explain why helium and **not** hydrogen is used to fill party balloons.

..... [1]

(ii) Give **one** use of argon.

..... [1]

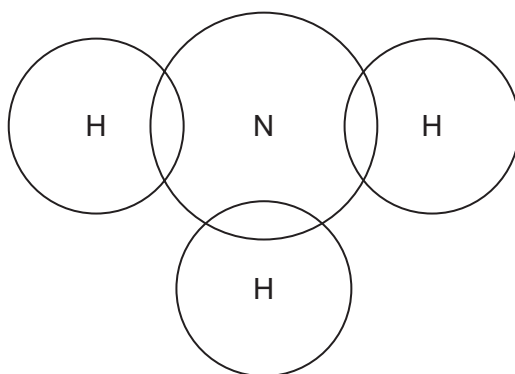
(c) Carbon dioxide is a compound.

What is meant by the term *compound*?

.....

..... [1]

- (d) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of ammonia. Show outer shell electrons only.



[2]

[Total: 10]

- 2 The table shows the percentage by volume of each of the gases present in the exhaust gases from a petrol engine.

name	percentage by volume
carbon monoxide	1.0
carbon dioxide	
hydrogen	0.2
nitrogen	77.0
nitrogen dioxide	0.3
oxygen	0.7
hydrocarbons	0.3
water vapour	5.0
total	100.0

- (a) (i) Calculate the percentage by volume of carbon dioxide in the exhaust gases.

.....% [1]

- (ii) Which gas shown in the table is present in the lowest percentage by volume?

..... [1]

- (iii) Which **two** elements in the table combine to form nitrogen dioxide?

..... and [1]

- (iv) Give the formula for nitrogen dioxide.

..... [1]

- (v) Where does the nitrogen in the exhaust gases come from?

..... [1]

- (b) The carbon monoxide in the exhaust gases comes from the incomplete combustion of hydrocarbons.

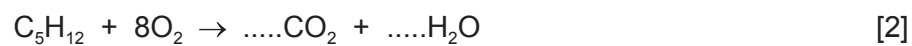
- (i) What is meant by the term *hydrocarbon*?

.....
 [2]

- (ii) Give **one** adverse effect of carbon monoxide on health.

..... [1]

(iii) Balance the chemical equation for the complete combustion of pentane.



[Total: 10]

3 Limonene is a volatile liquid which smells of oranges.

- (a) A teacher placed a beaker of limonene at the front of a classroom.
At first, the students at the back of the classroom could not smell the limonene.
After two minutes, the smell of limonene had spread throughout the classroom.
The air in the classroom was still and calm.

(i) Explain these observations using the kinetic particle model.

.....

.....

.....

.....

..... [3]

- (ii) The melting point of limonene is -74°C .
The boiling point of limonene is 176°C .

What is the physical state of limonene at -80°C ?
Explain your answer.

.....

..... [2]

(b) An enzyme present in peppermint plants is a catalyst for the oxidation of limonene.

State what is meant by the terms:

(i) *catalyst*

.....

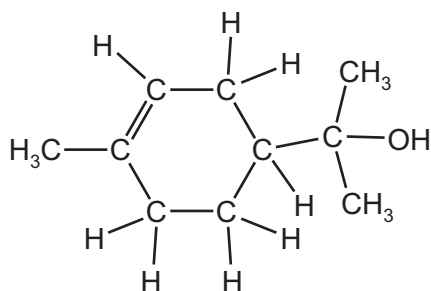
..... [1]

(ii) *oxidation*

.....

..... [1]

- (c) Limonene can be made from a colourless compound called α -terpineol. The structure of α -terpineol is shown.



- (i) What feature of the structure of the α -terpineol molecule shows that it is an unsaturated compound?

..... [1]

- (ii) Describe how the colour of aqueous bromine changes when an excess of α -terpineol is added to it.

from to [2]

[Total: 10]

4 This question is about iron and its compounds.

(a) The table shows how easy it is to reduce four metal oxides by heating with carbon.

metal oxide	ease of reduction with carbon
chromium(III) oxide	only reduced above 1700 °C
iron(III) oxide	only reduced above 650 °C
magnesium oxide	not reduced at 1750 °C
nickel(II) oxide	only reduced above 300 °C

Use this information to put the metals in order of their reactivity. Put the least reactive metal first.

least reactive
→
 most reactive

[2]

(b) Iron is a transition element. Potassium is an element in Group I of the Periodic Table.

Describe **three** ways in which the properties of iron differ from those of potassium.

- 1
- 2
- 3

[3]

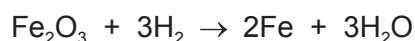
(c) Iron wire burns in oxygen.

Balance the chemical equation for this reaction.



[2]

(d) Pure iron can be made by reducing iron(III) oxide, Fe_2O_3 , with hydrogen.



How does this equation show that iron(III) oxide is reduced?

.....

..... [1]

(e) When iron reacts with dilute hydrochloric acid, iron(II) chloride is formed.

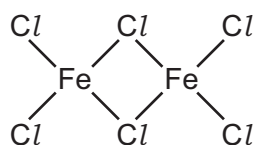
(i) Describe a test for iron(II) ions.

test

result

[2]

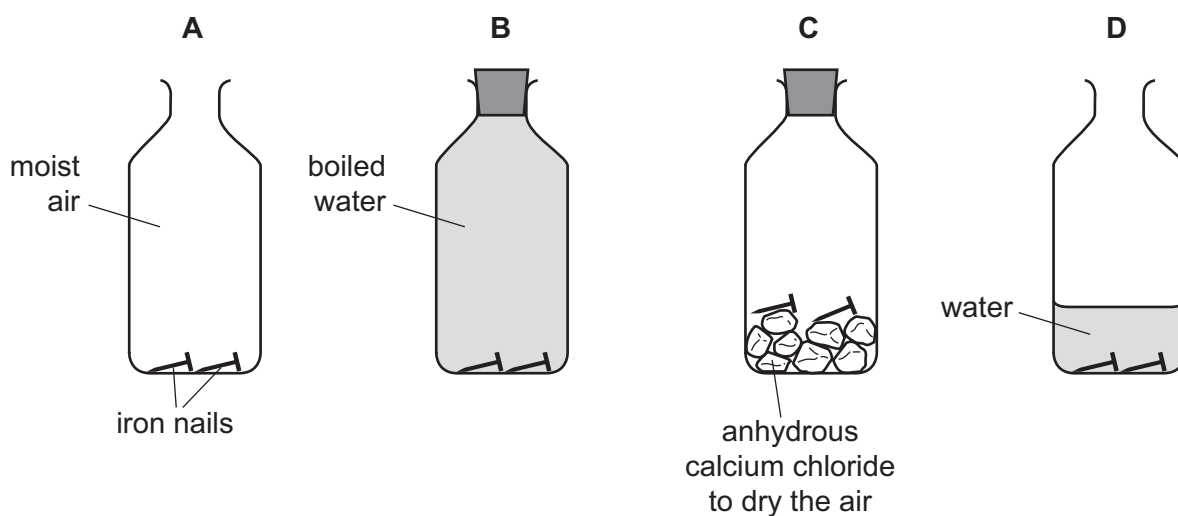
(ii) Another chloride of iron has the structure shown.



Deduce the molecular formula of this compound showing the number of iron and chlorine atoms.

..... [1]

(f) Some iron nails were placed in bottles under different conditions.



In which bottles will the iron nails **not** rust?
Give reasons for your answer.

.....
.....
..... [2]

[Total: 13]

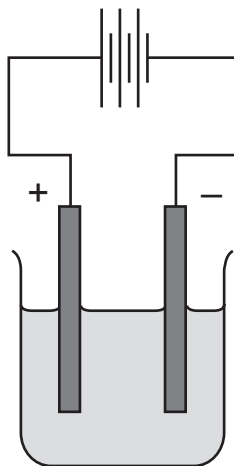
- 5 (a) Complete the sentence about electrolysis using words from the list.

breakdown compound electricity electroplating
element gaseous heat molten

Electrolysis is the of an ionic when
 or in aqueous solution by the passage of

[4]

- (b) Molten zinc iodide can be electrolysed using the apparatus shown.



On the diagram, label:

- the anode
- the cathode
- the electrolyte

[2]

- (c) Why are the electrodes made of graphite?

..... [1]

- (d) Predict the products of the electrolysis of molten zinc iodide at:

the negative electrode

the positive electrode.

[2]

- (e) When chlorine is bubbled through a colourless aqueous solution of zinc iodide, the solution turns brown.

Name the brown substance. Suggest, using ideas about reactivity of the halogens, why this reaction occurs.

.....

..... [2]

[Total: 11]

6 This question is about isotopes.

(a) An atom of an isotope of fluorine is represented by the symbol shown.



Describe the structure of an atom of this isotope of fluorine.

In your answer, include:

- the position of the protons, neutrons and electrons in the atom
- the number of protons, neutrons and electrons present in the atom.

.....

.....

.....

.....

.....

.....

..... [5]

(b) Complete the sentence about isotopes using words from the list.

atomic compound element ions molecular nucleons

Isotopes are atoms of the same which have the same

..... number but different numbers of

[3]

(c) Give **one** medical use of radioactive isotopes.

..... [1]

(d) Which **one** of the following isotopes is used as a source of energy?

Draw a circle around the correct answer.



[1]

[Total: 10]

7 This question is about Group I elements and their compounds.

(a) The properties of some Group I elements are shown in the table.

element	boiling point /°C	atomic radius /pm	relative thermal conductivity	observations when it reacts with cold water
sodium	883	186	3.9	rapid bubbling but does not burst into flame
potassium	759	227		very rapid bubbling and bursts into flame
rubidium	688		1.6	
caesium	671	265	1.0	explodes

(i) Complete the table to estimate:

- the relative thermal conductivity of potassium
- the atomic radius of rubidium.

[2]

(ii) Describe the trend in the boiling points of the Group I elements.

..... [1]

(iii) Use the information in the table to predict what you would observe when rubidium reacts with cold water.

..... [1]

(b) Which **one** of the statements about the formation of a sodium ion from a sodium atom is correct?

Tick **one** box.

A sodium atom gains an electron.

☐

A sodium atom loses an electron.

☐

A sodium atom loses a proton.

☐

A sodium atom gains a proton.

☐

[1]

- (c) Is sodium oxide an acidic oxide or a basic oxide?
Give a reason for your answer.

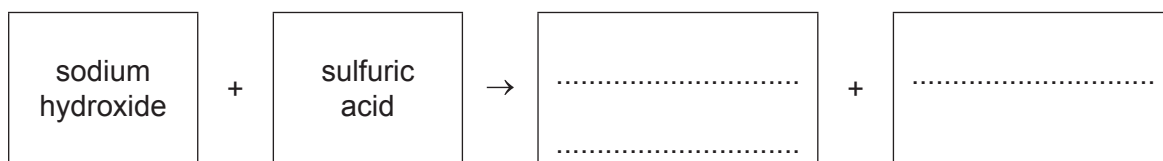
.....
 [1]

- (d) A compound of sodium has the formula $\text{C}_4\text{H}_5\text{Na}$.

Calculate the relative formula mass of $\text{C}_4\text{H}_5\text{Na}$.
 Show all your working.
 Use your Periodic Table to help you.

relative formula mass = ... [2]

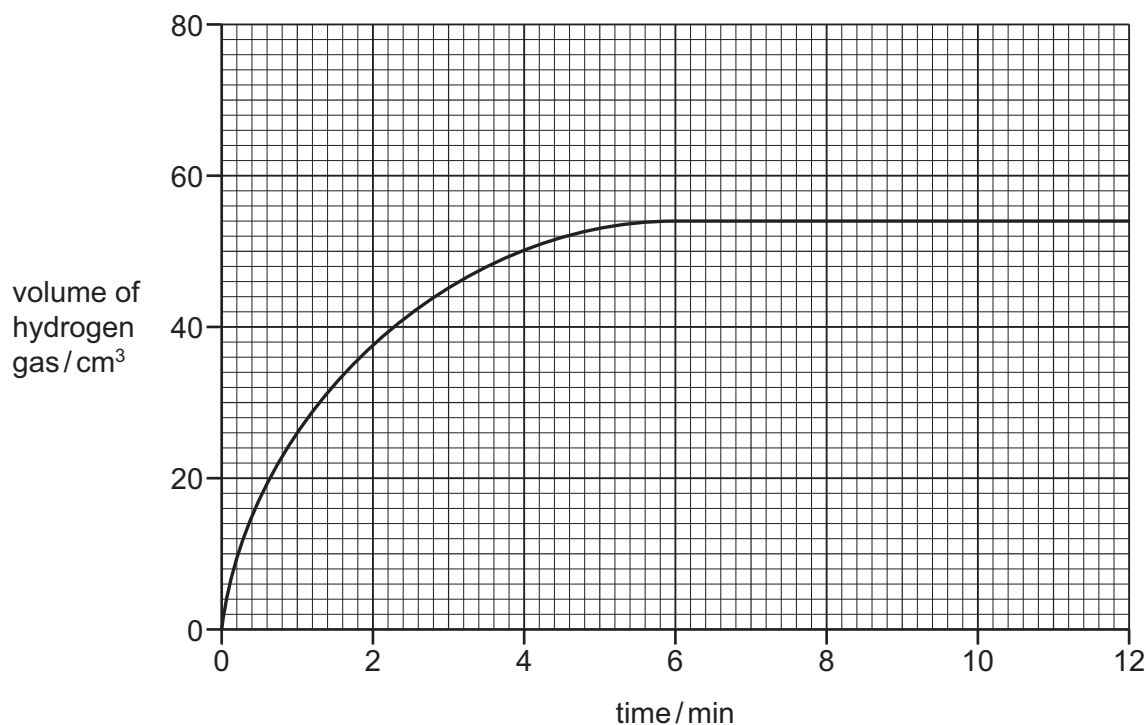
- (e) Complete the word equation for the reaction of sodium hydroxide with sulfuric acid.



[2]

[Total: 10]

- 8 When zinc reacts with hydrochloric acid, hydrogen gas is produced. The graph shows how the volume of hydrogen gas produced changes with time when an excess of zinc is reacted with 0.2 mol/dm^3 hydrochloric acid.



- (a) Explain why the volume of hydrogen gas remains constant after six minutes.

..... [1]

- (b) What volume of hydrogen gas was released in the first **two** minutes of the reaction?

..... [1]

- (c) The experiment is repeated using the same volume of 0.1 mol/dm^3 hydrochloric acid. All other conditions are kept the same.

On the grid, draw the graph for the experiment using 0.1 mol/dm^3 hydrochloric acid. [2]

- (d) Give the name of the salt formed when zinc reacts with hydrochloric acid.

..... [1]

- (e) Which **one** of the following pH values could be the pH of dilute hydrochloric acid? Draw a circle around the correct answer.

pH 1

pH 7

pH 9

pH 13

[1]

[Total: 6]

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The Periodic Table of Elements

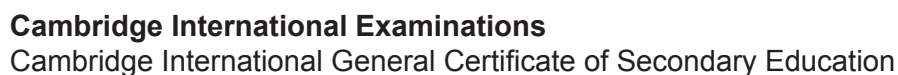
Group																	
I	II	1 Hhydrogen1										III	IV	V	VI	VII	VIII
3 Li lithium 7	4 Be beryllium 9	Key atomic number atomic symbol name relative atomic mass										5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	2 He helium 4
		11 Na sodium 23	12 Mg magnesium 24	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40								
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —
87 Fr francium —	88 Ra radium —	89–103 actinoids	104 Rf rutherfordium —	105 Db dubnium —	106 Sg seaborgium —	107 Bh bohrium —	108 Hs hassium —	109 Mt meitnerium —	110 Ds darmstadtium —	111 Rg roentgenium —	112 Cn copernicium —	114 Fl flerovium —	116 Lv livermorium —				

lanthanoids

57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
89 Ac actinium —	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium —	94 Pu plutonium —	95 Am americium —	96 Cm curium —	97 Bk berkelium —	98 Cf californium —	99 Es einsteinium —	100 Fm fermium —	101 Md mendelevium —	102 No nobelium —	103 Lr lawrencium —

actinoids

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).



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This document consists of **16** printed pages.

1 The names of nine gases are given.

ammonia
carbon monoxide
chlorine
ethane
ethene
helium
hydrogen
neon
oxygen

(a) Answer the following questions about these gases.
Each gas may be used once, more than once or not at all.
State which gas:

(i) bleaches damp litmus paper

..... [1]

(ii) dissolves in water to form an alkali

..... [1]

(iii) is a monatomic gas with ten protons in its nucleus

..... [1]

(iv) is formed when hydrocarbons undergo incomplete combustion

..... [1]

(v) is an unsaturated hydrocarbon.

..... [1]

(b) Diatomic hydrogen molecules contain covalent bonds.

State what is meant by the terms:

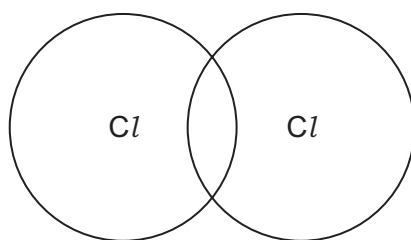
(i) *diatomic*

..... [1]

(ii) *covalent bonds*

..... [1]

- (c) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of chlorine. Show outer shell electrons only.



[2]

[Total: 9]

- 2 The table shows the percentage by volume of each of the gases present in the exhaust gases from a petrol engine with a catalytic converter.

name	percentage by volume
carbon monoxide	0.20
carbon dioxide	15.00
hydrocarbons	0.02
hydrogen	0.01
nitrogen	
oxides of nitrogen	0.02
water vapour	12.75
total	100.00

- (a) (i) Calculate the percentage by volume of nitrogen in the exhaust gases.

.....% [1]

- (ii) Which gas shown in the table is present in the lowest percentage by volume?

..... [1]

- (b) (i) Give **one** adverse effect of oxides of nitrogen on health.

..... [1]

- (ii) Balance the chemical equation for the reaction of nitrogen dioxide with sodium hydroxide.



- (iii) State the name of the salt with the formula NaNO_3 .

..... [1]

- (c) Petrol contains saturated hydrocarbons.

State what is meant by the terms:

- (i) *saturated* [1]

- (ii) *hydrocarbon* [2]

(d) The table shows the composition of a sample of dry natural gas.

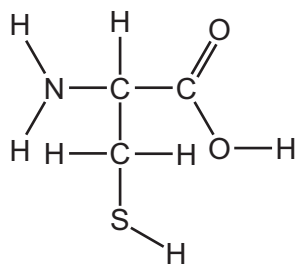
name of gas	percentage by volume
methane	95.0
ethane	3.2
propane	0.2
butane	0.1
carbon dioxide	0.5
nitrogen	1.0
total	100.0

Calculate the percentage by volume of hydrocarbons in the sample of dry natural gas.

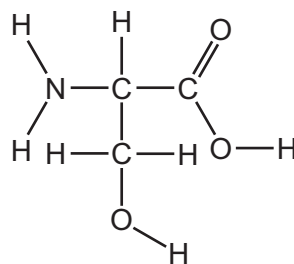
.....% [1]

[Total: 10]

- 3 (a) The structures of two compounds, **A** and **B**, are shown.



compound **A**



compound **B**

- (i) How many different types of atoms are present in compound **A**?

..... [1]

- (ii) On structure **B** draw a circle around the alcohol functional group.

[1]

- (iii) Compounds **A** and **B** are formed in the body by enzyme-catalysed reactions.

What is the purpose of a catalyst?

..... [1]

- (iv) Enzymes are polymers of compounds called amino acids.

What is meant by the term *polymer*?

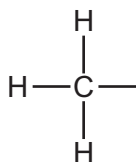
.....
 [1]

- (b) Ethanoic acid is a carboxylic acid.

- (i) Give **one** property of ethanoic acid.

..... [1]

- (ii) Complete the structure of ethanoic acid showing all of the atoms and all of the bonds.



[1]

(c) Ethanoic acid can be made by the oxidation of ethanol.

- (i) The melting point of ethanol is -114°C .
The boiling point of ethanol is 78°C .

What is the physical state of ethanol at -120°C ?
Explain your answer.

.....
..... [2]

- (ii) Complete the sentences about the manufacture of ethanol using words from the list.

a catalyst addition an enzyme cracking
ethane ethene high low

Ethanol can be manufactured by the of steam to

The reaction takes place at a temperature in the presence of
..... [4]

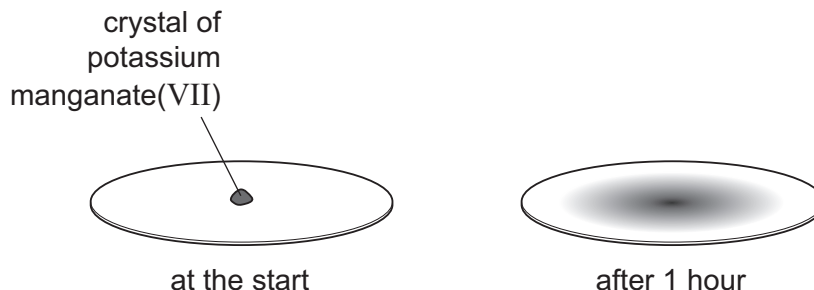
[Total: 12]

4 This question is about manganese and its compounds.

(a) Potassium manganate(VII) is soluble in water.

A purple crystal of potassium manganate(VII) was placed in the middle of a piece of damp filter paper.

After 1 hour, the purple colour had spread over most of the filter paper.



Explain these observations using the kinetic particle model.

.....

.....

.....

.....

..... [3]

(b) Potassium manganate(VII) is produced from manganese(IV) oxide by an oxidation reaction.

What is meant by the term *oxidation*?

.....

..... [1]

(c) Potassium manganate(VII) decomposes when heated. The products are oxygen and manganese(IV) oxide.

(i) Describe a test for oxygen.

test

result

[2]

(ii) Manganese(IV) oxide reacts with concentrated hydrochloric acid.

Balance the chemical equation for this reaction.



[2]

(d) The table compares the reactivity of four metals with hydrochloric acid of the same concentration.

metal	reactivity with hydrochloric acid
lead	No bubbles seen. Metal does not disappear.
magnesium	Rapid formation of bubbles. Metal disappears rapidly.
manganese	Steady formation of bubbles. Metal disappears slowly.
tin	Bubbles formed slowly. Metal disappears very slowly.

Use this information to put the metals in order of their reactivity. Put the least reactive metal first.

least reactive  most reactive

[2]

(e) Manganese is a transition element. Sodium is an element in Group I of the Periodic Table.

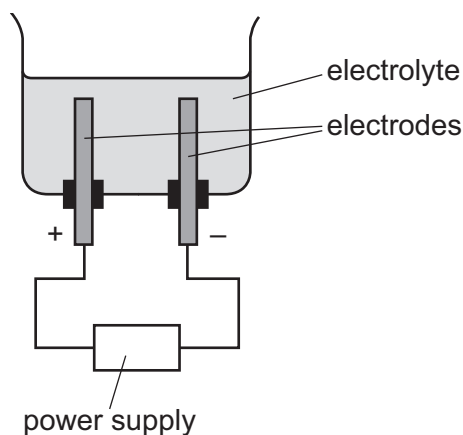
Describe **three** ways in which the properties of manganese differ from those of sodium.

- 1
- 2
- 3

[3]

[Total: 13]

- 5 (a) Electrolysis of concentrated aqueous sodium chloride can be done using the apparatus shown.



- (i) During electrolysis, a gas is produced at each electrode.

Complete the diagram to show how the gases can be collected.

[1]

- (ii) The positive electrode is called the anode.

State the name of the negative electrode.

..... [1]

- (iii) Predict the main products of the electrolysis of concentrated aqueous sodium chloride at:
the negative electrode

the positive electrode.

[2]

- (iv) Give the name of a suitable element to use as the electrodes in this electrolysis.

..... [1]

(b) Sodium hydroxide is manufactured by the electrolysis of sodium chloride.

(i) After electrolysis, 1000 cm^3 of solution contains 750 g of sodium hydroxide.

What mass of sodium hydroxide is present in 200 cm^3 of this solution?

..... [1]

(ii) What effect would impurities have on the melting point of sodium hydroxide?

..... [1]

(c) Describe how you could prepare a sample of solid sodium chloride from a solution of sodium chloride.

..... [1]

[Total: 8]

6 This question is about isotopes.

(a) An atom of an isotope of nitrogen is represented by the symbol shown.



Describe the structure of an atom of this isotope of nitrogen.

In your answer, include:

- the position of the protons, neutrons and electrons in the atom
- the number of protons, neutrons and electrons present in the atom.

.....

.....

.....

.....

.....

.....

..... [5]

(b) What is meant by the term *isotopes*?

.....

.....

..... [2]

(c) Give **one** industrial use of radioactive isotopes.

..... [1]

[Total: 8]

- 7 (a) The properties of some Group VII elements are shown in the table.

element	melting point in °C	boiling point in °C	density at room temperature in g/cm ³	colour
chlorine	−101	−35	0.0032	green
bromine	−7	59	3.1	red-brown
iodine	114	184		grey-black
astatine		337	6.4	

- (i) Complete the table to suggest:
- the density of iodine
 - the melting point of astatine
 - the colour of astatine.

[3]

- (ii) Suggest why the density of chlorine at room temperature is much lower than the density of bromine and astatine at room temperature.

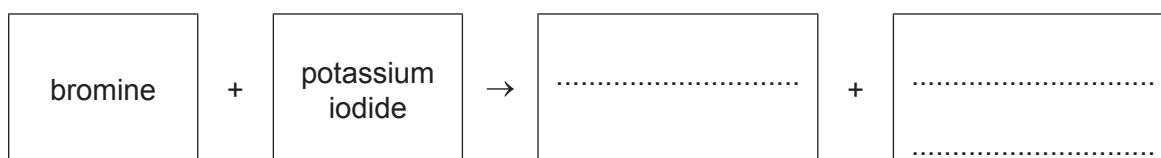
.....
 [1]

- (iii) Describe the trend in the boiling points of the halogens.

..... [1]

- (b) Aqueous bromine reacts with aqueous potassium iodide.

Complete the word equation for this reaction.



[2]

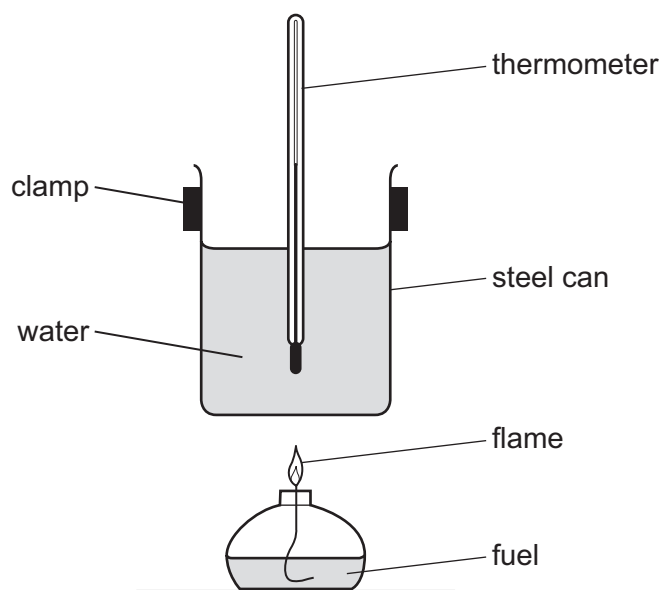
- (c) A compound has the formula C₂F₄Cl₂.

Calculate the relative molecular mass of C₂F₄Cl₂.
 Show all your working.
 Use your Periodic Table to help you.

relative molecular mass = ... [2]

[Total: 9]

- 8 The energy released by burning four different fuels is compared using the apparatus shown. A known mass of each fuel is burned and the temperature rise of the water is measured.



- (a) Suggest **two** factors that should be kept constant in this experiment.

1

2

[2]

- (b) The table shows the temperature changes when four different fuels, **A**, **B**, **C** and **D**, are burned.

fuel	mass of fuel burned /g	initial temperature of the water /°C	final temperature of the water /°C
A	2	20	30
B	1	18	24
C	4	21	37
D	2	20	28

Which fuel gave the greatest temperature rise per gram?

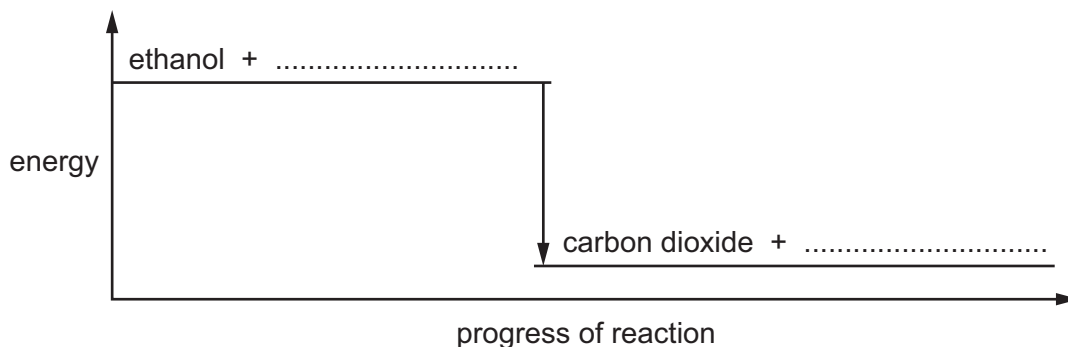
..... [1]

- (c) Ethanol is a fuel.

Give **one** other use of ethanol.

..... [1]

(d) The energy level diagram for the complete combustion of ethanol is shown.



(i) Complete the diagram by filling in the missing reactant and the missing product. [2]

(ii) Is the complete combustion of ethanol exothermic or endothermic?
Use the information in the diagram to explain your answer.

.....
..... [1]

(e) A steel can is used in the experiment.

(i) Stainless steel is an alloy of iron.

What is meant by the term *alloy*?

.....
..... [1]

(ii) Describe the arrangement and type of motion of the particles in solid iron.

arrangement

type of motion

[2]

(iii) Suggest why stainless steel is used instead of pure iron for making cutlery.

.....
..... [1]

[Total: 11]

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The Periodic Table of Elements

Group																																																		
I	II	1 Hhydrogen1										III	IV	V	VI	VII	VIII																																	
3 Li lithium 7	4 Be beryllium 9	Key atomic number atomic symbol name relative atomic mass										5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20																																	
																		11 Na sodium 23	12 Mg magnesium 24																															
	19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64							30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84																										
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131	55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —	87 Fr francium —	88 Ra radium —	89–103 actinoids	104 Rf rutherfordium —	105 Db dubnium —	106 Sg seaborgium —	107 Bh bohrium —	108 Hs hassium —	109 Mt meitnerium —	110 Ds darmstadtium —	111 Rg roentgenium —	112 Cn copernicium —	114 Fl flerovium —	116 Lv livermorium —	—

lanthanoids

57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
89 Ac actinium —	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium —	94 Pu plutonium —	95 Am americium —	96 Cm curium —	97 Bk berkelium —	98 Cf californium —	99 Es einsteinium —	100 Fm fermium —	101 Md mendelevium —	102 No nobelium —	103 Lr lawrencium —

actinoids

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).