



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

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CHEMISTRY

0620/21

Paper 2

May/June 2014

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 in the spaces at the top of this page.

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 20.

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 **17** printed pages and **3** blank pages.



1 (a) Choose from the list of substances below to answer the following questions.

calcium oxide
carbon dioxide
carbon monoxide
copper
hydrogen
magnesium
methane
oxygen
water

Each substance may be used once, more than once or not at all.

Which substance:

- (i) releases hydrogen when it reacts with steam,
 [1]
- (ii) is produced at the cathode when concentrated aqueous sodium chloride is electrolysed,
 [1]
- (iii) is a product of the incomplete combustion of carbon,
 [1]
- (iv) is used in electrical wiring,
 [1]
- (v) is manufactured by heating limestone?
 [1]

(b) Complete the following sentences about the Periodic Table of elements using words from the list below.

argon	colour	density	sodium
one	similarity	trend	seven

Chlorine, bromine and iodine are elements in Group of the Periodic Table.

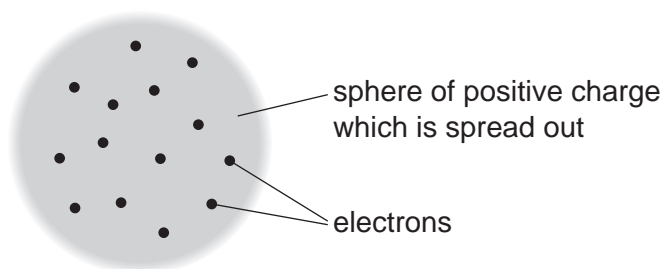
These elements show a in down the group.

They all react rapidly with to form ionic compounds. [4]

[Total: 9]

3

- 2 In 1904, J. J. Thomson suggested a model of the atom. He called this the 'plum pudding' model. This model of an atom, containing 14 electrons, is shown below.



- (a) Describe how Thomson's model of the atom differs from our present ideas of the structure of an atom.

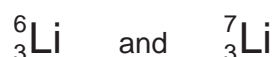
.....

.....

.....

..... [3]

- (b) Lithium has two naturally-occurring isotopes. These can be written as:



- (i) Describe the difference between these isotopes.

..... [1]

- (ii) Isotopes can be radioactive or non-radioactive. State **one** industrial use of radioactive isotopes.

..... [1]

- (c) Lithium is in Group I of the Periodic Table. The table shows some properties of the Group I elements.

metal	melting point/°C	atomic radius/nm
lithium		0.157
sodium	98	0.191
potassium	63	
rubidium	39	0.250
caesium	29	0.272

Deduce:

the melting point of lithium, °C

the atomic radius of potassium nm

[2]

4

(d) Lithium reacts with water. An alkaline solution and a colourless gas are formed.

(i) Complete the word equation for this reaction.

lithium + water → + [2]

(ii) What is the most likely pH of the alkaline solution?
Put a ring around the correct answer.

pH 2

pH 5

pH 7

pH 13

[1]

(e) Draw the electronic structure of a potassium atom.

[2]

[Total: 12]

5

3 The table shows some fractions obtained from the distillation of petroleum.

fraction	number of carbon atoms	boiling point of the fraction/ $^{\circ}\text{C}$
refinery gas	1–4	under 40
gasoline	5–10	40–160
kerosene	10–16	160–250
diesel	16–20	250–300
fuel oil	20–30	300–350

(a) What is the relationship between the number of carbon atoms and the boiling points of the fractions?

..... [1]

(b) State the names of **two** petroleum fractions not given in the table.

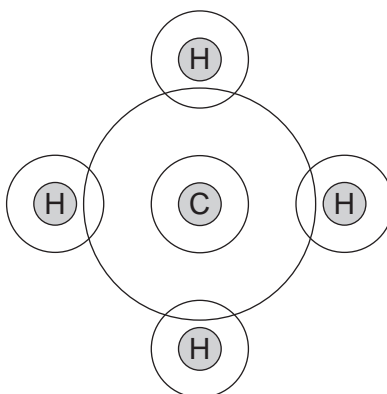
..... and [2]

(c) Two of the compounds present in refinery gas are methane and ethane.

(i) Draw the structure of ethane. Show all atoms and bonds.

[1]

(ii) Complete the dot and cross diagram of methane to show **all** the electrons.



[2]

6

- (d) Refinery gas also contains propane.
Propane can be cracked in the presence of a catalyst to form hydrogen.

- (i) Complete the symbol equation for this reaction.



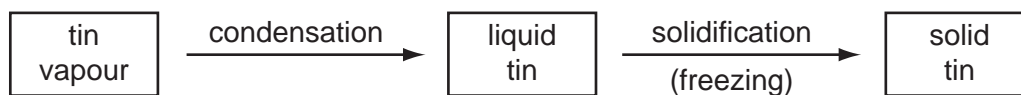
- (ii) A catalyst is one condition needed to crack an alkane.

State **one** other condition needed to crack an alkane.

..... [1]

[Total: 8]

- 4 The diagram shows the changes of state when tin vapour is cooled slowly to room temperature.



- (a) Explain what happens to the arrangement and motion of the atoms during these changes.

.....

.....

.....

.....

..... [4]

- (b) Tin is a metal in Group IV of the Periodic Table.
How many electrons does tin have in its outer shell?

..... [1]

- (c) State **one** physical property of tin.

..... [1]

- (d) The table below describes the reaction of some metals with dilute hydrochloric acid.

iron	bubbles of gas produced and temperature of the mixture rises slowly
magnesium	many bubbles of gas produced rapidly and temperature of the mixture rises rapidly
silver	no bubbles of gas given off and no temperature change
tin	a few bubbles of gas given off slowly and temperature of the mixture rises very slowly

Put these metals in order of their reactivity.

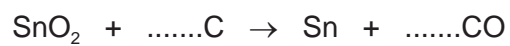
least reactive \longrightarrow most reactive

[2]

8

(e) Tin is extracted by heating tin(IV) oxide with carbon.

(i) Complete the symbol equation for this reaction.



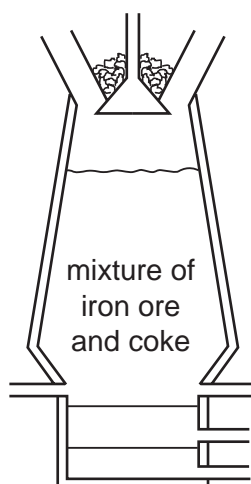
[2]

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

..... [1]

[Total: 11]

5 The diagram shows a blast furnace for extracting iron.



(a) On the diagram above, write:

- the letter **A** to show where the air blast enters the furnace,
- the letter **W** to show where the waste gases exit the furnace.

[2]

(b) Which **one** of the following is an ore of iron?
Put a ring around the correct answer.

calcite fluorite hematite halite

[1]

(c) In the furnace, the coke burns to form carbon dioxide. This reaction is exothermic.

(i) What is meant by the term *exothermic*?

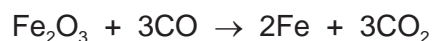
..... [1]

(ii) Describe a test for carbon dioxide.

test

result [2]

(d) In the blast furnace, carbon dioxide reacts with more coke to form carbon monoxide.
The carbon monoxide reduces iron(III) oxide to iron.

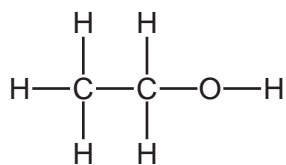


How does this equation show that iron(III) oxide is being reduced?

..... [1]

[Total: 7]

6 The structure of ethanol is shown below.



(a) On the structure above, put a ring around the alcohol functional group. [1]

(b) Ethanol can be made by fermentation.

(i) Complete the word equation for fermentation.

..... → ethanol + [2]

(ii) What type of catalysts are used in fermentation?
Put a ring around the correct answer.

acids

carbonates

enzymes

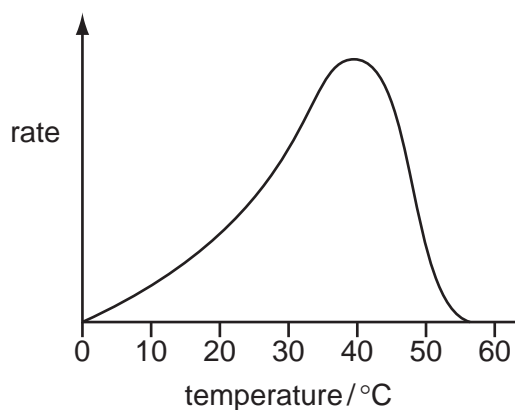
metals

[1]

(c) Ethanol can also be made by hydration.
Complete the symbol equation for this reaction.

..... + H₂O → C₂H₅OH [1]

(d) The diagram below shows how the rate of fermentation changes with temperature.



Describe how the rate of fermentation changes with temperature.

.....

 [2]

(e) The table shows some properties of different alcohols.

alcohol	formula	melting point / °C	boiling point / °C	density in g/cm ³
methanol	CH ₄ O	-94	65	
ethanol	C ₂ H ₆ O	-117	79	0.789
propanol	C ₃ H ₈ O	-126	98	0.804
butanol	C ₄ H ₁₀ O	-89	117	0.810
pentanol	C ₅ H ₁₂ O	-79	138	0.815

(i) Describe how density changes with the number of carbon atoms in the alcohol.

..... [1]

(ii) Which **one** of these alcohols has the lowest melting point?

..... [1]

(iii) Is pentanol a solid, liquid or gas at room temperature?
Explain your answer.

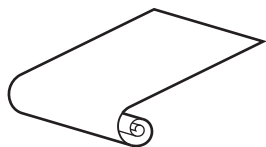
.....

.....

..... [1]

[Total: 10]

- 7 A student used chromatography to separate the dyes in the blue ink from a ball-point pen. She used the equipment shown in the diagrams below.



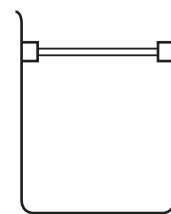
chromatography paper



solvent

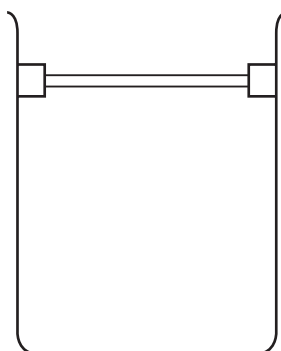


large watchglass



chromatography tank

- (a) Complete the diagram below to show how she set up the apparatus.



[3]

- (b) Describe how chromatography could be used by the student to separate the dyes.

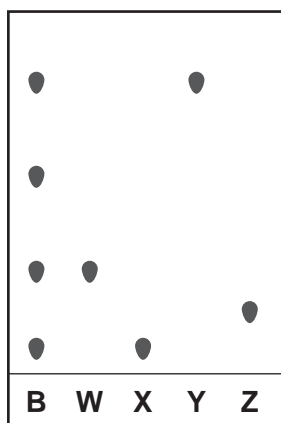
.....

 [3]

- (c) The student used water as a solvent. Suggest a different solvent that she could use.

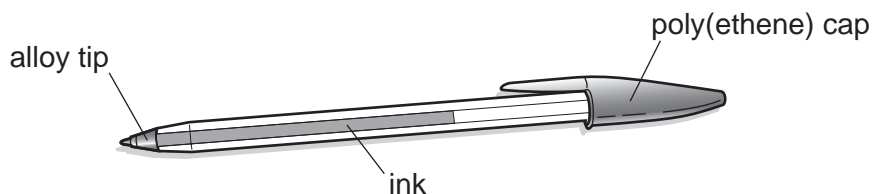
..... [1]

(d) The diagram below shows the results of the chromatography using the blue ink, **B**, and several pure dyes, **W**, **X**, **Y** and **Z**.



- (i) Which of the dyes, **W**, **X**, **Y** and **Z**, were in the blue ink?
 [1]
- (ii) How many dyes in the ink had been separated by this chromatography?
 [1]

(e) The diagram shows the ball-point pen used in the experiment.



- (i) The cap of the pen is made of poly(ethene). Describe the formation of poly(ethene) from ethene. In your answer, include the words:
 - monomer,
 - polymer.

 [2]
- (ii) The tip of the pen is made from an alloy. What is meant by the term *alloy*?

 [1]

(f) The table shows some properties of four alloys.

alloy	strength /GPa	density in g/cm ³	thermal conductivity in W/m/K
low strength steel	250	7.70	60
high strength steel	300	7.90	56
low strength aluminium	70	2.72	170
high strength aluminium	220	2.80	100

(i) How does the strength of the steel and aluminium alloys vary with their thermal conductivity?

..... [1]

(ii) Which **one** of these alloys is the best one to use to make the body of an aircraft? Give **two** reasons for your answer.

.....

.....

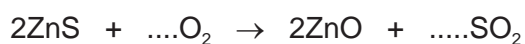
..... [3]

[Total: 16]

8 Zinc can be extracted from zinc sulfide ore in three steps.

(a) In the first step, zinc sulfide is heated in air to produce zinc oxide.

(i) Complete the symbol equation for this reaction.



[2]

(ii) The product sulfur dioxide, SO_2 , is harmful to the environment.
Explain why it is harmful to the environment and state **one** effect it has on buildings.

.....

..... [2]

(b) In the second step, zinc oxide reacts with sulfuric acid to form zinc sulfate.



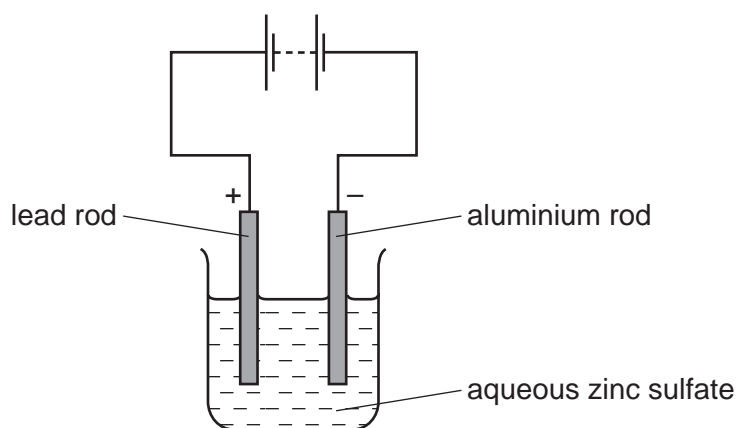
Zinc sulfate is soluble in water.

Some insoluble impurities in the zinc oxide do not react with the sulfuric acid.

Suggest how these insoluble impurities are removed from the zinc sulfate solution.

..... [1]

(c) In the third step, zinc is extracted from zinc sulfate by electrolysis using the cell shown below.



(i) Which word best describes the aluminium rod?
Put a ring around the correct answer.

anion

anode

cathode

cation

electrolyte

product

[1]

- (ii) Suggest which statement about this electrolysis is completely correct.
Tick **one** box.

Zinc is formed at the positive electrode and hydrogen at the negative electrode.

Zinc is formed at the positive electrode and oxygen at the negative electrode.

Zinc is formed at the negative electrode and hydrogen at the positive electrode.

Zinc is formed at the negative electrode and oxygen at the positive electrode.

[1]

[Total: 7]

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DATA SHEET
The Periodic Table of the Elements

		Group																																																																																																																																																																																																																																																																																					
I	II	III	IV	V	VI	VII	0																																																																																																																																																																																																																																																																																
7 Li Lithium 3	9 Be Beryllium 4	1 H Hydrogen 1	11 B Boron 5	12 C Carbon 6	13 Al Aluminium 13	14 N Nitrogen 7	15 O Oxygen 8	16 F Fluorine 9	17 Ne Neon 10	18 Ar Argon 18	19 K Potassium 19	20 Ca Calcium 20	21 Sc Scandium 21	22 Ti Titanium 22	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	30 Zn Zinc 30	31 Ga Gallium 31	32 Ge Germanium 32	33 As Arsenic 33	34 Se Selenium 34	35 Br Bromine 35	36 Kr Krypton 36	37 Rb Rubidium 37	38 Sr Strontium 38	39 Y Yttrium 39	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	47 Ag Silver 47	48 Cd Cadmium 48	49 In Indium 49	50 Sn Tin 50	51 Sb Antimony 51	52 Te Tellurium 52	53 I Iodine 53	54 Xe Xenon 54	55 Cs Caesium 55	56 Ba Barium 56	57 La Lanthanum 57	72 Hf Hafnium 72	73 Ta Tantalum 73	74 W Tungsten 74	75 Re Rhenium 75	76 Os Osmium 76	77 Ir Iridium 77	78 Pt Platinum 78	79 Au Gold 79	80 Hg Mercury 80	81 Tl Thallium 81	82 Pb Lead 82	83 Bi Bismuth 83	84 Po Polonium 84	85 At Astatine 85	86 Rn Radon 86	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	96 Cm Curium 96	97 Bk Berkelium 97	98 Cf Californium 98	99 Es Einsteinium 99	100 Fm Fermium 100	101 Md Mendelevium 101	102 No Nobelium 102	103 Lr Lawrencium 103	104 Rf Rutherfordium 104	105 Db Dubnium 105	106 Sg Seaborgium 106	107 Bh Bohrium 107	108 Hs Hassium 108	109 Mt Meitnerium 109	110 Ds Darmstadtium 110	111 Rg Roentgenium 111	112 Cn Copernicium 112	113 Nh Nihonium 113	114 Fl Flerovium 114	115 Mc Moscovium 115	116 Lv Livermorium 116	117 Ts Tennessine 117	118 Og Oganesson 118	119 Uu Ununennium 119	120 Uub Unbibium 120	121 Uut Untrium 121	122 Uuq Unquadrium 122	123 Uuq Unquadrium 123	124 Uup Unpentium 124	125 Uuq Unquadrium 125	126 Uup Unpentium 126	127 Uuq Unquadrium 127	128 Uup Unpentium 128	129 Uuq Unquadrium 129	130 Uup Unpentium 130	131 Uuq Unquadrium 131	132 Uup Unpentium 132	133 Uuq Unquadrium 133	134 Uup Unpentium 134	135 Uuq Unquadrium 135	136 Uup Unpentium 136	137 Uuq Unquadrium 137	138 Uup Unpentium 138	139 Uuq Unquadrium 139	140 Uup Unpentium 140	141 Uuq Unquadrium 141	142 Uup Unpentium 142	143 Uuq Unquadrium 143	144 Uup Unpentium 144	145 Uuq Unquadrium 145	146 Uup Unpentium 146	147 Uuq Unquadrium 147	148 Uup Unpentium 148	149 Uuq Unquadrium 149	150 Uup Unpentium 150	151 Uuq Unquadrium 151	152 Uup Unpentium 152	153 Uuq Unquadrium 153	154 Uup Unpentium 154	155 Uuq Unquadrium 155	156 Uup Unpentium 156	157 Uuq Unquadrium 157	158 Uup Unpentium 158	159 Uuq Unquadrium 159	160 Uup Unpentium 160	161 Uuq Unquadrium 161	162 Uuq Unquadrium 162	163 Uuq Unquadrium 163	164 Uuq Unquadrium 164	165 Uuq Unquadrium 165	166 Uuq Unquadrium 166	167 Uuq Unquadrium 167	168 Uuq Unquadrium 168	169 Uuq Unquadrium 169	170 Uuq Unquadrium 170	171 Uuq Unquadrium 171	172 Uuq Unquadrium 172	173 Uuq Unquadrium 173	174 Uuq 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*58-71 Lanthanoid series
†90-103 Actinoid series

Key

a	X
b	X

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

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

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