Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

1339612500

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**

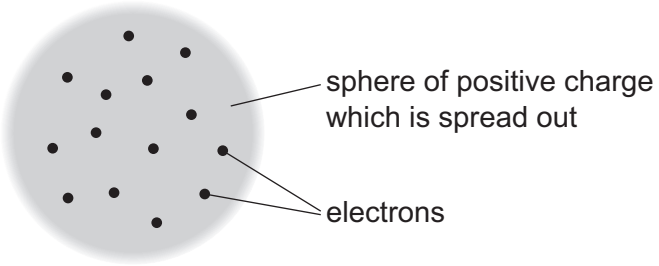
Chlorine, bromine and iodine are elements in Group ..... of the Periodic Table.

These elements show a ..... in ..... down the group.

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

[Total: 9]

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:

$^{6}_{3}Li$ and $^{7}_{3}Li$

(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]

[Turn over

(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]

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

fraction	number of carbon atoms	boiling point of the fraction / °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.

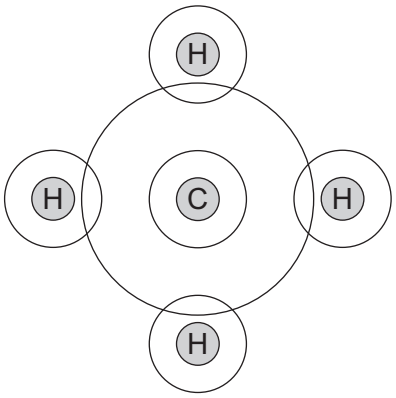
..... and ..... [2]

(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]

(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.

$$C_3H_8 \rightarrow \text{.....} + H_2$$

[1]

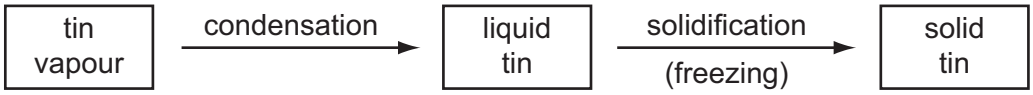
(ii) A catalyst is one condition needed to crack an alkane.

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 ⟶ most reactive

[2]

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

(i) Complete the symbol equation for this reaction.

$$SnO_2 + ...C \rightarrow Sn + ...CO$$

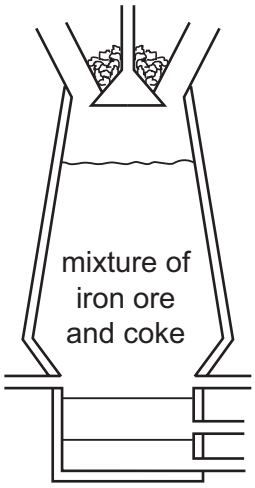
[2]

(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.

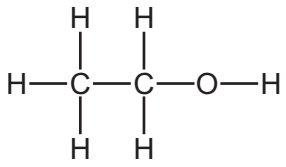
$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

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**

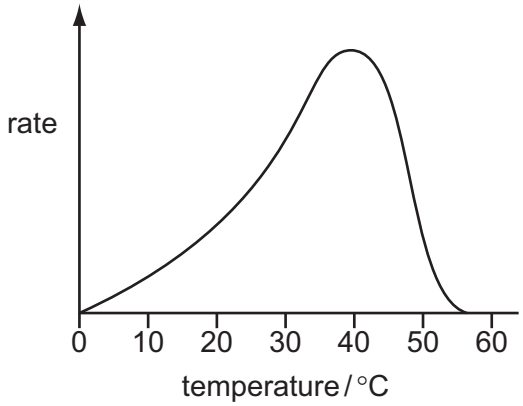
[1]

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

..... + H_2O → C_2H_5OH

[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_4O	–94	65	
ethanol	C_2H_6O	–117	79	0.789
propanol	C_3H_8O	–126	98	0.804
butanol	$C_4H_{10}O$	–89	117	0.810
pentanol	$C_5H_{12}O$	–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.

.....

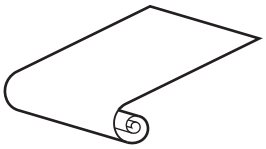
.....

..... [1]

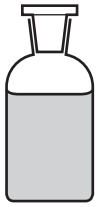
[Total: 10]

[Turn over

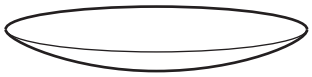
7 A student used chromatography to separate the dyes in the blue ink from a ball-point pen. She used the equipment shown in the diagrams below.



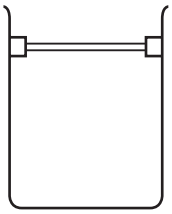
chromatography paper



solvent

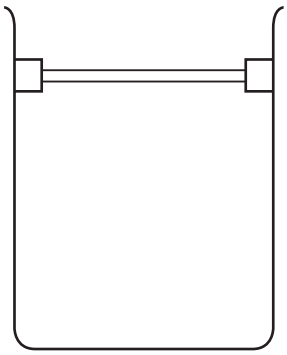


large watchglass



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.

.....

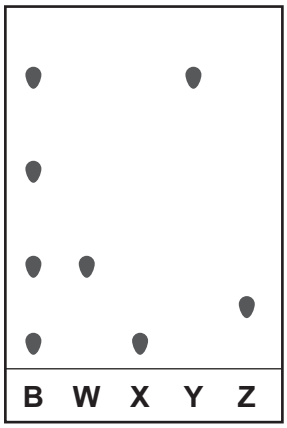
.....

..... [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**.



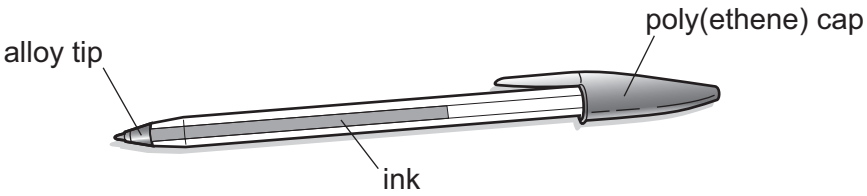
(i) Which of the dyes, **W**, **X**, **Y** and **Z**, were in the blue ink?

..... [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.

$$2ZnS + ...O_2 \rightarrow 2ZnO + ...SO_2$$

[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]

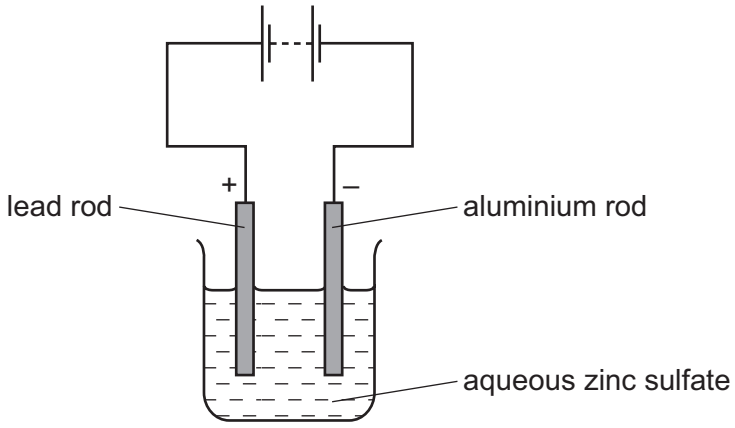
(b) In the second step, zinc oxide reacts with sulfuric acid to form zinc sulfate.

zinc oxide + sulfuric acid → zinc sulfate + water

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
							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	64 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	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	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key: a = relative atomic mass; **X** = atomic symbol; b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).