



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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CHEMISTRY

0620/21

Paper 2

May/June 2015

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 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.

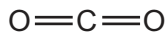
The number of marks is given in brackets [] at the end of each question or part question.

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

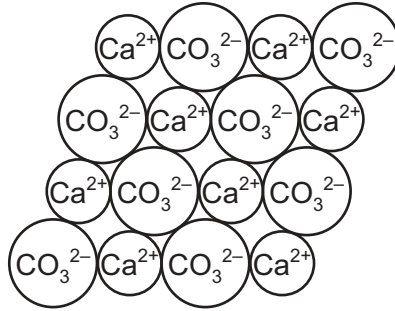
This document consists of **16** printed pages.

1 The structures of six substances containing carbon are shown below.

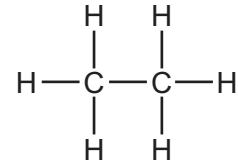
A



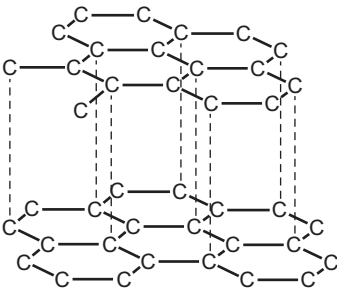
B



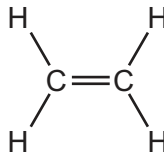
C



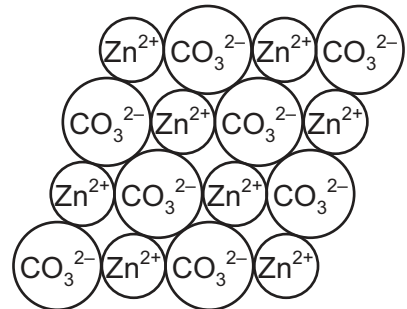
D



E



F

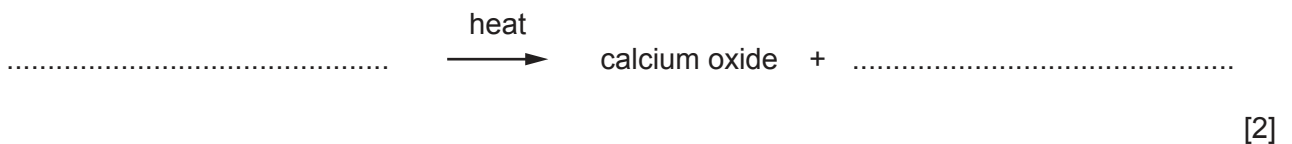


Answer the following questions about these substances.
Each substance may be used once, more than once or not at all.

(a) Which substance, **A**, **B**, **C**, **D**, **E** or **F**,

- (i) is an element, [1]
- (ii) is a saturated hydrocarbon, [1]
- (iii) is added to the blast furnace to help in the extraction of iron, [1]
- (iv) has a giant covalent structure, [1]
- (v) is a product of respiration, [1]
- (vi) contains a metal ion with 20 protons? [1]

(b) Complete the word equation for the thermal decomposition of substance **B**.



(c) Describe a test for substance **A**.

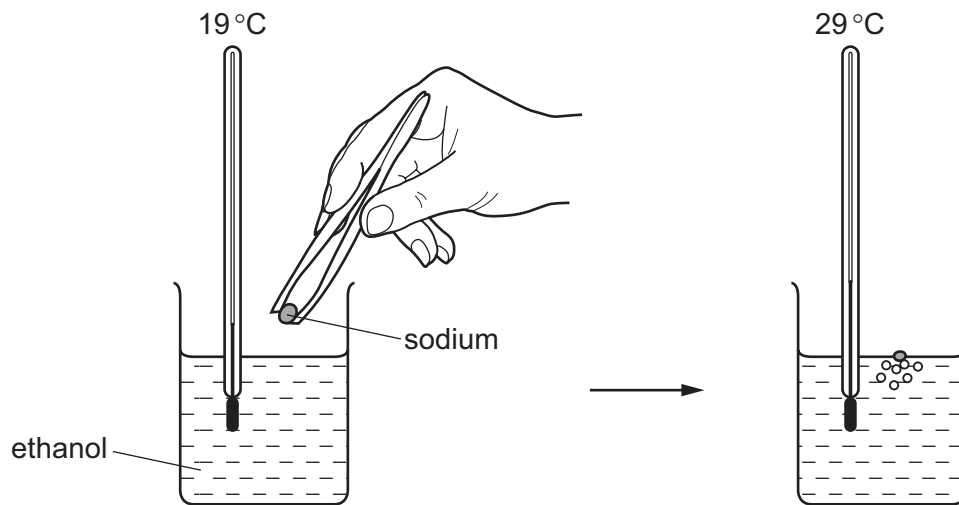
test

result

[2]

[Total: 10]

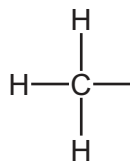
- 2 A small piece of sodium is added to some ethanol. The temperature was measured before and after the sodium was added.



- (a) Explain how this experiment shows that the reaction is exothermic.

..... [1]

- (b) Complete the structure of ethanol to show all atoms and bonds.



[1]

(c) Ethanol can be made by the reaction of steam with ethene.

(i) Write the word equation for this reaction.

..... [1]

(ii) What conditions are needed for this reaction?
Tick **two** boxes.

enzyme catalyst

high temperature (300 °C)

low temperature (10 °C)

phosphoric acid catalyst

presence of light

[2]

(iii) What will be observed when ethene is bubbled through aqueous bromine?

..... [1]

(d) Ethanol can also be made by fermentation.

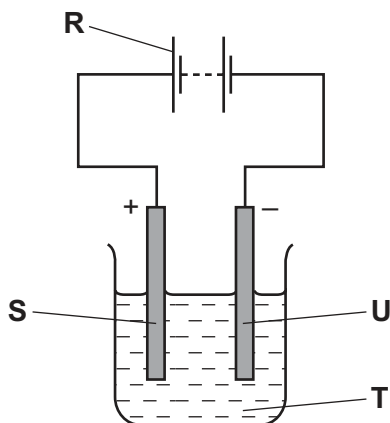
The fermentation mixture contains solids as well as an aqueous solution of ethanol.

Suggest how the ethanol can be purified from this fermentation mixture.

.....
.....
.....
..... [3]

[Total: 9]

- 3 The diagram shows the apparatus used for the electrolysis of molten sodium bromide.



- (a) (i) What does the term *electrolysis* mean?

.....
 [1]

- (ii) Which letter, **R**, **S**, **T** or **U**, in the diagram above represents the cathode?

..... [1]

- (b) Complete the word equation for the electrolysis of molten sodium bromide.

sodium bromide → + [2]

- (c) A solution of sodium bromide in water is neutral.

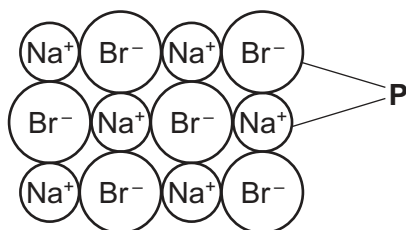
Which **one** of the following pH values is neutral?

Put a ring around the correct answer.

pH 0 pH 6 pH 7 pH 10 pH 14

[1]

- (d) The diagram below shows the arrangement of the particles in sodium bromide at room temperature.



- (i) Give the name of the type of particles, **P**, present in sodium bromide.

..... [1]

- (ii) What is the state of sodium bromide at room temperature?
Use the information in the diagram to explain your answer.

.....

 [2]

- (e) Sodium bromide can be made by heating sodium in bromine vapour.

Complete the balanced symbol equation for this reaction.



[2]

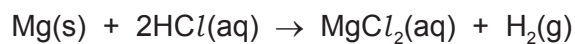
- (f) Bromine has two naturally-occurring isotopes.

What is the meaning of the term *isotope*?

.....
 [1]

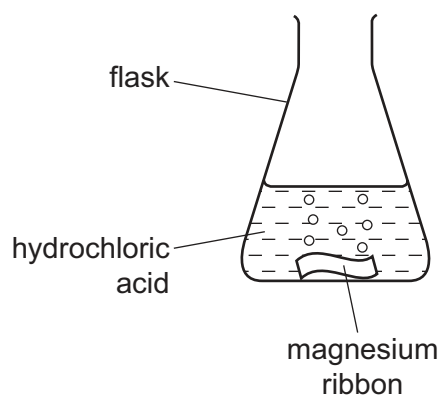
[Total: 11]

- 4 A student investigated the reaction of magnesium with dilute hydrochloric acid.



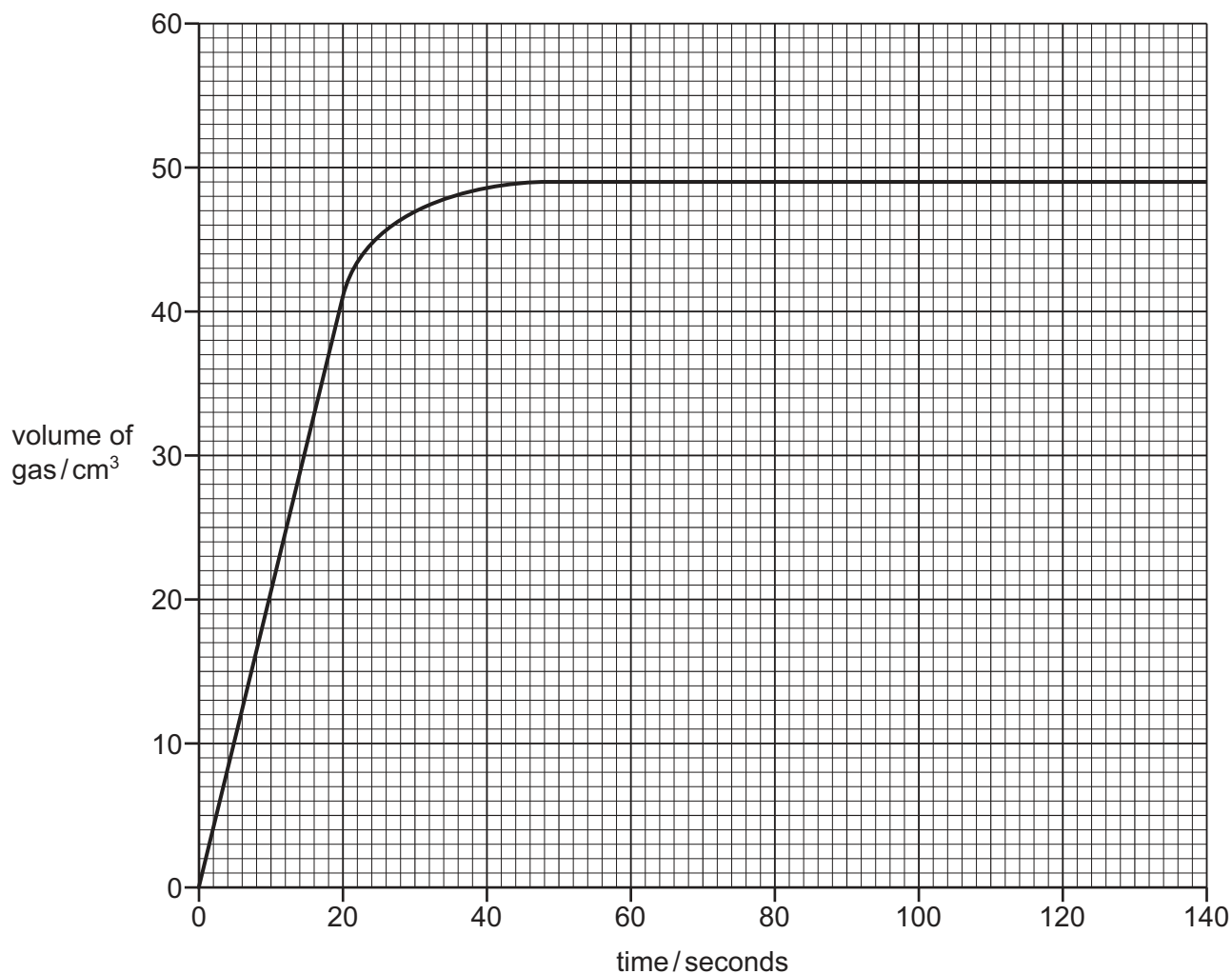
She measured the volume of gas given off at various times during the reaction.

- (a) Complete the diagram of the apparatus she would use to measure the volume of the gas given off.
Label the apparatus.



[3]

- (b) The student carried out the reaction at 25 °C using magnesium ribbon. Her results are shown below.



- (i) How long does it take for the reaction to stop?

..... seconds [1]

- (ii) What is the volume of hydrogen made after 20 seconds?

..... cm³ [1]

- (iii) On the grid above, draw a line to show how the volume of gas changes when the experiment is carried out at 15 °C and all other conditions remain the same. [2]

- (iv) The student repeated the experiment using magnesium powder. All other conditions remain the same.

How does the rate of reaction with magnesium powder compare with the rate of reaction with magnesium ribbon?

..... [1]

(c) (i) Draw a diagram to show the electron arrangement in a molecule of hydrogen.

[1]

(ii) What type of bonding is present in a hydrogen molecule?

..... [1]

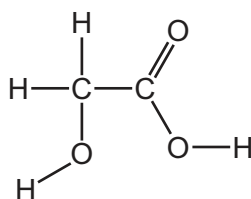
(d) Magnesium chloride is a salt.
Magnesium sulfate is also a salt.

Give the name of two **compounds** which react together to form magnesium sulfate.

..... and [2]

[Total: 12]

5 The structure of glycolic acid is shown below.



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

(b) Glycolic acid is prepared by heating a mixture of methanal, carbon monoxide and water with a sulfuric acid catalyst.

(i) The formula of methanal is HCHO.

Calculate the relative molecular mass of methanal.

[1]

(ii) What is the function of the catalyst?

..... [1]

(iii) State **one** adverse effect of carbon monoxide on humans.

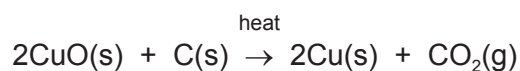
..... [1]

(c) Glycolic acid can also be prepared by the reduction of oxalic acid.

(i) What does the term *reduction* mean?

..... [1]

(ii) Give the name of the reducing agent in the following reaction.



name of reducing agent [1]

- (d) Glycolic acid is found in unripe grapes.
Grape skins contain a number of different coloured pigments.

Describe how you could obtain a solution of these pigments from grape skins.

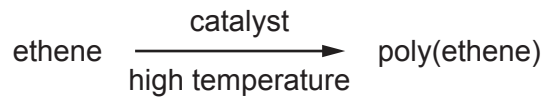
.....

.....

.....

..... [3]

- (e) Glycolic acid can undergo polymerisation.
Ethene can also undergo polymerisation.
The equation for the polymerisation of ethene is shown below.



Give the name of the monomer in this equation.

..... [1]

- (f) Long chain alkanes can be cracked to produce shorter chain alkanes and alkenes.

- (i) What conditions are needed for cracking?

.....

..... [2]

- (ii) Complete the equation for the cracking of hexadecane, $\text{C}_{16}\text{H}_{34}$, to form octane, C_8H_{18} , and ethene only.



[Total: 13]

6 The table shows some physical properties of the metals, **A**, **B**, **C** and **D**.

metal	electrical conductivity	density in g/cm ³	boiling point /°C	hardness
A	fairly good	8.64	765	hard
B	good	0.97	883	soft
C	good	7.14	907	hard
D	good	0.86	760	soft

(a) (i) Which **two** metals in the table are Group I metals?
Give a reason for your answer.

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

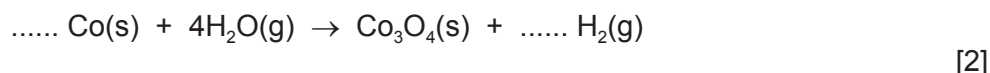
(ii) None of the metals **A**, **B**, **C** or **D** are transition elements.

Give **two** properties of transition elements or their compounds that make them different from metals **A**, **B**, **C** and **D**.

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

(iii) Cobalt is a transition element.
When it is heated very strongly in steam, hydrogen is given off.

Complete the symbol equation for this reaction.



(iv) Iron is also a transition element.

Describe how iron is converted to steel.
In your answer, refer to basic oxides and oxygen.

.....
.....
.....
..... [3]

(b) When lithium reacts with water it moves about on the surface of the water, bubbles are seen and the lithium disappears slowly.

Predict how the reaction of potassium with water compares with the reaction of lithium with water.

In your answer, include

- any differences in observations,
- the names of the products formed when lithium and potassium react with water.

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 14]

(b) The table shows some properties of the Group 0 elements helium, neon, argon and krypton.

element	electron arrangement	density of the liquefied gas in g/cm ³	melting point /°C	boiling point /°C
helium	2	0.15	-272	-269
neon		1.20	-248	-245
argon	2,8,8	1.40	-189	-186
krypton	2,8,18,8	2.15	-157	-152

(i) Describe how the density of the liquefied noble gases changes down Group 0.

..... [1]

(ii) Deduce the electron arrangement of neon.

..... [1]

(iii) What is the state of argon at -188°C?

..... [1]

(iv) Which element in the table has the highest melting point?

..... [1]

(c) The table below shows the number of electrons, protons and neutrons in some isotopes of helium, argon and neon.

Complete the table.

element	number of electrons	number of protons	number of neutrons
${}^3_2\text{He}$	2	2
${}^{38}_{18}\text{Ar}$	18	20
.....	10	10	11

[3]

[Total: 11]

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		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		93 Nb Niobium 41	96 Mo Molybdenum 42	101 Ru Ruthenium 44	101 Rh Rhodium 45	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		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	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86	
87 Fr Francium	88 Ra Radium		226 Ra Radium	227 Ac Actinium													
			140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 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	232 Pa Protactinium 91	238 U Uranium 92	238 Np Neptunium 93	244 Pu Plutonium 94	247 Am Americium 95	251 Cm Curium 96	257 Bk Berkelium 97	261 Cf Californium 98	265 Es Einsteinium 99	267 Fm Fermium 100	271 Md Mendelevium 101	277 No Nobelium 102	285 Lr Lawrencium 103	

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

a	X
b	

Key
 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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