Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1564763095

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.

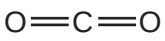
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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

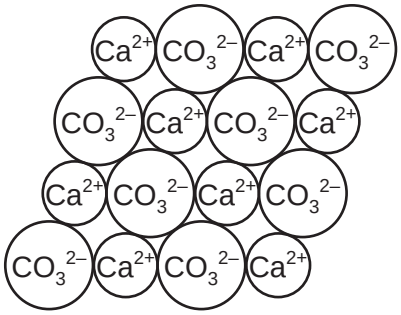
This document consists of **16** printed pages.

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

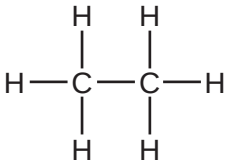
A



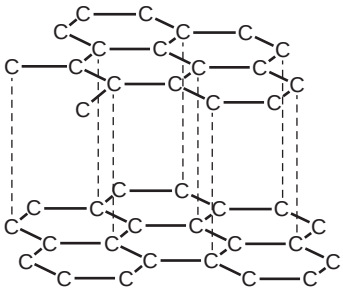
B



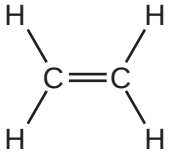
C



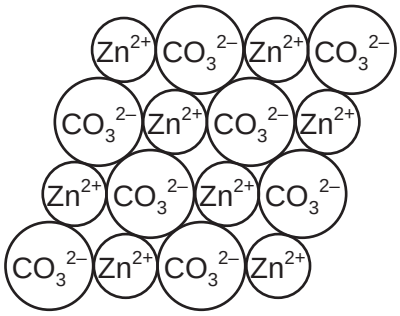
D



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**.

..... $\xrightarrow{\text{heat}}$ calcium oxide + ...

[2]

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

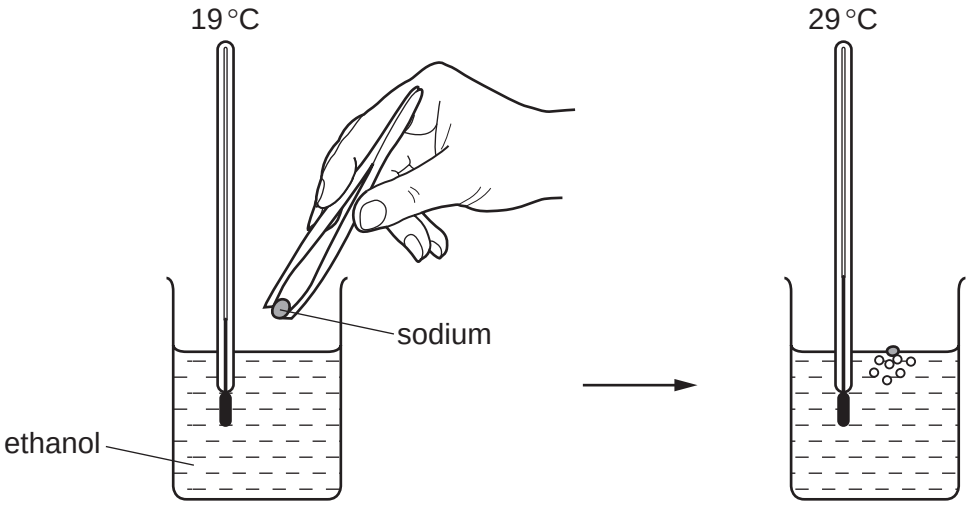
test .....

result .....

[2]

[Total: 10]

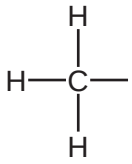
2 A small piece of sodium is added to some ethanol. The temperature was measured before and after the sodium was added.



(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.

.....

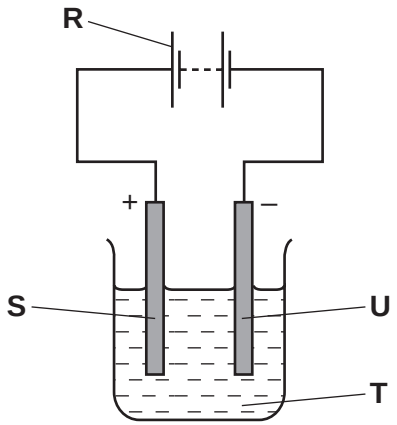
.....

.....

..... [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]

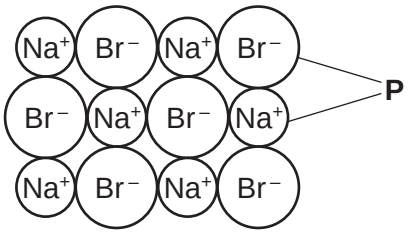
(c) A solution of sodium bromide in water is neutral.

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.

..... Na + ... → 2NaBr

[2]

(f) Bromine has two naturally-occurring isotopes.

What is the meaning of the term *isotope*?

.....

..... [1]

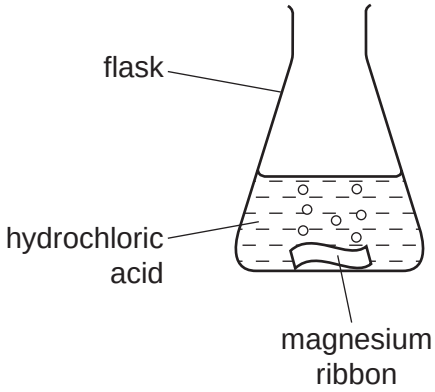
[Total: 11]

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

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

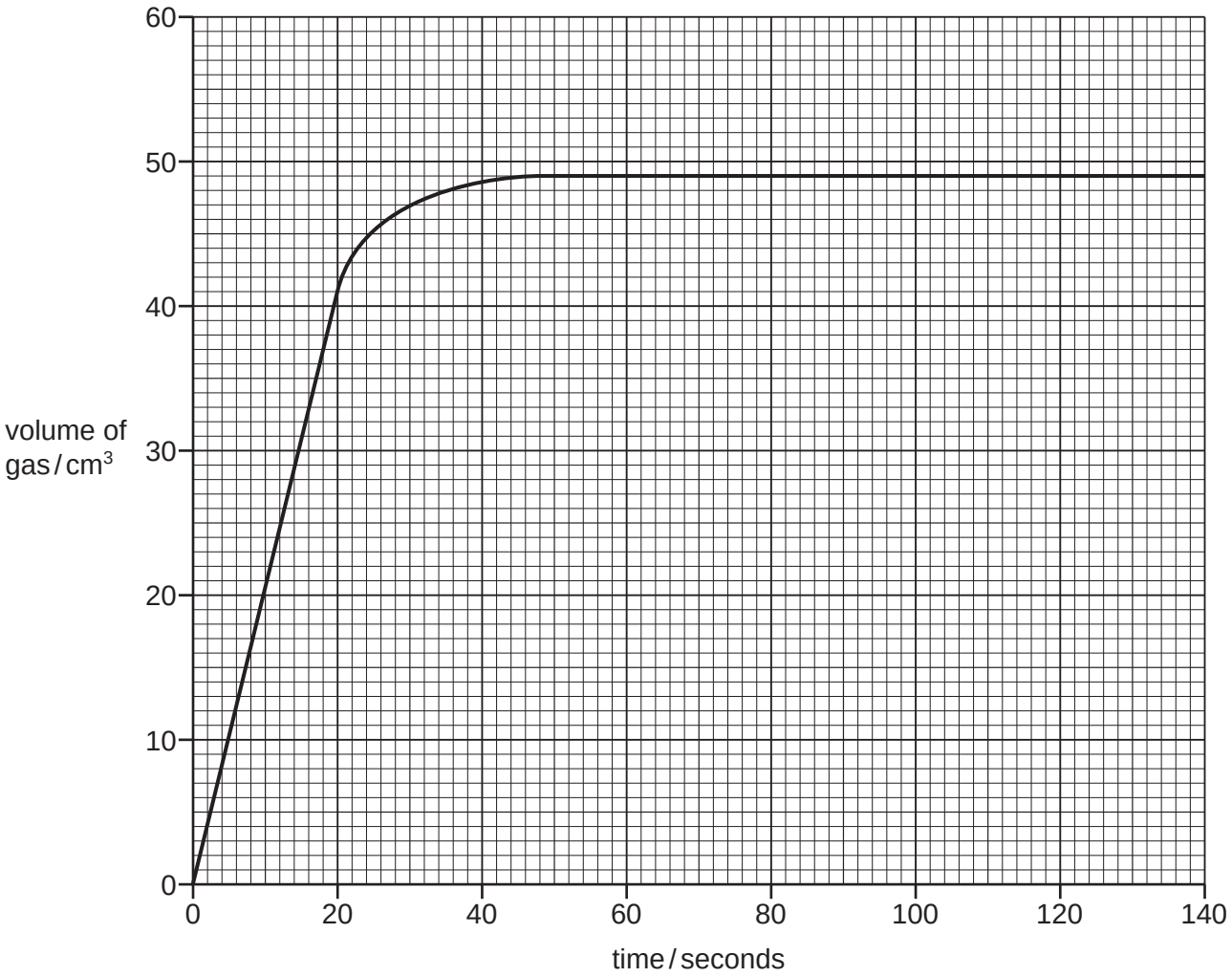
She measured the volume of gas given off at various times during the reaction.

(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?

..... cm^3 [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]

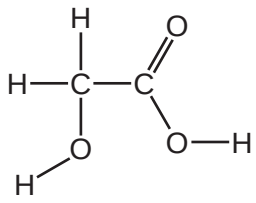
(d) Magnesium chloride is a salt.
Magnesium sulfate is also a salt.

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.

$$2CuO(s) + C(s) \xrightarrow{\text{heat}} 2Cu(s) + CO_2(g)$$

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.

$$\text{ethene} \xrightarrow[\text{high temperature}]{\text{catalyst}} \text{poly(ethene)}$$

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, $C_{16}H_{34}$, to form octane, C_8H_{18}, and ethene only.

$$C_{16}H_{34} \rightarrow C_8H_{18} + \ldots\ldots C_2H_4$$

[1]

[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.

..... $Co(s)$ + $4H_2O(g)$ → $Co_3O_4(s)$ + ... $H_2(g)$

[2]

(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.

.....

.....

.....

.....

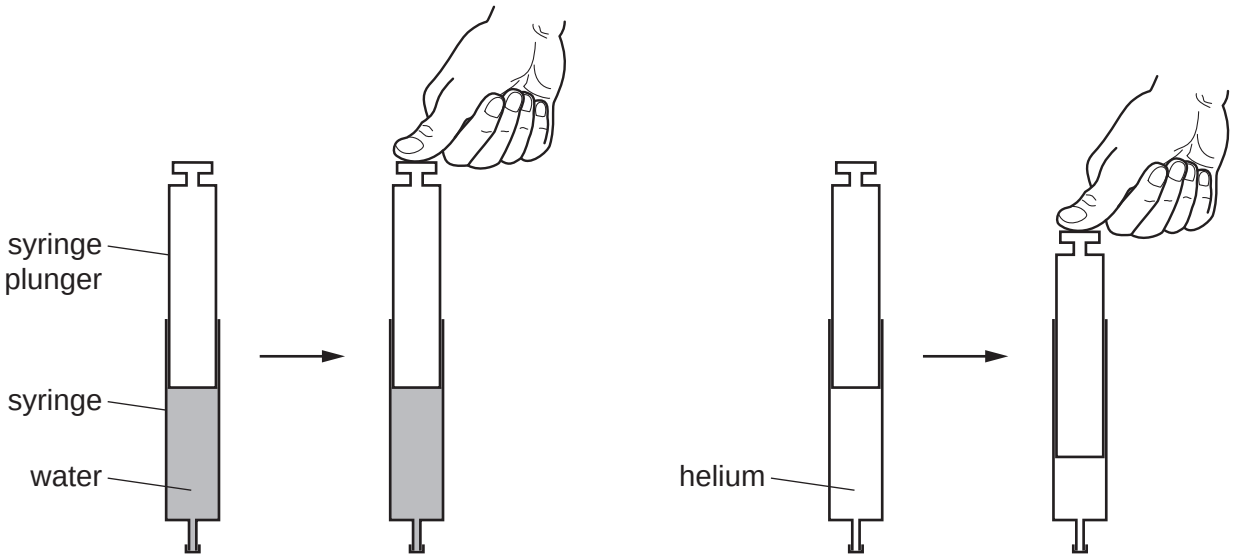
.....

.....

..... [5]

[Total: 14]

7 **(a)** A student took two identical syringes.
He filled one with water and the other with helium gas and sealed the end of both syringes.
He then pushed the syringe plungers with equal force.
The diagram shows what happened.



Describe and explain these results using ideas about particles in liquids and gases.

.....

.....

.....

.....

.....

.....

..... [4]

(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
$^{3}_{2}$He	2	2	.....
$^{38}_{18}$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
																4 **He** Helium 2
					1 **H** Hydrogen 1											
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
X
b

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.).