

CANDIDATE
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CHEMISTRY

0620/32

Paper 3 Theory (Core)

October/November 2017

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.

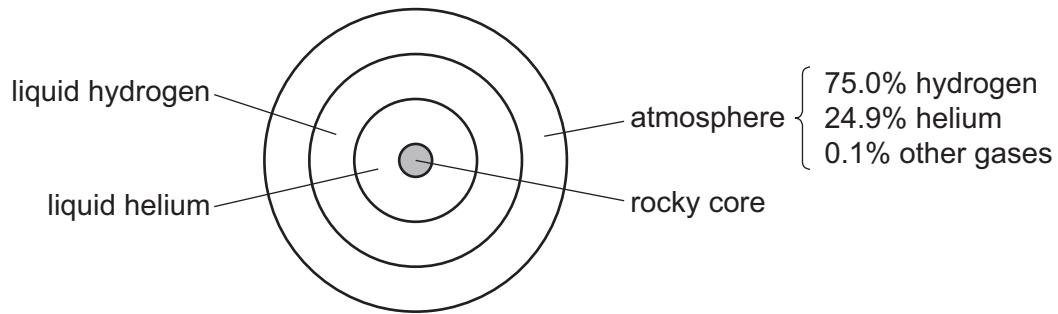
At the end of the examination, fasten all your work securely together.

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.

2 The diagram shows the composition of the planet Saturn.



(a) Describe how Saturn's atmosphere differs from the Earth's atmosphere.
Give **three** differences.

- 1
-
- 2
-
- 3
-

[3]

(b) Some properties of hydrogen and helium are given in the table.

| element | density of the liquid in g/cm ³ | melting point in °C | boiling point in °C |
|----------|--------------------------------------------|---------------------|---------------------|
| hydrogen | 0.07 | -259 | -253 |
| helium | 0.15 | -272 | -269 |

(i) Use the information to suggest why the layer of liquid hydrogen in Saturn floats on top of the liquid helium.

..... [1]

(ii) What is the physical state of hydrogen at -250 °C?
Explain your answer.

.....

..... [2]

(c) The atmosphere of Saturn contains small amounts of ammonia.

(i) Describe a test for ammonia.

test

result

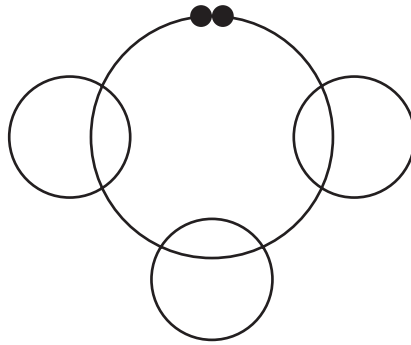
[2]

(ii) Ammonia is a covalent compound.

Complete the diagram to show

- the arrangement of electrons in a molecule of ammonia,
- the symbols of the atoms present.

Show outer electrons only.



[2]

(d) Saturn's atmosphere also contains small amounts of ammonium hydrosulfide.

Calculate the relative molecular mass of ammonium hydrosulfide, NH_4SH .
Use your Periodic Table to help you.

relative molecular mass = [2]

(e) Saturn's atmosphere also contains small amounts of methane.

Small amounts of methane are present in the Earth's atmosphere.

Methane is a greenhouse gas.

(i) Name another greenhouse gas present in the Earth's atmosphere.

..... [1]

(ii) Scientists are concerned about the increase in the amount of greenhouse gases in the Earth's atmosphere.

Explain why.

..... [1]

[Total: 14]

3 The following compounds are present in a liquid used for cleaning metal.

ethanoic acid
ethanol
glycerol
sodium chloride
water

(a) (i) Draw the structure of the functional group present in ethanoic acid.

[1]

(ii) Which **one** of the following pH values is acidic?
Put a circle around the correct answer.

pH4 pH7 pH9 pH13

[1]

(iii) Ethanoic acid reacts with sodium hydroxide.

What type of reaction is this?
Put a circle around the correct answer.

neutralisation **oxidation** **polymerisation** **reduction**

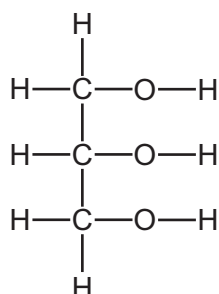
[1]

(iv) The reaction of ethanoic acid with sodium hydroxide is exothermic.

What is meant by the term *exothermic*?

..... [1]

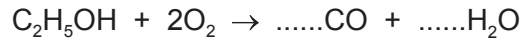
(b) The structure of glycerol is shown.



Deduce the molecular formula of glycerol showing the number of carbon, hydrogen and oxygen atoms.

..... [1]

(c) Balance the chemical equation for the incomplete combustion of ethanol.



[2]

(d) (i) Describe a method of obtaining pure samples of **both** sodium chloride and water from aqueous sodium chloride. Explain why this method works.

.....

.....

.....

.....

..... [3]

(ii) Which physical property could you measure to find out if a sample of water is pure?

..... [1]

(iii) Sodium chloride contains chloride ions.

Describe a test for chloride ions.

test

result

[2]

[Total: 13]

4 The table shows the properties of four substances.

| substance | boiling point | electrical conductivity of solid | electrical conductivity when molten | solubility in water |
|-----------------|---------------|----------------------------------|-------------------------------------|---------------------|
| calcium iodide | very high | does not conduct | conducts | |
| phosphorus | low | does not conduct | does not conduct | insoluble |
| sodium chloride | very high | does not conduct | conducts | soluble |
| zinc | high | | conducts | insoluble |

(a) Complete the table to show the solubility in water of calcium iodide and the electrical conductivity of solid zinc. [2]

(b) Give **one** piece of evidence from the table that shows that phosphorus is a simple covalent substance.

..... [1]

(c) What information in the table shows that sodium chloride is an ionic compound?

.....
 [2]

(d) Molten calcium iodide can be electrolysed.

Predict the products of this electrolysis at

the positive electrode (anode),

the negative electrode (cathode).

[2]

(e) An atom of phosphorus has 31 nucleons.

Deduce the number of protons and neutrons present in **one** atom of phosphorus.
 Use your Periodic Table to help you.

number of protons

number of neutrons

[2]

(f) Phosphorus burns in an excess of air to form phosphorus(V) oxide.

Is phosphorus(V) oxide an acidic oxide or a basic oxide?
Explain your answer.

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

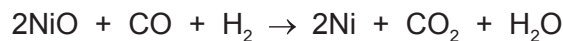
(g) Arsenic is in the same group of the Periodic Table as phosphorus.
Arsenic sublimes at 613 °C.

What is meant by the term *sublimation*?

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

[Total: 11]

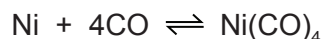
- 5 Nickel can be obtained from nickel(II) oxide by heating it with a mixture of carbon monoxide and hydrogen.



- (a) How does this equation show that the nickel(II) oxide is reduced?

..... [1]

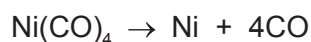
- (b) Nickel can be purified by reacting impure nickel with carbon monoxide. A compound called tetracarbonylnickel, $\text{Ni}(\text{CO})_4$, is formed.



What is the meaning of the symbol \rightleftharpoons ?

..... [1]

- (c) The tetracarbonylnickel is heated to obtain pure nickel.



- (i) Suggest why the nickel obtained can be separated easily from the carbon monoxide.

..... [1]

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

..... [1]

- (d) Nickel is a transition element.
Potassium is a Group I element.

- (i) Describe **two** differences in the physical properties of nickel and potassium.

1

.....

2

.....

[2]

- (ii) Describe **one** difference in the properties of nickel(II) chloride and potassium chloride.

..... [1]

- (e) The properties and relative reactivity with water of some Group I elements are shown in the table.

| element | density in g/cm ³ | boiling point in °C | relative reactivity with water |
|-----------|------------------------------|---------------------|---------------------------------------------------------|
| sodium | | 883 | forms bubbles rapidly but does not burst into flames |
| potassium | 0.86 | 760 | forms bubbles very rapidly and bursts into flames |
| rubidium | 1.53 | | |
| caesium | 1.88 | 669 | reacts explosively |

- (i) Complete the table

- to predict the boiling point of rubidium,
- for the relative reactivity of rubidium with water.

[2]

- (ii) Describe the general trend in the density of the Group I elements.

..... [1]

[Total: 10]

6 Ethanol can be manufactured from ethene or by the fermentation of glucose.

(a) Describe these **two** methods of manufacturing ethanol.

In your answer, include

- the names of any additional substances needed,
- the reaction conditions.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

(b) Ethene is an unsaturated hydrocarbon.

(i) Describe how you could distinguish between an unsaturated hydrocarbon and a saturated hydrocarbon using aqueous bromine.

.....

.....

..... [2]

(ii) Ethene molecules can form polymers.

Which phrase describes a polymer?

Tick **one** box.

a giant structure containing one type of atom

a large molecule formed by cracking monomers

a large molecule formed by the addition of many ions

a large molecule formed from many monomers

[1]

(iii) *Terylene* is a polymer.

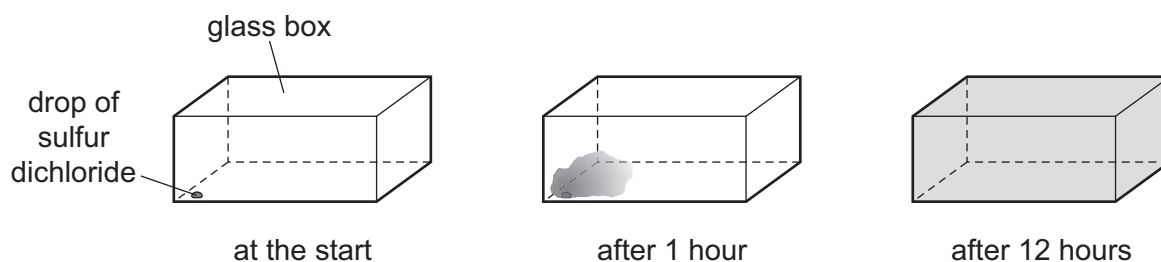
Give **one** use of *Terylene*.

..... [1]

[Total: 9]

7 Sulfur dichloride, SCl_2 , is a red liquid which vaporises easily at room temperature and pressure.

- (a) A drop of sulfur dichloride was placed in the corner of a glass box. The glass box was closed and left for 12 hours. After 12 hours a red vapour had spread to fill the whole box.



Explain these observations using the kinetic particle model.

.....

.....

.....

.....

.....

..... [3]

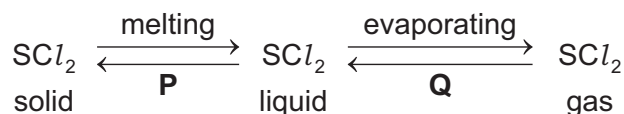
- (b) Sulfur dichloride can be made by passing chlorine through liquid disulfur dichloride, S_2Cl_2 .

Complete the chemical equation for this reaction.



[2]

- (c) Some changes of state of sulfur dichloride are shown.



Name the changes of state represented by **P** and **Q**.

P

Q

[2]

[Total: 7]

8 Calcium carbonate (limestone) decomposes when heated.

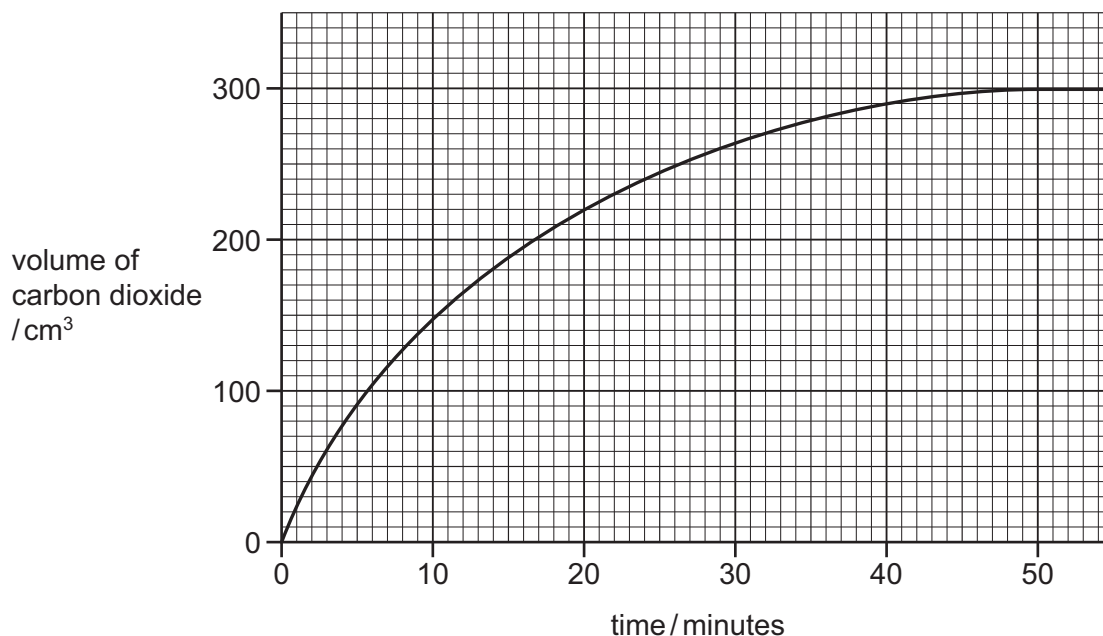


(a) When 20.0g of calcium carbonate are decomposed, 11.2g of calcium oxide (lime), CaO, are formed.

Calculate the mass of calcium oxide formed when 160.0g of calcium carbonate are decomposed.

..... g [1]

(b) The graph shows the volume of carbon dioxide produced when some small pieces of calcium carbonate are heated and decompose.



(i) Deduce the volume of carbon dioxide produced during the first 20 minutes of the decomposition.

..... [1]

(ii) At what time was the reaction complete?

..... [1]

(iii) What would be the effect, if any, on the rate of reaction if the same mass of powdered calcium carbonate were used?

..... [1]

(c) The table shows how limestone is used.

| use of limestone | percentage of limestone used for this purpose |
|----------------------------|-----------------------------------------------|
| agriculture | |
| cement manufacture | 37 |
| chemical industries | 14 |
| iron and steel manufacture | 11 |
| road building | 20 |
| other uses | 2 |
| total | 100 |

(i) What percentage of limestone is used in agriculture?

..... [1]

(ii) Limestone and lime are used in agriculture.

Why is lime used in agriculture?

.....
 [2]

[Total: 7]

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The Periodic Table of Elements

| Group | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|-----------------------------------|----------------------------------------|------------------------------------|-------------------------------------|------------------------------------|-------------------------------------|-------------------------------------|---------------------------------------|--------------------------------------|--------------------------------------|------------------------------------|------------------------------------|------------------------------------|-------------------------------------|-------------------------------------|--------------------------------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|-------------------------------|
| I | II | | | | | | | | | | | III | IV | V | VI | VII | VIII | | | | | | | | | | | | | | | |
| <p style="text-align: center;">Key</p> <table border="1" style="margin: auto;"> <tr> <td style="text-align: center;">atomic number</td> </tr> <tr> <td style="text-align: center;">atomic symbol</td> </tr> <tr> <td style="text-align: center;">name</td> </tr> <tr> <td style="text-align: center;">relative atomic mass</td> </tr> </table> | | | | | | | | | | | | atomic number | atomic symbol | name | relative atomic mass | 1 H hydrogen 1 | | | | | | | | | | | | | | | | 2 He helium 4 |
| | | | | | | | | | | | | atomic number | | | | | | | | | | | | | | | | | | | | |
| atomic symbol | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| name | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| relative atomic mass | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 Li lithium 7 | 4 Be beryllium 9 | | | | | | | | | | | 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 | | | | | | | | | | | 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 – | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | |
|-------------------------------------|-----------------------------------|----------------------------------------|-------------------------------------|------------------------------------|------------------------------------|------------------------------------|--------------------------------------|-----------------------------------|--------------------------------------|-------------------------------------|----------------------------------|--------------------------------------|-------------------------------------|-------------------------------------|
| 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 – |

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