Cambridge IGCSE

Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2741546944

CHEMISTRY **0620/33**

Paper 3 Theory (Core) **May/June 2019**

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.

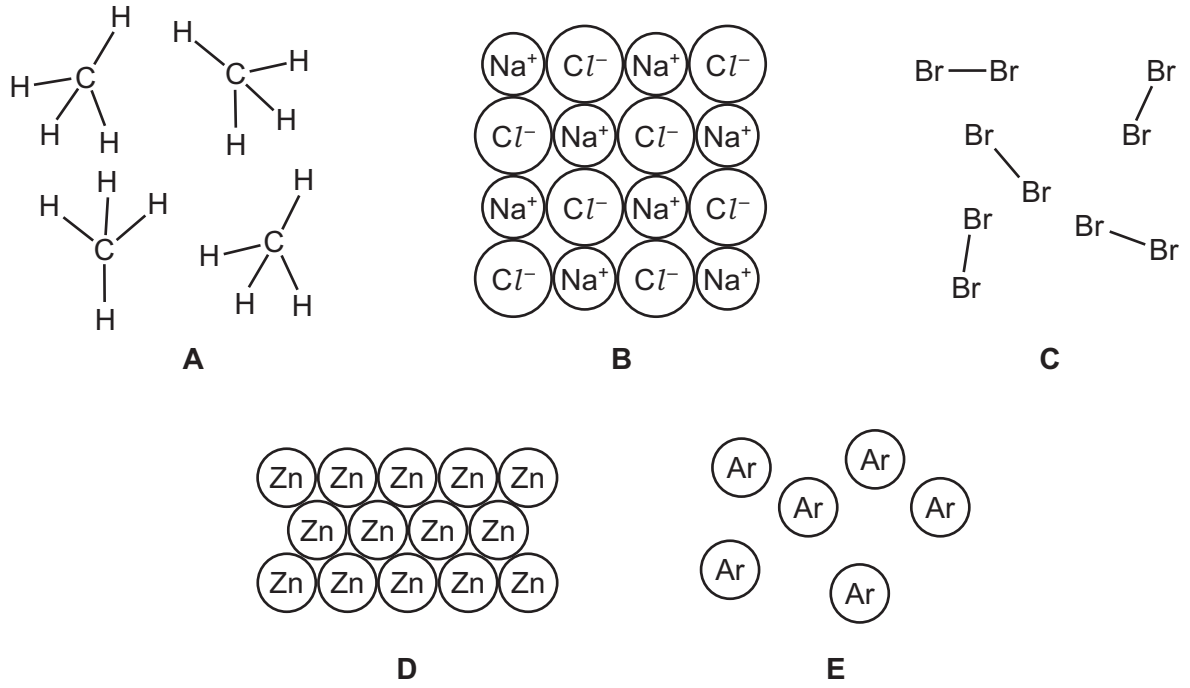
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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

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

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1 The diagram shows part of the structures of five substances, **A**, **B**, **C**, **D** and **E**.



(a) Answer the following questions about these structures.
Each structure may be used once, more than once or not at all.

(i) Which **two** of these structures, **A**, **B**, **C**, **D** or **E**, are compounds?

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

(ii) Which **one** of these structures, **A**, **B**, **C**, **D** or **E**, is monatomic?

..... [1]

(iii) Which **one** of these structures, **A**, **B**, **C**, **D** or **E**, conducts electricity when solid?

..... [1]

(iv) Which **one** of these structures, **A**, **B**, **C**, **D** or **E**, is the main constituent of natural gas?

..... [1]

(v) Which **one** of these structures, **A**, **B**, **C**, **D** or **E**, is a solid which is soluble in water?

..... [1]

(vi) Which **one** of these structures, **A**, **B**, **C**, **D** or **E**, is a hydrocarbon?

..... [1]

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(b) Substance **E** is present in air.
Air is a mixture of different gases.

Describe **two** characteristics of a mixture.

1 .....

.....

2 .....

.....
[2]

[Total: 9]

2 This question is about iron and iron compounds.

(a) Iron can be extracted from iron ore by reduction with carbon in a blast furnace.

(i) Which **one** of these substances is an ore of iron?
Draw a circle around the correct answer.

bauxite **graphite** **hematite** **limestone**

[1]

(ii) The equation shows one of the reactions occurring in the blast furnace.

$$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$$

How does this equation show that Fe_2O_3 is reduced?

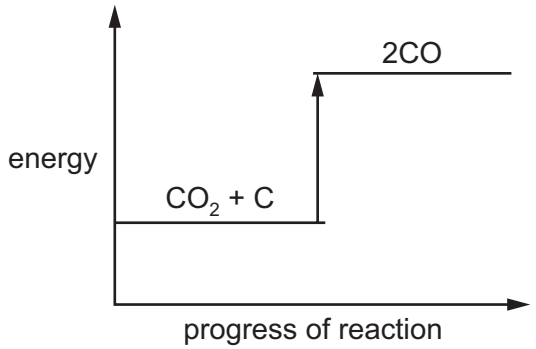
.....

..... [1]

(iii) The carbon dioxide formed can be reduced by carbon.

$$CO_2 + C \rightarrow 2CO$$

The energy level diagram for this reaction is shown.



Explain how this diagram shows that the reaction is endothermic.

.....

..... [1]

(iv) Explain why iron is extracted by reduction with carbon and **not** by electrolysis.
Refer to the position of iron in the reactivity series in your answer.

.....

..... [1]

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(b) Describe **three** properties of iron that show that it is a transition element and **not** a Group I element.

1 .....

2 .....

3 .....

[3]

(c) Iron reacts with chlorine to form iron(III) chloride, Fe_2Cl_6.

(i) Balance the chemical equation for this reaction.

$$.....Fe + ...Cl_2 \rightarrow Fe_2Cl_6$$

[2]

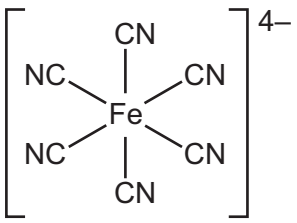
(ii) At 400 °C Fe_2Cl_6 molecules decompose.

$$Fe_2Cl_6 \rightleftharpoons 2FeCl_3$$

What is meant by the symbol $\rightleftharpoons$?

..... [1]

(d) The structure of an ion is shown.



Deduce the molecular formula of this ion to show the number of iron, carbon and nitrogen atoms.

..... [1]

[Total: 11]

3 The table shows the percentage by mass of the elements in the oceans and in the biosphere. The biosphere is all living organisms.

element	percentage by mass in the oceans	percentage by mass in the biosphere
calcium	0.05	0.40
carbon	0.01	39.00
chlorine	1.80	0.05
hydrogen	11.00	6.60
magnesium	0.12	0.10
oxygen	85.80	53.00
silicon	0.00	0.10
sodium	1.15	0.05
other elements	0.07	
total	100.00	100.00

(a) Answer these questions using only the information in the table.

(i) Deduce the percentage by mass of other elements present in the biosphere.

..... % [1]

(ii) Which metallic element is present in the oceans in the greatest percentage by mass?

..... [1]

(iii) Give **two** major differences in the percentage by mass of the elements in the oceans and in the biosphere.

1 .....

.....

2 .....

.....
[2]

(b) Living organisms respire. Water is produced during respiration.

(i) Name the other product of respiration.

..... [1]

(ii) Describe a chemical test for water.

test .....

observations .....
[2]

[Total: 7]

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4 This question is about chlorine and compounds of chlorine.

(a) Use the kinetic particle model to describe the arrangement **and** type of motion of the molecules in:

- solid chlorine .....

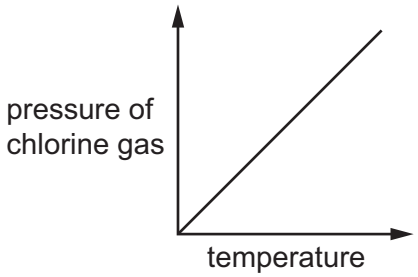
.....

- chlorine gas. .....

.....

[4]

(b) The graph shows how the pressure of chlorine gas changes when temperature increases. The volume is kept constant.



Describe how the pressure of the chlorine gas changes with temperature.

.....

..... [1]

(c) **(i)** Complete the word equation to show the halogen and halide compound which react to form the products iodine and sodium chloride.

.....	+	....	→	iodine	+	sodium chloride

[2]

(ii) Explain, in terms of the reactivity of the halogens, why aqueous bromine will **not** react with aqueous sodium chloride.

.....

..... [1]

(d) Chlorine reacts with warm turpentine, $C_{10}H_{16}$.

Balance the chemical equation for this reaction.

$$C_{10}H_{16} + 8Cl_2 \rightarrow .....C + ...HCl$$

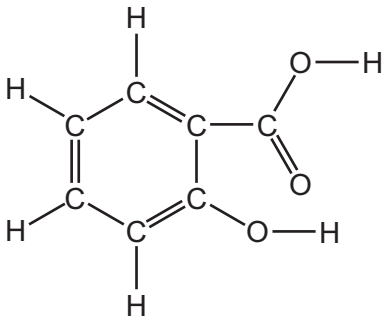
[2]

[Total: 10]

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[Turn over

5 The structure of compound **S** is shown.



(a) (i) Draw a circle around the carboxylic acid functional group in this structure. [1]

(ii) How many different **types** of atom are shown in this structure?

..... [1]

(b) The melting point of pure **S** is 159 °C.
The boiling point of pure **S** is 200 °C.

(i) What is the physical state of pure **S** at 100 °C?
Explain your answer.

.....

..... [2]

(ii) Which **one** of these statements about an impure sample of compound **S** is correct?
Tick **one** box.

The melting point of impure **S** is 159 °C and the boiling point is above 200 °C. ☐

The melting point of impure **S** is below 159 °C and the boiling point is 200 °C. ☐

The melting point of impure **S** is 159 °C and the boiling point is 200 °C. ☐

The melting point of impure **S** is below 159 °C and the boiling point is above 200 °C. ☐

[1]

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(c) Aqueous ethanoic acid has chemical properties which are typical of acids.

Describe **two** chemical properties of aqueous ethanoic acid.

1 .....

.....

2 .....

.....

[2]

(d) Ethanol can be converted into ethene by passing ethanol vapour over a catalyst of aluminium oxide.

$$C_2H_5OH \rightarrow C_2H_4 + \mathbf{X}$$

(i) Identify compound **X**.

..... [1]

(ii) Explain why a catalyst is used.

..... [1]

(iii) Draw the structure of a molecule of ethanol. Show all of the atoms and all of the bonds.

[1]

(e) Ethene can be polymerised.

(i) State the name of the polymer formed from ethene.

..... [1]

(ii) *Terylene* is also a polymer.

State **one** use of *Terylene*.

..... [1]

[Total: 12]

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[Turn over

6 This question is about zinc and compounds of zinc.

(a) Describe how you could prepare a pure sample of crystals of hydrated zinc sulfate using dilute sulfuric acid and an excess of zinc.

.....

.....

.....

.....

..... [3]

(b) The equation shows the effect of heat on anhydrous zinc sulfate.

$$ZnSO_4 \xrightarrow{\text{heat}} ZnO + SO_3$$

(i) What type of chemical reaction is this?
Tick **one** box.

addition	☐
decomposition	☐
displacement	☐
oxidation	☐

[1]

(ii) When 12.60 g of anhydrous zinc sulfate is heated, the mass of zinc oxide formed is 6.34 g.

Calculate the mass of zinc oxide formed when 63.0 g of anhydrous zinc sulfate is heated.

mass of zinc oxide = ... g [1]

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(c) Complete the table to calculate the relative formula mass of anhydrous zinc sulfate, $ZnSO_4$. Use your Periodic Table to help you.

type of atom	number of atoms	relative atomic mass	
zinc	1	65	1 × 65 = 65
sulfur			
oxygen			

relative formula mass = ...

[2]

(d) Complete the table to show the number of electrons, protons and neutrons in the sulfur atom and zinc ion shown.

	number of electrons	number of neutrons	number of protons
$^{36}_{16}S$			
$^{67}_{30}Zn^{2+}$			30

[4]

(e) An alloy contains zinc, copper and aluminium.

What is meant by the term *alloy*?

.....

..... [1]

[Total: 12]

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[Turn over

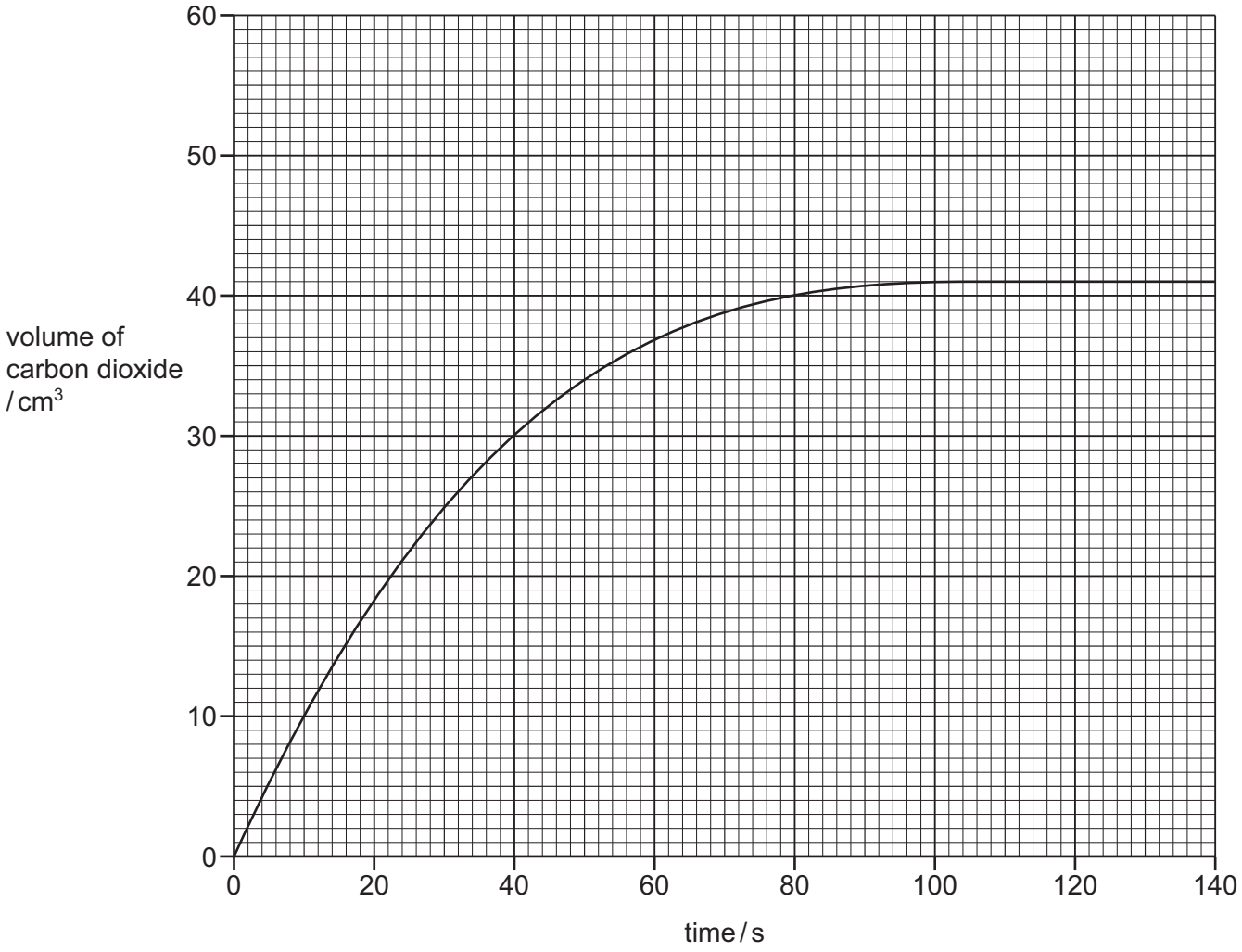
7 A student investigates the rate of reaction of large pieces of magnesium carbonate with an excess of dilute nitric acid.

$$MgCO_3 + 2HNO_3 \rightarrow Mg(NO_3)_2 + CO_2 + H_2O$$

(a) Name the salt formed when magnesium carbonate reacts with dilute nitric acid.

..... [1]

(b) The graph shows how the volume of carbon dioxide changes with time.



(i) After how many seconds did the reaction finish?

..... s [1]

(ii) From the graph, deduce the volume of carbon dioxide produced during the first 50 seconds of the experiment.

.....cm^3 [1]

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(iii) The experiment is repeated using smaller pieces of the same mass of magnesium carbonate.
All other conditions are kept the same.

Draw a line **on the grid** for the experiment using smaller pieces of magnesium carbonate.
[2]

(iv) How does increasing the temperature affect the rate of this reaction?
All other conditions are kept the same.

..... [1]

(v) How does decreasing the concentration of nitric acid affect the rate of this reaction?
All other conditions are kept the same.

..... [1]

(c) Nitric acid contains nitrate ions.

Complete these sentences about the test for nitrate ions using words from the list.

aluminium	**ammonia**	**blue**	**chloride**	**copper**
green	**iron**	**nitrate**	**oxygen**	**red**

Aqueous sodium hydroxide and ..... foil are added to the solution being tested. The mixture is warmed gently. The ..... produced turns damp ..... litmus paper ..... .

[3]

[Total: 10]

8 This question is about Group IV elements and their compounds.

(a) Lead compounds are pollutants in the air.

(i) State **one** source of lead compounds in the air.

..... [1]

(ii) State **one** adverse effect of lead compounds on health.

..... [1]

(b) The table shows how easy it is to reduce four metal oxides with carbon.

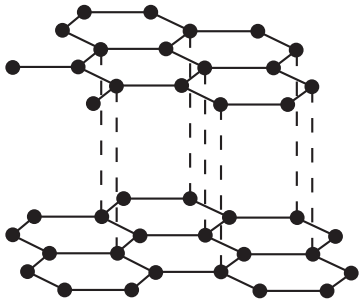
metal oxide	ease of reduction with carbon
bismuth(III) oxide	reduced by carbon only above 250 °C
chromium(III) oxide	reduced by carbon only above 1200 °C
lead(II) oxide	reduced by carbon only above 440 °C
zinc oxide	reduced by carbon only above 990 °C

Use the information in the table to put the four metals in order of their reactivity.
Put the least reactive metal first.

least reactive → most reactive

[2]

(c) Part of the structure of graphite is shown.



Use the information from the diagram to explain why graphite is used as a lubricant.

.....

..... [1]

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(d) When carbon burns in a limited supply of air, a poisonous gas is formed.

Name this gas.

..... [1]

(e) When carbon is completely burned in air, carbon dioxide is formed.
Carbon dioxide forms a slightly acidic solution in water.

Which **one** of these pH values is the pH of a slightly acidic solution?
Draw a circle around the correct answer.

pH 6 pH 7 pH 8 pH 10

[1]

(f) Carbon dioxide is a greenhouse gas.

(i) Name **one** other major greenhouse gas.

..... [1]

(ii) State **one** effect that greenhouse gases have on the environment.

..... [1]

[Total: 9]

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
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 –		

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids	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
actinoids	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 dm^3 at room temperature and pressure (r.t.p.).