Candidate Name _____

Centre Number _____

Candidate Number _____

CAMBRIDGE INTERNATIONAL EXAMINATIONS
Cambridge International
General Certificate of Secondary Education

0620/41
CHEMISTRY
Paper 4 Theory (Extended)

May/June 2018
TIME: 1 hours 15 minutes

SUITABLE FOR VISUALLY IMPAIRED CANDIDATES

Candidates answer on the Question Paper.
No Additional Materials are required.

READ INSTRUCTIONS OVERLEAF

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 31.

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.

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1 Substances can be classified as elements, compounds or mixtures.

(a) What is meant by the term <u>compound</u>?

_____

_____

_____ **[2]**

(b) Mixtures can be separated by physical processes.

A sequence of physical processes can be used to separate common salt (sodium chloride) from a mixture containing sand and common salt only.

Give the order and the correct scientific term for the physical processes used to separate the common salt from the mixture.
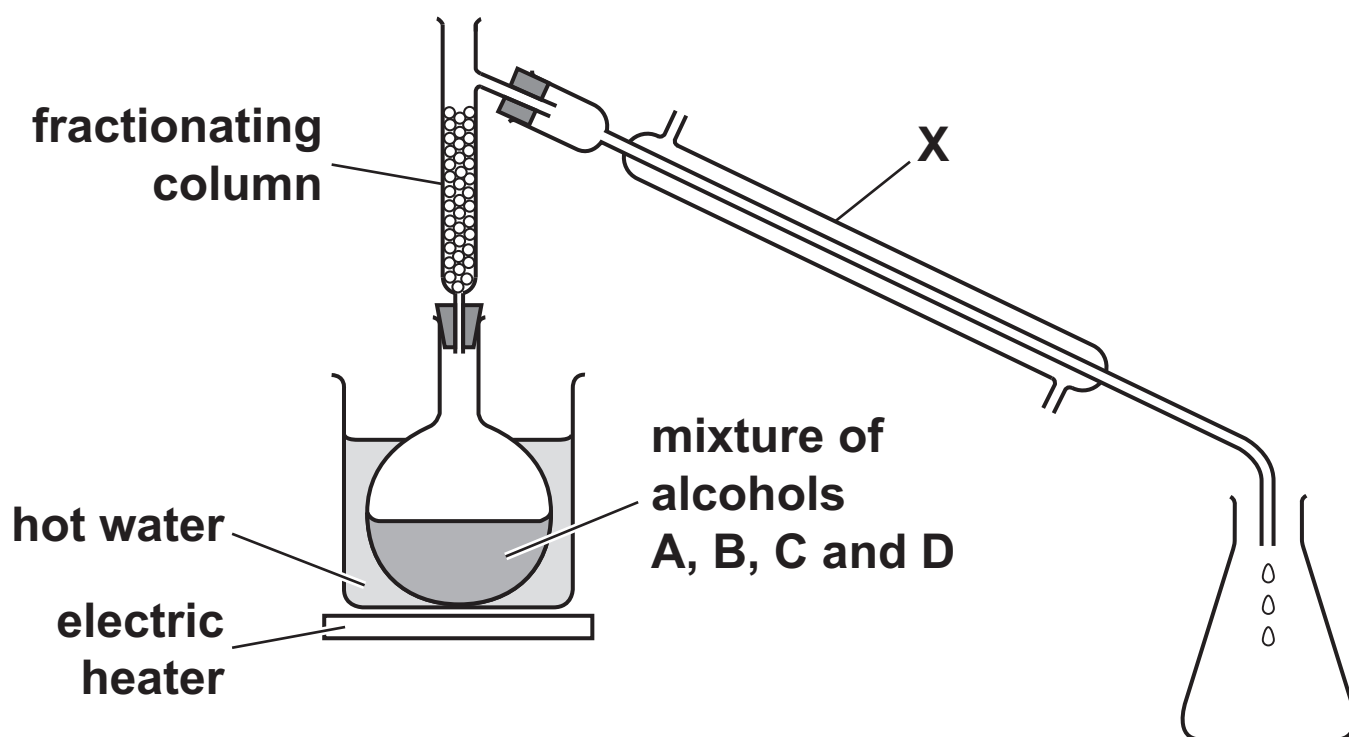
1 _____

2 _____

3 _____
[4]

The boiling points of four different alcohols, A, B, C and D, are shown.

alcohol	boiling point/°C
A	56
B	78
C	122
D	160

(c) A student suggested that the apparatus shown could be used to separate the mixture of alcohols.

(i) Apparatus X needs to have cold water flowing through it.

- Draw an arrow on the diagram to show where the cold water enters apparatus X.

- Name apparatus X.

_____

[2]

(ii) Part of the fractionating column is missing. This means that the experiment will not work.

- Draw on the diagram the part of the fractionating column which is missing.

- Explain why the experiment will NOT work with this part of the fractionating column missing.

_____

_____

[2]

(iii) Suggest why a Bunsen burner is NOT used to heat the flask.

_____ [1]

(iv) **A hot water bath cannot be used to separate alcohols C and D.**

Explain why.

_____

_____

_____ **[2]**

[Total: 13]

2 Flerovium, Fl, atomic number 114, was first made in research laboratories in 1998.

(a) Flerovium was made by bombarding atoms of plutonium, Pu, atomic number 94, with atoms of element Z.

- The nucleus of ONE atom of plutonium combined with the nucleus of ONE atom of element Z.
- This formed the nucleus of ONE atom of flerovium.

Suggest the identity of element Z.

_____ [1]

(b) In which period of the Periodic Table is flerovium?

_____ [1]

(c) Predict the number of outer shell electrons in an atom of flerovium.

_____ [1]

(d) Two isotopes of flerovium are ^{286}Fl and ^{289}Fl. The nuclei of both of these isotopes are unstable and emit energy when they split up.

(i) State the term used to describe isotopes with unstable nuclei.

_____ [1]

(ii) Complete the table to show the number of protons, neutrons and electrons in the atoms of the isotopes shown.
There are six spaces to fill.

isotope	^{286}Fl	^{289}Fl
number of protons		
number of neutrons		
number of electrons		

[2]

(e) Only a relatively small number of atoms of flerovium have been made in the laboratory and the properties of flerovium have not yet been investigated.

It has been suggested that flerovium is a typical metal.

 (i) Suggest TWO physical properties of flerovium.

1 _____

2 _____

[2]

(ii) Suggest ONE chemical property of flerovium oxide.

_____ [1]

[Total: 9]

3 This question is about iron.

(a) Three of the raw materials added to a blast furnace used to extract iron from hematite are coke, hematite and limestone.

Name ONE other raw material added to the blast furnace.

_____ [1]

(b) A series of reactions occurs in a blast furnace during the extraction of iron from hematite.

Describe these reactions.
Include:
- ONE chemical equation for the reduction of hematite
- ONE chemical equation for the formation of slag.

_____

_____

_____

_____

_____

_____

_____

_____ [5]

(c) The iron extracted from hematite using a blast furnace is impure.

Identify the main impurity in this iron and explain how it is removed in the steel-making process.

main impurity _____

how it is removed _____

_____

_____

[3]

[Total: 9]

4 This question is about masses, volumes and moles.

(a) Which term is defined by the following statement?

The average mass of naturally occurring atoms of an element on a scale where the ^{12}C atom has a mass of exactly 12 units.

_____ [1]

(b) Butane, C_4H_{10}, has a relative MOLECULAR mass of 58.
Potassium fluoride, KF, has a relative FORMULA mass of 58.

Explain why the term relative molecular mass can be used for butane but CANNOT be used for potassium fluoride.

_____

_____ [2]

(c) A 0.095 g sample of gaseous element Y occupies $60.0 \, cm^3$ at room temperature and pressure.

- Determine the number of moles of element Y in $60.0 \, cm^3$.

moles of element Y = _____ mol

- Calculate the relative molecular mass of element Y and hence suggest the identity of element Y.

relative molecular mass = _____

identity of element Y = _____

[3]

(d) A 1.68 g sample of phosphorus was burned and formed 3.87 g of an oxide of phosphorus.

Calculate the empirical formula of this oxide of phosphorus.

empirical formula = _____ **[4]**

(e) Another oxide of phosphorus has the empirical formula P_2O_3.
One molecule of this oxide of phosphorus contains four atoms of phosphorus.

Calculate the mass of ONE mole of this oxide of phosphorus.

mass = _____ g [2]

[Total: 12]

5 **(a)** The table gives some chemical properties of transition elements and their compounds, and of Group I elements and their compounds.

chemical property	transition elements	Group I elements
ability to act as catalysts	yes	no
exist as coloured compounds	yes	no

(i) What is meant by the term <u>catalyst</u>?

_____

_____

_____ **[2]**

(ii) Give ONE other chemical property shown by transition elements which is NOT shown by Group I elements.
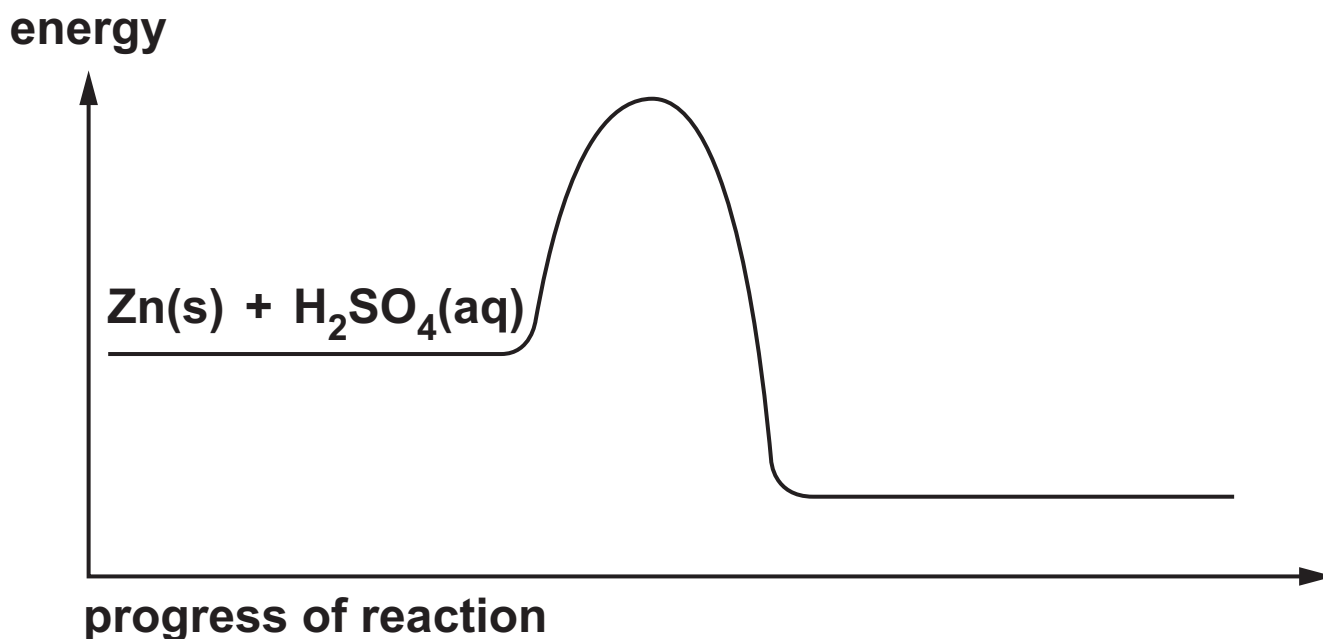
_____ **[1]**

(b) Give TWO physical properties shown by transition elements which are NOT shown by Group I elements.

1 _____

2 _____ **[2]**

(c) The energy level diagram shows the energy profile for the reaction between zinc and dilute sulfuric acid.

energy

$Zn(s) + H_2SO_4(aq)$

progress of reaction

(i) Complete the diagram by adding the formulae of the products. Include state symbols. [3]

(ii) Draw an arrow on the diagram to represent the activation energy. [1]

(iii) Is the reaction endothermic or exothermic? Explain your answer.
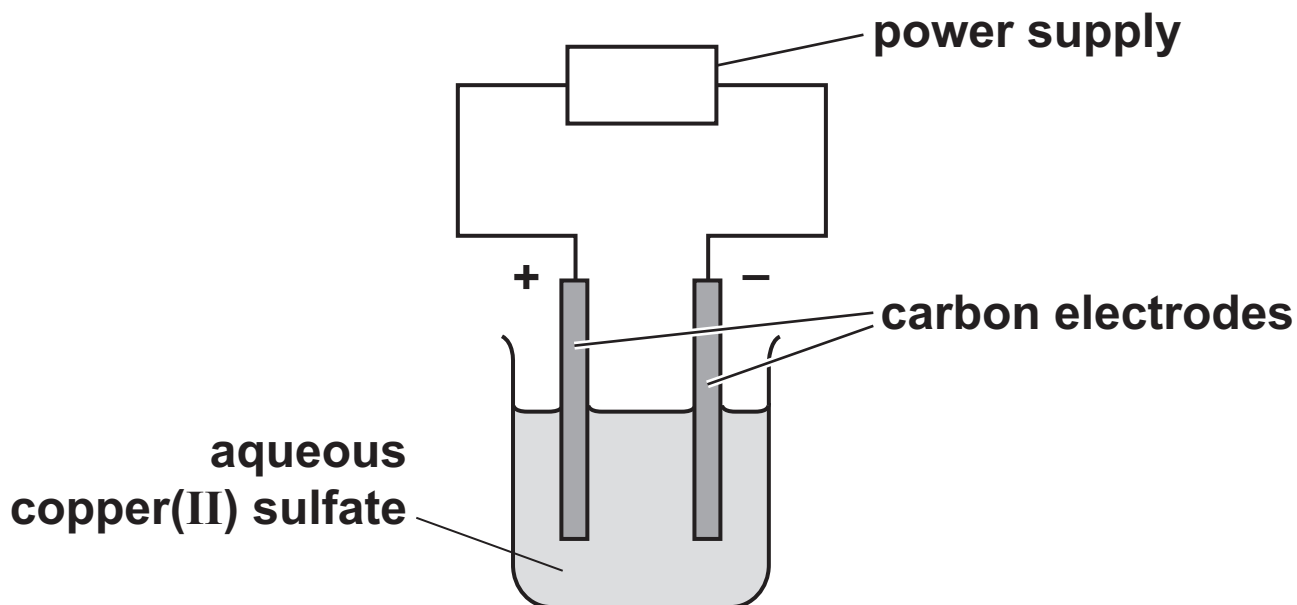
_____

_____ [1]

19

(d) The reaction between zinc and dilute sulfuric acid can be catalysed by the addition of aqueous copper(II) sulfate.

On the diagram, add the energy profile for the catalysed reaction.

energy

Zn(s) + H₂SO₄(aq)

progress of reaction
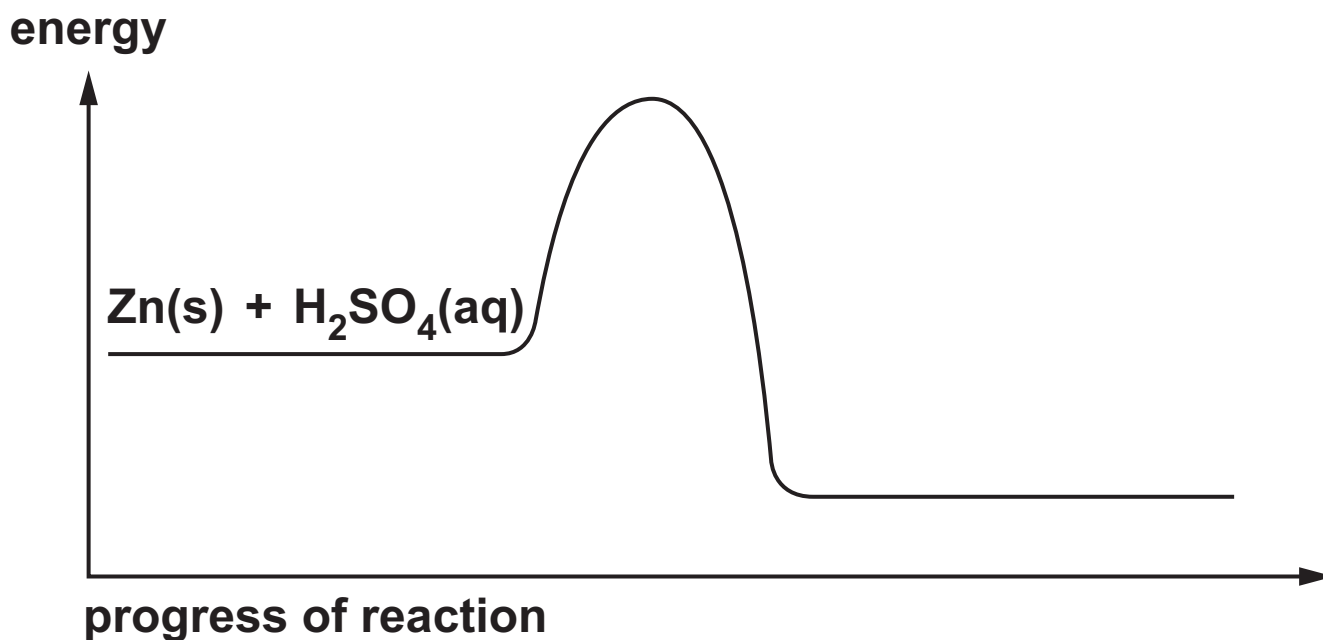
[1]

(e) A student electrolyses aqueous copper(II) sulfate using the apparatus shown.

Oxygen gas forms at the positive electrode (anode).

(i) Write an ionic half-equation for the reaction at the negative electrode (cathode). Include state symbols.

_____ [3]

(ii) Describe what the student observes at the negative electrode.

_____ [1]

(iii) Give TWO OTHER observations which the student makes during the electrolysis.

1 _____

2 _____

[2]

(iv) What difference would the student observe at the positive electrode if the aqueous copper(II) sulfate were replaced by concentrated aqueous copper(II) chloride?

_____ [1]

[Total: 18]

6 **The table shows the structures of four hydrocarbons.**

P	$CH_3–CH_3$
Q	$CH_2=CH_2$
R	$CH_2=CH–CH_3$
S	$CH_2=CH–CH_2–CH_3$

(a) **Why are compounds P, Q, R and S known as hydrocarbons?**

_____

_____ **[2]**

(b) **Compound P is saturated.**

What is meant by the term <u>saturated</u>?

_____

_____ **[1]**

(c) Compound P undergoes a substitution reaction with chlorine.

(i) What is meant by the term <u>substitution reaction</u>?

_____

_____ **[1]**

(ii) State a condition required for this reaction to occur.

_____ **[1]**

(iii) Write a chemical equation for this reaction.

_____ **[2]**

(d) Compound R undergoes an addition reaction with bromine.

  (i) Why is this reaction an addition reaction?

  _____ **[1]**

  (ii) A compound containing bromine is formed in this reaction.

  Draw the structure of this compound. Show all of the atoms and all of the bonds.

  [1]

(e) Draw the structure of an unbranched isomer of compound S. Show all of the atoms and all of the bonds. Name this unbranched isomer of compound S.

structure

name_____

  [2]

(f) Compound Q undergoes polymerisation.

 (i) Name the polymer formed.

_____ **[1]**

 (ii) Complete the chemical equation to show the polymerisation of compound Q.

$$n\ CH_2{=}CH_2 \longrightarrow$$

[2]

(g) Amino acids undergo polymerisation to form proteins. Part of a protein molecule with the linkages missing is shown.

Draw the linkages on the diagram. Show all of the atoms and all of the bonds.
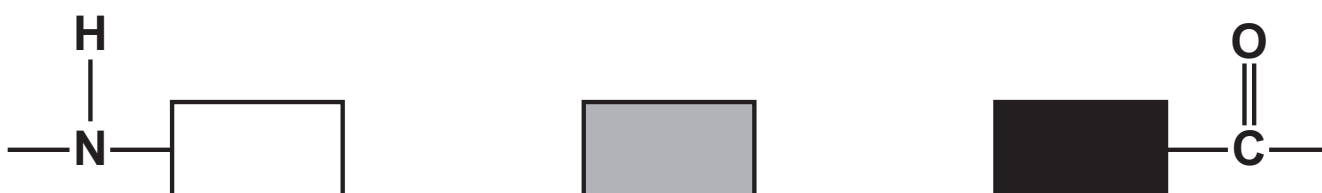
[2]

(h) The structure shows an ester.

$$CH_3—CH_2—CH_2—C\overset{\displaystyle O}{\underset{\displaystyle O—CH_2—CH_3}{\|}}$$
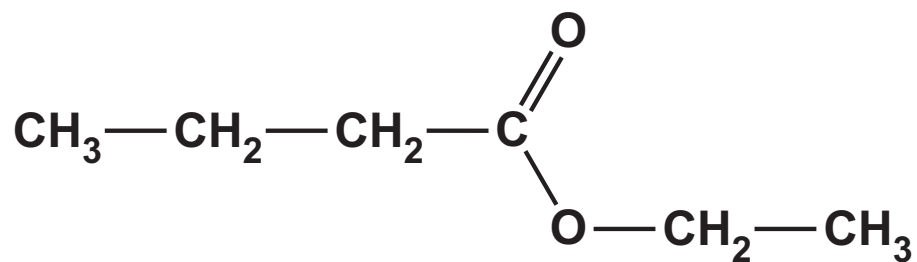
Write the word equation for a reaction which could be used to make this ester.

_____ **[3]**

[Total: 19]

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The Periodic Table of Elements

Group

Key

atomic number
atomic symbol
name
relative atomic mass

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 –		

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 dm³ at room temperature and pressure (r.t.p.).

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