



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
General Certificate of Education Ordinary Level

CANDIDATE  
NAME

CENTRE  
NUMBER

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CANDIDATE  
NUMBER

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**CHEMISTRY**

**5070/02**

Paper 2 Theory

**October/November 2008**

**1 hour 30 minutes**

Candidates answer on the Question Paper.

Additional Materials: Answer Booklet/Paper

**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 a soft pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

**Section A**

Answer **all** questions.

Write your answers in the spaces provided in the Question Paper.

**Section B**

Answer any **three** questions.

Write your answers on any lined pages and/or separate answer paper.

A copy of the Periodic Table is printed on page 20.

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.

For Examiner's Use	
<b>Section A</b>	
<b>B7</b>	
<b>B8</b>	
<b>B9</b>	
<b>B10</b>	
<b>Total</b>	

This document consists of **20** printed pages.



## Section A

Answer **all** the questions in this section in the spaces provided.

The total mark for this section is 45.

A1 The diagram shows part of the Periodic Table.

											He
						B	C	N	O	F	Ne
						Al	Si	P	S	Cl	Ar
	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
										I	Xe

Answer these questions using **only** the elements shown in the diagram.

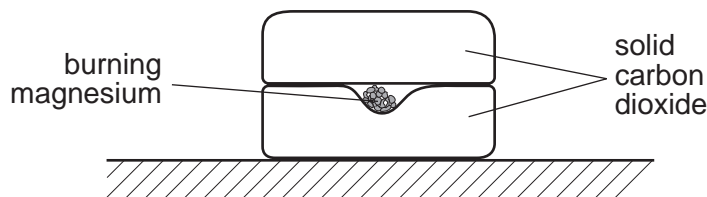
Each element can be used once, more than once or not at all.

Write the symbol for

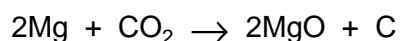
- (i) an element which is in Group 5 and Period 3,  [1]
- (ii) an element which is used as a gas in balloons,  [1]
- (iii) an element which forms ions in aqueous solution which give a white precipitate on reaction with aqueous silver nitrate,  [1]
- (iv) an element which forms an ion of type  $X^{3-}$ ,  [1]
- (v) an element which is a catalyst for the hydrogenation of alkenes,  [1]
- (vi) two elements which combine to form a compound which causes acid rain.  and  [1]

[Total: 6]

- A2** Several small pieces of magnesium are placed on a block of solid carbon dioxide. The carbon dioxide is at a temperature of  $-60^{\circ}\text{C}$ . The magnesium is ignited and another block of solid carbon dioxide is immediately placed on top.



A vigorous reaction is observed.



- (a)** Suggest what could be seen as the reaction proceeds to completion.

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

- (b)** Why is another block of solid carbon dioxide placed above the burning magnesium?

..... [1]

- (c)** State **one** factor in the experiment which slows down the reaction.

..... [1]

- (d)** When 2 moles of magnesium react with one mole of carbon dioxide, 810 kJ of energy are released.  
 Calculate the energy released when 2.0 g of magnesium reacts completely with carbon dioxide.

[2]

- (e) In a second experiment 6.0 g of magnesium and 4.4 g of carbon dioxide are used. Which solid, magnesium or carbon dioxide is in excess?  
Show your working.

[2]

- (f) Explain, in terms of the energy changes taking place in both bond-making and bond-breaking, why the reaction is exothermic.

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

[Total: 10]

**A3** Household waste can be disposed of by being dumped into landfill sites, recycled or incinerated. In a landfill site, bacteria break down vegetable waste to produce a mixture of gases.

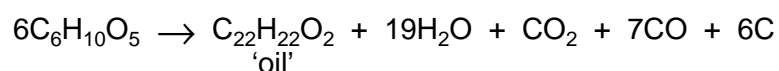
**(a)** Name **two** gases which are likely to be formed by this bacterial action.

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

**(b)** A small amount of butanoic acid is also formed by bacterial action in landfill sites. Draw the structure of butanoic acid.

[1]

**(c)** A type of 'oil' can be made from the cellulose in waste paper. The waste paper is heated at 350 °C under high pressure and in the presence of a nickel catalyst. The equation for this reaction is shown.



**(i)** State the function of a catalyst.

.....[1]

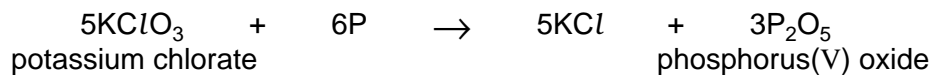
**(ii)** The 'oil',  $\text{C}_{22}\text{H}_{22}\text{O}_2$ , can be used for heating. Write an equation for the complete combustion of this 'oil'.

[2]

[Total: 6]

- A4** The head of a safety match contains potassium chlorate and antimony sulphide. The matchbox contains red phosphorus. When a match is struck on the side of the box, the friction produces enough heat to light the match.

(a) The equation for this reaction is shown.



Which is the oxidant and which is the reductant in this reaction?

Explain your answer.

oxidant .....

reductant .....

explanation .....

.....[2]

- (b) Phosphorus(V) oxide,  $\text{P}_2\text{O}_5$ , absorbs water from the air to form meta-phosphoric acid,  $\text{HPO}_3$ .

(i) Write an equation for this reaction.

[1]

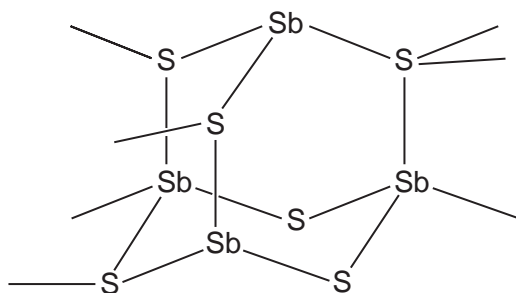
- (ii) On addition of more water, phosphoric acid is formed. Phosphoric acid has typical acidic properties. What would you observe when aqueous phosphoric acid is added to

aqueous sodium carbonate, .....

blue litmus paper? .....

[2]

(c) Part of the chain structure of antimony sulphide is shown below.

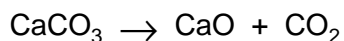


Deduce the empirical formula of antimony sulphide.

..... [1]

[Total: 6]

- A5** Cement is made by heating clay with crushed calcium carbonate. During this process calcium carbonate is first converted to calcium oxide.



- (a) (i) What name is given to this type of chemical reaction?

.....[1]

- (ii) Suggest why calcium oxide is used to neutralise acidic soils.

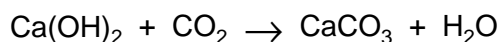
.....[1]

- (b) Concrete is made from cement, sand and water. When set, concrete is slightly porous. When rain water soaks through concrete, some of the uncombined calcium oxide dissolves to form calcium hydroxide.

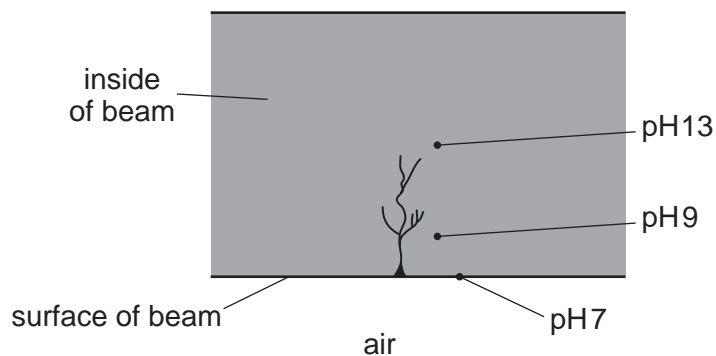
- (i) Write an equation for this reaction.

[1]

- (ii) The aqueous calcium hydroxide in wet concrete reacts with carbon dioxide in the air.



The diagram shows the pH at various points inside a cracked concrete beam.

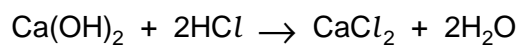


Describe and explain the change in pH from the surface to the centre of the beam.

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



- (iii) 25.0 cm<sup>3</sup> of an aqueous solution of calcium hydroxide is exactly neutralised by 18.0 cm<sup>3</sup> of 0.040 mol/dm<sup>3</sup> hydrochloric acid.



Calculate the concentration, in mol/dm<sup>3</sup>, of the aqueous calcium hydroxide.

concentration = .....mol/dm<sup>3</sup> [3]

[Total: 9]

**A6** Electrolysis is used to produce many important chemicals such as chlorine, sodium hydroxide and aluminium.

**(a)** Chlorine is used in both water treatment and as a bleach.

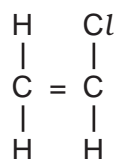
**(i)** Why is chlorine used in water treatment?

..... [1]

**(ii)** Name a substance, other than chlorine, that is used to bleach wood pulp.

..... [1]

**(b)** Chlorine is used to make chloroethene.



Chloroethene can be polymerised to form poly(chloroethene).

Draw a section of a poly(chloroethene) chain to show at least two repeating units.

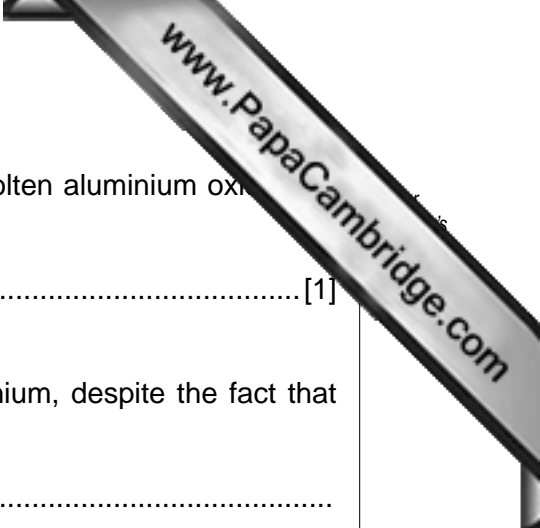
[1]

**(c)** In the production of aluminium, sodium hydroxide is used to separate aluminium oxide from the impurities in the bauxite ore. The main impurity in the ore is iron(III) oxide. Aluminium oxide is an amphoteric oxide whilst iron(III) oxide is a basic oxide. Suggest how these two oxides can be separated by the addition of aqueous sodium hydroxide.

.....

.....

..... [2]



(d) Aluminium is extracted by the electrolysis of a mixture of molten aluminium oxide and cryolite. What is the function of the cryolite?

..... [1]

(e) Acidic foods can be safely packed in aluminium containers.  
Explain why the acid in the food does not attack the aluminium, despite the fact that aluminium is a reactive metal.

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

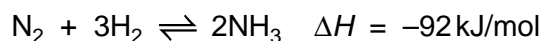
[Total: 8]

## Section B

Answer **three** questions from this section.

The total mark for this section is 30.

**B7** Ammonia is made by the Haber process using an iron catalyst.



- (a) On the same axes draw energy profile diagrams to show both the catalysed and the uncatalysed reaction. Label the diagram to show
- the catalysed and uncatalysed reactions,
  - the reactants and products,
  - the enthalpy change for the reaction. [3]
- (b) The raw materials for the Haber process can be obtained from the air and from hydrocarbons produced by the distillation of petroleum.
- (i) Describe how pure nitrogen can be separated from other gases in the air. [1]
- (ii) Describe how hydrogen can be made from hydrocarbons. [2]
- (c) Explain how the position of equilibrium in the Haber process is altered by
- (i) an increase in pressure, [2]
- (ii) an increase in temperature. [2]

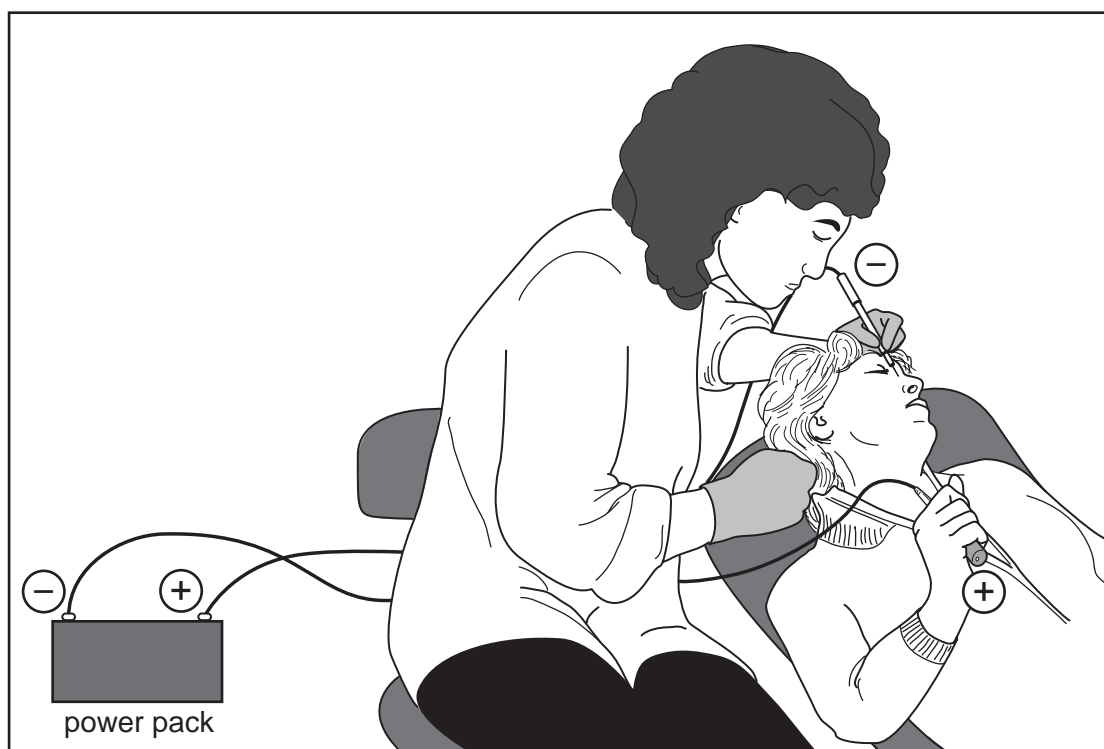
[Total: 10]

**B8** Sorrel is a small green plant.

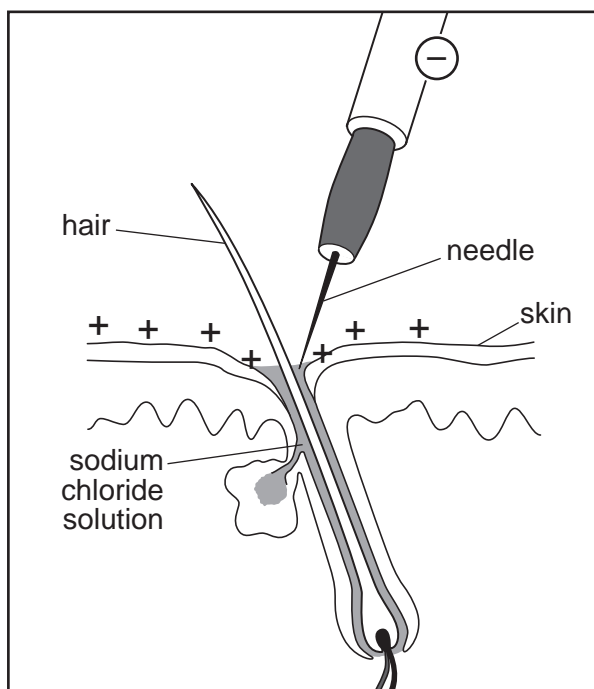
- (a) The pigments in the sorrel leaf can be separated by chromatography.
- (i) Describe how chromatography can be used to separate different pigments. [1]
  - (ii) Explain what is meant by  $R_f$  value. [1]
- (b) Sorrel plants contain a poisonous carboxylic acid **X**.  
What can be deduced about **X** from each of the following three pieces of information?
- (i) When **X** is warmed with acidified potassium manganate(VII), the solution changes from pink to colourless. [1]
  - (ii) Aqueous bromine is not decolourised when added to a solution of **X**. [1]
  - (iii) A  $0.1 \text{ mol/dm}^3$  solution of **X** has a pH of 3 whereas a  $0.1 \text{ mol/dm}^3$  solution of hydrochloric acid has a pH of 1. [1]
- (c) Analysis of 10.0 g of carboxylic acid **X** shows that it contains 2.67 g carbon, 0.220 g hydrogen and 7.11 g oxygen.
- (i) Deduce the empirical formula of **X**. [3]
  - (ii) The relative molecular mass of **X** is 90. Deduce the molecular formula of **X**. [1]

[Total: 10]

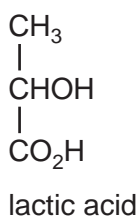
- B9** Electrolysis can be used to remove unwanted hair. The customer holds a metal bar with a positive electrode. A needle, which acts as the negative electrode, is held by the operator.



- (a) What do you understand by the term *electrolysis*? [1]
- (b) The solution around the tip of the needle is mainly a dilute aqueous solution of sodium chloride.



- (i) Name all the ions present in the solution during this electrolysis. [1]
- (ii) During electrolysis a small amount of chlorine is formed at the surface of the skin. Write an ionic equation for this reaction. [1]
- (iii) During electrolysis, a gas forms at the tip of the needle and the solution changes from pH 7 to pH 10. Explain both these changes. [2]
- (c) Explain why aqueous sodium chloride solution conducts electricity but solid sodium chloride does not. [2]
- (d) The sweat glands in the skin produce small amounts of lactic acid.



Lactic acid reacts with ethanol to form an ester.

- (i) State the conditions needed to form an ester. [2]
- (ii) Draw the structure of the ester produced by the reaction of lactic acid with ethanol. [1]

[Total: 10]

**B10** Radioactive iodine is used to treat some cancerous tumours.

- (a) Two radioactive isotopes of iodine are  $^{125}_{53}\text{I}$  and  $^{131}_{53}\text{I}$ .

For each isotope state the type and number of subatomic particles present.

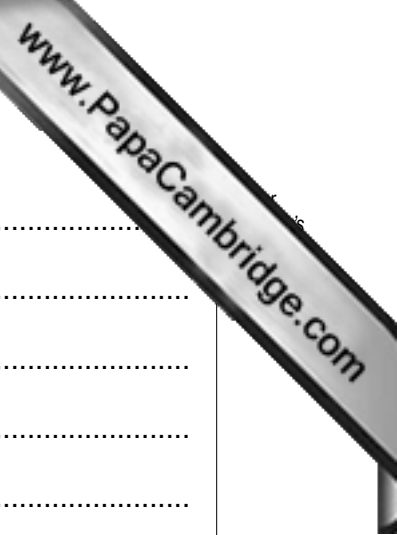
- (b) Name a reagent that reacts with iodide ions to form iodine molecules.  
Describe the colour change that occurs in this reaction. [2]
- (c) Zinc can reduce iodine to iodide ions.  
Write an ionic equation for this reaction. [2]
- (d) In cancer treatment, the radioactive iodine can be injected into the tumour with a titanium needle.
- (i) Titanium is a transition element. State **three** characteristic properties of transition elements. [2]
- (ii) An oxide of titanium is formed from  $\text{Ti}^{3+}$  ions and oxide ions.  
Deduce the formula of this compound. [1]
- (iii) Titanium(IV) chloride,  $\text{TiCl}_4$ , reacts with water to form titanium(IV) oxide,  $\text{TiO}_2$ , and hydrogen chloride. Write an equation for this reaction. [1]

[Total: 10]





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A series of horizontal dotted lines spanning the width of the page, intended for writing an answer.

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**DATA SHEET**  
**The Periodic Table of the Elements**

		Group												
I	II	III	IV	V	VI	VII	0							
7 <b>Li</b> Lithium 4	9 <b>Be</b> Beryllium 4	1 <b>H</b> Hydrogen 1	11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	14 <b>N</b> Nitrogen 7	16 <b>O</b> Oxygen 8	19 <b>F</b> Fluorine 9	20 <b>Ne</b> Neon 10						
23 <b>Na</b> Sodium 12	24 <b>Mg</b> Magnesium 12	27 <b>Al</b> Aluminium 13	28 <b>Si</b> Silicon 14	31 <b>P</b> Phosphorus 15	32 <b>S</b> Sulphur 16	35.5 <b>Cl</b> Chlorine 17	40 <b>Ar</b> Argon 18							
39 <b>K</b> Potassium 20	40 <b>Ca</b> Calcium 20	45 <b>Sc</b> Scandium 21	48 <b>Ti</b> Titanium 22	55 <b>Mn</b> Manganese 25	59 <b>Co</b> Cobalt 27	59 <b>Ni</b> Nickel 28	64 <b>Cu</b> Copper 29	65 <b>Zn</b> Zinc 30	73 <b>Ge</b> Germanium 32	75 <b>As</b> Arsenic 33	79 <b>Se</b> Selenium 34	84 <b>Kr</b> Krypton 36		
85 <b>Rb</b> Rubidium 38	88 <b>Sr</b> Strontium 38	89 <b>Y</b> Yttrium 39	91 <b>Zr</b> Zirconium 40	101 <b>Ru</b> Ruthenium 44	103 <b>Rh</b> Rhodium 45	106 <b>Pd</b> Palladium 46	108 <b>Ag</b> Silver 47	112 <b>Cd</b> Cadmium 48	119 <b>Sn</b> Tin 50	122 <b>Sb</b> Antimony 51	128 <b>Te</b> Tellurium 52	131 <b>Xe</b> Xenon 54		
133 <b>Cs</b> Caesium 56	137 <b>Ba</b> Barium 56	139 <b>La</b> Lanthanum 57	178 <b>Hf</b> Hafnium 72	186 <b>Os</b> Osmium 76	192 <b>Ir</b> Iridium 77	195 <b>Pt</b> Platinum 78	197 <b>Au</b> Gold 79	201 <b>Hg</b> Mercury 80	207 <b>Pb</b> Lead 82	209 <b>Bi</b> Bismuth 83	209 <b>Po</b> Polonium 84	222 <b>Rn</b> Radon 86		
223 <b>Fr</b> Francium 88	226 <b>Ra</b> Radium 88	227 <b>Ac</b> Actinium 89												

140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	147 <b>Pm</b> Promethium 61	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	157 <b>Gd</b> Gadolinium 64	162 <b>Dy</b> Dysprosium 66	165 <b>Ho</b> Holmium 67	167 <b>Er</b> Erbium 68	169 <b>Tm</b> Thulium 69	175 <b>Lu</b> Lutetium 71
232 <b>Th</b> Thorium 90	231 <b>Pa</b> Protactinium 91	238 <b>U</b> Uranium 92	237 <b>Np</b> Neptunium 93	244 <b>Pu</b> Plutonium 94	243 <b>Am</b> Americium 95	247 <b>Cm</b> Curium 96	251 <b>Cf</b> Californium 98	252 <b>Es</b> Einsteinium 99	257 <b>Fm</b> Fermium 100	258 <b>Md</b> Mendelevium 101	260 <b>Lr</b> Lawrencium 103
159 <b>Tb</b> Terbium 65	159 <b>Tb</b> Terbium 65	159 <b>Tb</b> Terbium 65	159 <b>Tb</b> Terbium 65	159 <b>Tb</b> Terbium 65	159 <b>Tb</b> Terbium 65	159 <b>Tb</b> Terbium 65	159 <b>Tb</b> Terbium 65	159 <b>Tb</b> Terbium 65	159 <b>Tb</b> Terbium 65	159 <b>Tb</b> Terbium 65	159 <b>Tb</b> Terbium 65

a	<b>X</b>	b
y		

a = relative atomic mass  
 X = atomic symbol  
 b = atomic (proton) number

8–71 Lanthanoid series  
90–103 Actinoid series

The volume of one mole of any gas is 24dm<sup>3</sup> at room temperature and pressure (r.t.p.).