



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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CHEMISTRY

0620/21

Paper 2

May/June 2013

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 need to use a 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.

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.

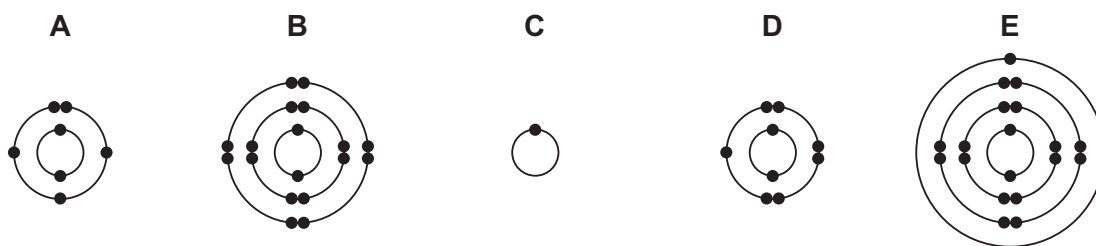
At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

This document consists of **15** printed pages and **1** blank page.



- 1 The electronic structures of five atoms of different elements, **A**, **B**, **C**, **D** and **E**, are shown below.



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

(a) Which structure

(i) is in Period 4 of the Periodic Table,

(ii) is a noble gas,

(iii) is in Group II of the Periodic Table,

(iv) has five electrons in its outer shell,

(v) has a proton (atomic) number of 7,

(vi) represents a fluorine atom?

[6]

(b) Complete the following sentences about elements using words from the list below.

alkali atom covalent ion
monatomic three transition two

An element is a substance containing only one type of

The Group VII elements exist as molecules containing atoms.

Carbon has a giant structure with many strong bonds.

Elements such as iron and copper, which form coloured compounds, are called elements. [4]

[Total: 10]

2 The table below shows some properties of the Group I elements.

| metal | density in g/cm ³ | melting point/°C | boiling point/°C |
|-----------|------------------------------|------------------|------------------|
| lithium | 0.53 | 181 | 1342 |
| sodium | 0.97 | 98 | 883 |
| potassium | 0.86 | 63 | |
| rubidium | 1.53 | 39 | 686 |
| caesium | 1.88 | 29 | 669 |

(a) Use the information in the table to explain why caesium is a liquid when the temperature is 34 °C.

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

(b) Suggest a value for the boiling point of potassium.

..... °C [1]

(c) (i) Describe the **general** trend in density down the group.

..... [1]

(ii) Which element does **not** follow this trend?

..... [1]

(d) State **three** physical properties of potassium, other than density, melting point and boiling point.

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

(e) Potassium reacts with water. The products are potassium hydroxide and hydrogen.

(i) Describe **two** observations when potassium reacts with water.

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

(ii) Complete the symbol equation for this reaction.



[Total: 11]

- 3 (a) Match the name of the homologous series on the left with its formula on the right. The first one has been done for you.

| | |
|-----------------|------------|
| halogenoalkane | C_2H_6 |
| alkane | CH_3COOH |
| alkene | C_2H_5OH |
| alcohol | C_2H_5Cl |
| carboxylic acid | C_2H_4 |

[4]

- (b) Draw the full structural formula of the compound, C_2H_6 , showing all atoms and bonds.

[1]

- (c) The compound with the formula C_2H_4 is an unsaturated hydrocarbon. Describe the difference between a saturated and an unsaturated hydrocarbon in terms of the bonds they contain.

.....

..... [2]

- (d) Describe a test to distinguish between a saturated and unsaturated hydrocarbon.

test

result with saturated hydrocarbon

.....

result with unsaturated hydrocarbon

..... [3]

[Total: 10]

4 Farmers spread fertilisers on the soil where crops are to be grown.

(a) Why do farmers use fertilisers? In your answer, include

- the names of the essential elements present in most fertilisers,
- the reasons why farmers use fertilisers.

.....

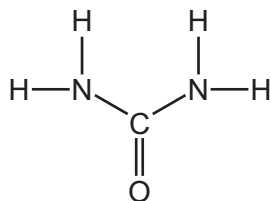
.....

.....

.....

..... [4]

(b) Urea can be used as a fertiliser.
The structure of urea is shown below.




(i) Deduce the molecular formula of urea.

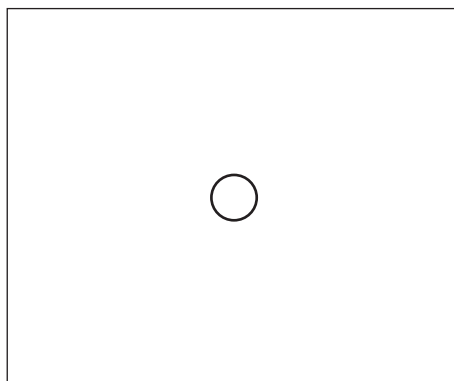
..... [1]

(ii) Calculate the relative molecular mass of urea. You must show all your working.

[2]

- (c) Urea is a solid at room temperature. Complete the diagram below to show the arrangement of the molecules in solid urea.

Show a molecule of urea as 



[2]

- (d) When urea is heated with an alkali, ammonia is given off.
Describe a test for ammonia.

test

result [2]

[Total: 11]

- 5 The table shows some properties of four substances, **A**, **B**, **C** and **D**.

For
Examiner's
Use

| substance | melting point/°C | does the solid conduct electricity? | does a solution of the solid conduct electricity? |
|-----------|------------------|-------------------------------------|---|
| A | 962 | yes | does not dissolve |
| B | 747 | no | dissolves and conducts |
| C | 113 | no | does not dissolve |
| D | 3550 | no | does not dissolve |

- (a) Which one of these substances has

(i) a giant covalent structure,

(ii) a simple molecular structure,

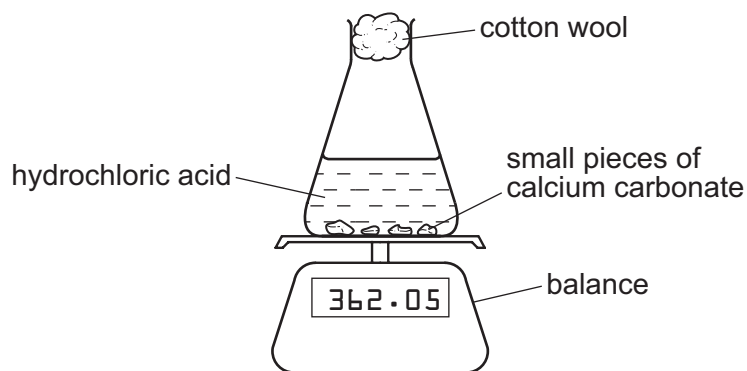
(iii) a metallic structure?

[3]

- (b) A student carried out an experiment to determine the rate of reaction of calcium carbonate with excess hydrochloric acid.



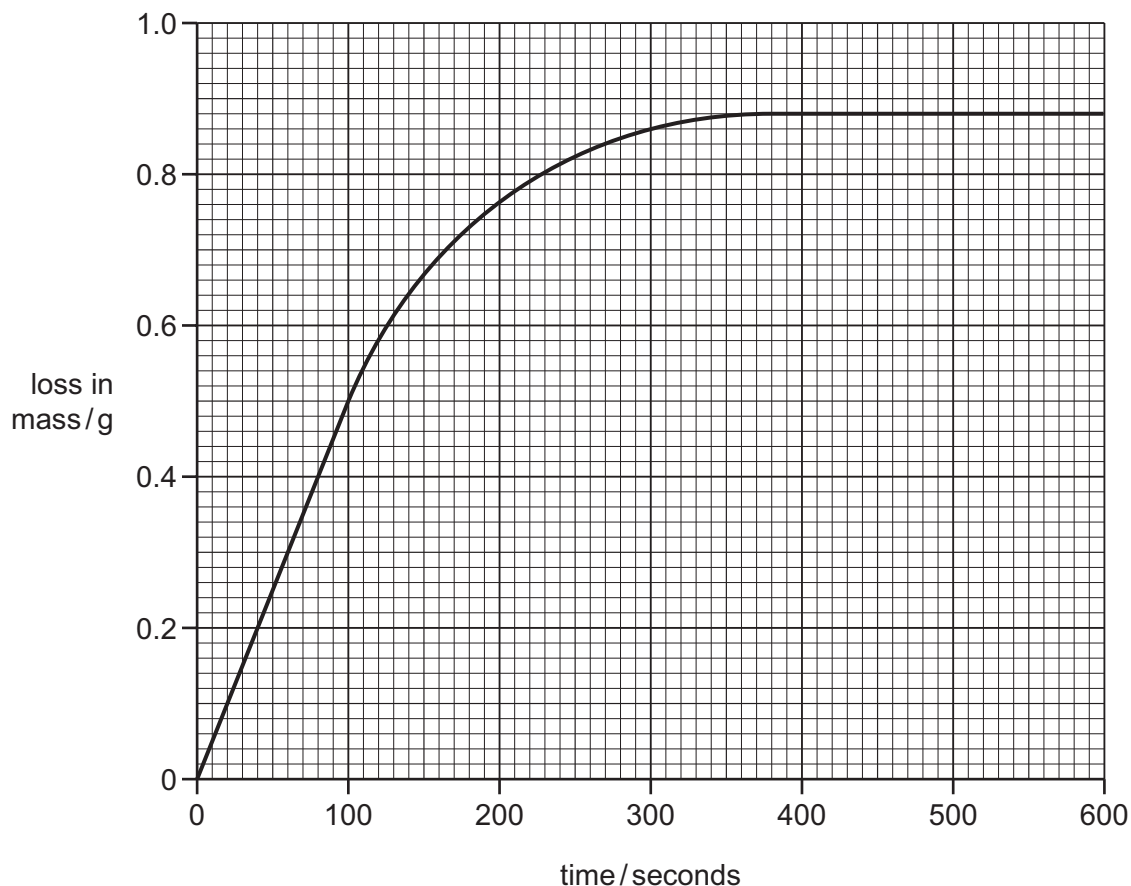
He recorded the loss of mass of the reaction mixture over a period of time.



- (i) Explain why the reaction mixture decreases in mass.

..... [1]

He carried out the reaction at constant temperature using 2 g of calcium carbonate in small pieces. The hydrochloric acid was in excess.
He plotted his results on a grid. This is shown below.



(ii) At what time has the reaction just finished?

..... s [1]

(iii) From the graph, deduce the loss in mass in the first 100 seconds.

..... g [1]

(iv) The student repeated the experiment keeping everything the same except for the size of the pieces of calcium carbonate. He used smaller pieces of calcium carbonate but the mass used was the same.

On the grid above, draw a line to show how the loss of mass changes with time when smaller pieces of calcium carbonate are used. [2]

(v) State the effect of increasing the concentration of hydrochloric acid on the rate (speed) of this reaction when all other factors remain constant.

..... [1]

[Total: 9]

- 6 (a) Propanol is a solvent.
Sugar is soluble in propanol. Salt (sodium chloride) is insoluble in propanol.
A student wants to separate a mixture of solid salt and solid sugar.

- (i) Describe how she could separate the salt from the sugar.
You may draw a labelled diagram to help you answer this question.

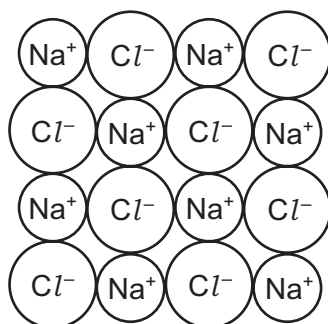
.....

 [3]

- (ii) Describe how the student could obtain solid sodium chloride from a solution of sodium chloride in water.

..... [1]

- (b) The diagram shows the structure of sodium chloride.



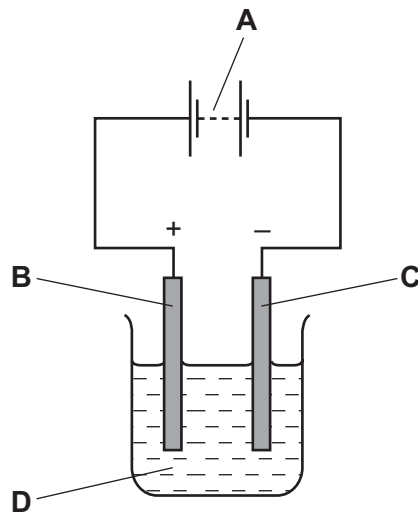
- (i) Deduce the simplest formula for sodium chloride.

..... [1]

- (ii) What type of bonding is present in sodium chloride?
Put a ring around the correct answer.

covalent ionic metallic weak [1]

- (c) The diagram shows the apparatus used to electrolyse a concentrated aqueous solution of sodium chloride.



- (i) Which letter on the diagram, **A**, **B**, **C** or **D**, represents the electrolyte?

..... [1]

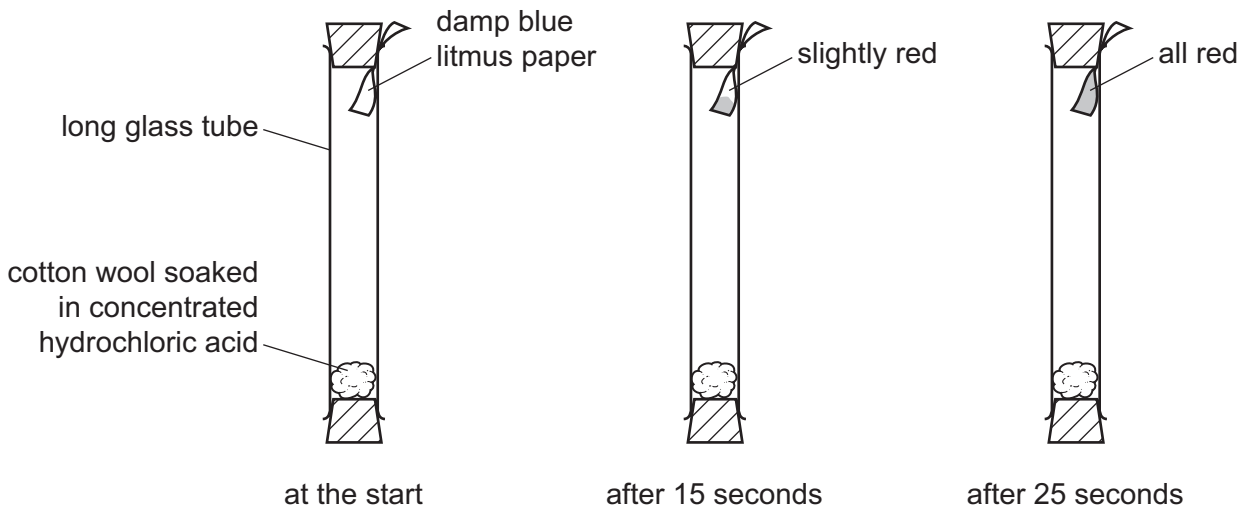
- (ii) Name the product formed at

the positive electrode,

the negative electrode. [2]

[Total: 9]

- 7 (a) A student set up the apparatus shown below.
The concentrated hydrochloric acid gives off hydrogen chloride gas.
After 15 seconds, the damp blue litmus paper begins to turn red.
After 25 seconds, the litmus paper has turned completely red.



Use ideas about moving particles to explain these observations.

.....

.....

.....

.....

..... [4]

- (b) Hydrogen chloride reacts with ammonia to form a salt which has the formula NH_4Cl .
State the name of this salt.

..... [1]

- (c) (i) Hydrochloric acid reacts with iron to form iron(II) chloride and hydrogen.
Write a word equation for this reaction.

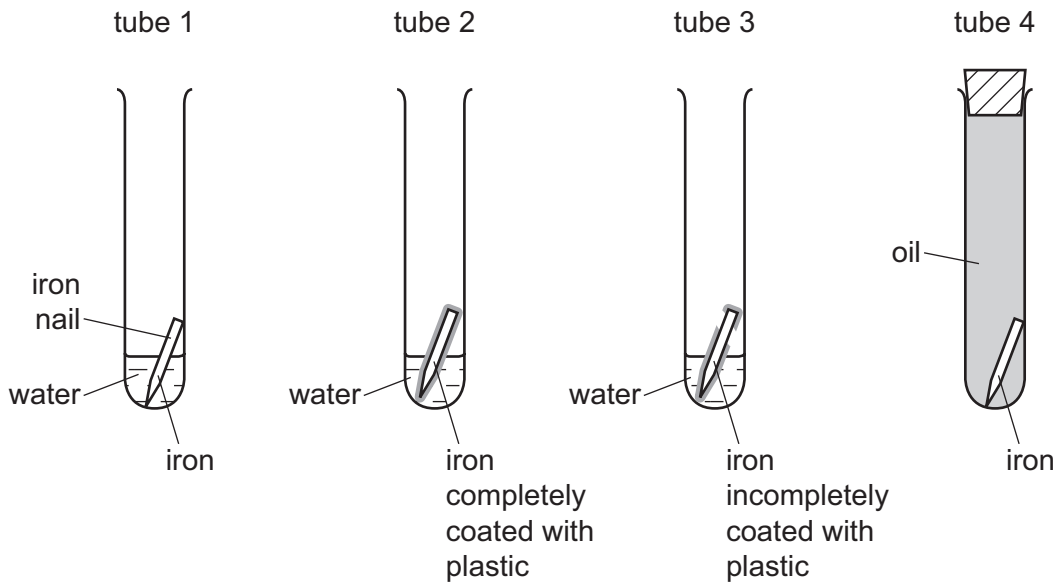
..... [1]

- (ii) Describe a test for iron(II) ions.

test

result [2]

(d) A student investigates various methods of protecting iron from rusting. She sets up four tubes as shown in the diagram below.



(i) Tube 1 contains unprotected iron. What is the purpose of this experiment?
 [1]

(ii) State the names of the **two** substances needed for iron to rust.
 and [2]

(iii) Explain why the iron in tube 4 does **not** rust.

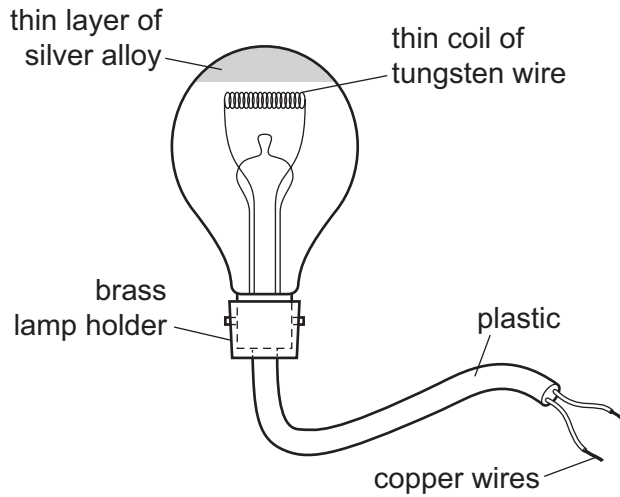
 [1]

(iv) Explain why the iron in tube 3 eventually rusts.

 [1]

[Total: 13]

8 The diagram shows a silvered light bulb.



Some properties of metals used in the light bulb are shown in the table below.

| metal | hardness | electrical conductivity | melting point /°C | price /\$ per tonne |
|----------|-------------|-------------------------|-------------------|---------------------|
| brass | hard | good | about 1000 | 7 000 |
| copper | fairly soft | very good | 1083 | 9 600 |
| silver | fairly soft | very good | 962 | 1 300 000 |
| tungsten | hard | good | 3410 | 450 |

(a) (i) Suggest why copper rather than tungsten is used for electrical wiring?

..... [1]

(ii) Suggest why silver is **not** used for electrical wiring.

..... [1]

(iii) Suggest **two** reasons why tungsten rather than copper is used to make the bulb filament.

reason 1

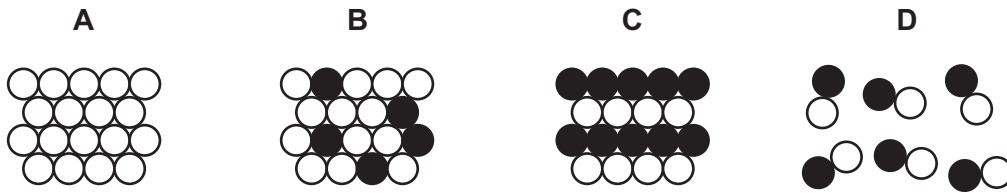
reason 2 [2]

(iv) Explain why the copper wires are covered with plastic.

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

(b) Brass is an alloy.

Which one of the following diagrams, **A**, **B**, **C** or **D**, best represents an alloy?



..... [1]

[Total: 7]

DATA SHEET
The Periodic Table of the Elements

| | | Group | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| I | II | III | IV | V | VI | VII | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 Li Lithium 3 | 9 Be Beryllium 4 | 1 H Hydrogen 1 | 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 | 48 Ti Titanium 22 | 51 V Vanadium 23 | 55 Mn Manganese 25 | 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 | 91 Zr Zirconium 40 | 93 Nb Niobium 41 | 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 | 178 Hf Hafnium 72 | 181 Ta Tantalum 73 | 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 | 210 Po Polonium 84 | 210 At Astatine 85 | 210 Rn Radon 86 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 87 Fr Francium | 226 Ra Radium | 227 Ac Actinium | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | *58-71 Lanthanoid series †90-103 Actinoid series | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <td style="width: 5%;"></td> <td style="width: 5%;">a</td> <td style="width: 5%;"></td> <td style="width: 5%;">X</td> <td style="width: 5%;"></td> <td style="width: 5%;">b</td> </tr> <tr> <td style="text-align: right;">Key</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </table> | | | | | | | | | | | a | | X | | b | Key | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | a | | X | | b | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Key | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <td style="width: 5%;"></td> <td style="width: 5%;">140</td> <td style="width: 5%;">141</td> <td style="width: 5%;">144</td> <td style="width: 5%;">150</td> <td style="width: 5%;">152</td> <td style="width: 5%;">157</td> <td style="width: 5%;">159</td> <td style="width: 5%;">162</td> <td style="width: 5%;">165</td> <td style="width: 5%;">167</td> <td style="width: 5%;">169</td> <td style="width: 5%;">173</td> <td style="width: 5%;">175</td> </tr> <tr> <td></td> <td>Ce</td> <td>Pr</td> <td>Nd</td> <td>Sm</td> <td>Eu</td> <td>Gd</td> <td>Tb</td> <td>Dy</td> <td>Ho</td> <td>Er</td> <td>Tm</td> <td>Yb</td> <td>Lu</td> </tr> <tr> <td></td> <td>Cerium</td> <td>Praseodymium</td> <td>Neodymium</td> <td>Samarium</td> <td>Europlum</td> <td>Gadolinium</td> <td>Terbium</td> <td>Dysprosium</td> <td>Holmium</td> <td>Erbium</td> <td>Thulium</td> <td>Ytterbium</td> <td>Lutetium</td> </tr> <tr> <td></td> <td>58</td> <td>59</td> <td>60</td> <td>62</td> <td>63</td> <td>64</td> <td>65</td> <td>66</td> <td>67</td> <td>68</td> <td>69</td> <td>70</td> <td>71</td> </tr> <tr> <td></td> <td>232</td> <td>232</td> <td>238</td> <td>238</td> <td>238</td> <td>238</td> <td>238</td> <td>238</td> <td>238</td> <td>238</td> <td>238</td> <td>238</td> <td>238</td> </tr> <tr> <td></td> <td>Th</td> <td>Pa</td> <td>U</td> <td>Pu</td> <td>Am</td> <td>Cm</td> <td>Bk</td> <td>Cf</td> <td>Es</td> <td>Fm</td> <td>Md</td> <td>No</td> <td>Lr</td> </tr> <tr> <td></td> <td>Thorium</td> <td>Protactinium</td> <td>Uranium</td> <td>Plutonium</td> <td>Americium</td> <td>Curium</td> <td>Berkelium</td> <td>Californium</td> <td>Einsteinium</td> <td>Fermium</td> <td>Mendelevium</td> <td>Nobelium</td> <td>Lawrencium</td> </tr> <tr> <td></td> <td>90</td> <td>91</td> <td>92</td> <td>94</td> <td>95</td> <td>96</td> <td>97</td> <td>98</td> <td>99</td> <td>100</td> <td>101</td> <td>102</td> <td>103</td> </tr> </table> | | | | | | | | | | | 140 | 141 | 144 | 150 | 152 | 157 | 159 | 162 | 165 | 167 | 169 | 173 | 175 | | Ce | Pr | Nd | Sm | Eu | Gd | Tb | Dy | Ho | Er | Tm | Yb | Lu | | Cerium | Praseodymium | Neodymium | Samarium | Europlum | Gadolinium | Terbium | Dysprosium | Holmium | Erbium | Thulium | Ytterbium | Lutetium | | 58 | 59 | 60 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | | 232 | 232 | 238 | 238 | 238 | 238 | 238 | 238 | 238 | 238 | 238 | 238 | 238 | | Th | Pa | U | Pu | Am | Cm | Bk | Cf | Es | Fm | Md | No | Lr | | Thorium | Protactinium | Uranium | Plutonium | Americium | Curium | Berkelium | Californium | Einsteinium | Fermium | Mendelevium | Nobelium | Lawrencium | | 90 | 91 | 92 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 |
| | 140 | 141 | 144 | 150 | 152 | 157 | 159 | 162 | 165 | 167 | 169 | 173 | 175 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Ce | Pr | Nd | Sm | Eu | Gd | Tb | Dy | Ho | Er | Tm | Yb | Lu | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Cerium | Praseodymium | Neodymium | Samarium | Europlum | Gadolinium | Terbium | Dysprosium | Holmium | Erbium | Thulium | Ytterbium | Lutetium | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 58 | 59 | 60 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 232 | 232 | 238 | 238 | 238 | 238 | 238 | 238 | 238 | 238 | 238 | 238 | 238 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Th | Pa | U | Pu | Am | Cm | Bk | Cf | Es | Fm | Md | No | Lr | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Thorium | Protactinium | Uranium | Plutonium | Americium | Curium | Berkelium | Californium | Einsteinium | Fermium | Mendelevium | Nobelium | Lawrencium | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 90 | 91 | 92 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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

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