

Candidate Name _____

Centre Number		Candidate Number									

EXAMINATIONS COUNCIL OF ZAMBIA

Examination for School Certificate Ordinary Level

Chemistry Paper 2 Theory

5070/2

Friday

4 NOVEMBER 2016

Candidates answer on the question paper

Additional Information:

Mathematical tables/Calculators (non-programmable)

Graph paper

Time 2 hours

Instructions to Candidates

Write your **name, centre number and candidate number** in the spaces at the top of this page and on any separate answer paper used.

There are **twelve (12) questions** in this paper.

Section A

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

Section B

Answer any **three** questions.

Write your answers in the separate Answer Booklet provided.

At the end of the examination, fasten your Answer Booklets securely to the question paper.

Information for Candidates

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

The **Periodic Table** is printed on page 12.

Cell phones are not allowed in the examination room.

FOR EXAMINER'S USE	
Section A	
Section B	
B9	
B10	
B11	
B12	
TOTAL	

Section A: [50 marks]

Answer all questions in the spaces provided.

- A1 (a)** One of the laboratory rules reads as follows:
DO NOT EAT ANYTHING IN THE LABORATORY

(i) Explain why this rule is important

.....
.....

(ii) State one other laboratory safety rule.

.....
.....

[3]

- (b)** Important skills which a chemist needs to have include correct measurement of quantities and choosing correct pieces of apparatus/equipment for carrying out some experimental procedures. State the name of a piece of apparatus which can be used to

(i) measure accurately a volume of 0.6cm^3 .

.....

(ii) measure the mass of a cooking oil sample.

.....

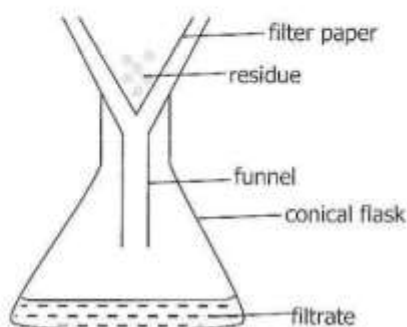
(iii) hold 50cm^3 of solution during a chemical reaction.

.....

[3]

[Total 6]

- A2** A soil sample was added to aqueous copper (II) sulphate solution forming a brown mixture. The mixture was filtered using the experimental set up shown below.



(a) State the

(i) name of the residue

.....

(ii) name of the filtrate

.....

(iii) colour of the filtrate

.....

[3]

(b) The copper (II) sulphate solution is a mixture of two compounds.

(i) Name the two compounds present in the copper (II) sulphate solution.

..... and

(ii) Describe in outline how the two compounds in the copper (II) sulphate solution can be separated.

.....

.....

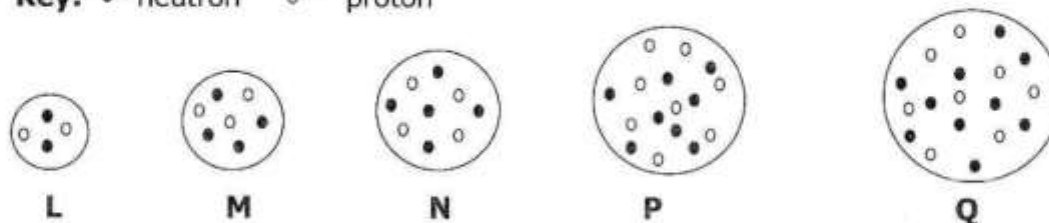
.....

[4]

[Total 7]

A3 The diagrams show the nuclei of 5 different atoms.

Key: • - neutron ○ - proton



(a) Which atom has

(i) an atomic number of 4?

..... [1]

(ii) mass number of 7?

..... [1]

(b) Using the letters **M** and **Q**, write the chemical formula of the compound formed if the atoms that contain nuclei **M** and **Q** reacted.

..... [1]

(c) What type of bond is formed for the reaction in **(b)** above?

..... [1]

(d) Which two letters represent nuclei of atoms which are isotopes?

..... [1]

[Total 5]

A4 10.00g of brass powder was added to excess dilute sulphuric acid and all the zinc reacted with the acid leaving a residue of copper. 1200cm³ of hydrogen gas measured at r.t.p was produced in the reaction of zinc and dilute sulphuric acid. After crystallizing the resulting zinc sulphate solution, 10.76g of hydrated zinc sulphate crystals, ZnSO₄•6H₂O were obtained.

(a) Write a balanced chemical equation for the reaction of zinc powder with dilute sulphuric acid. Include state symbols.

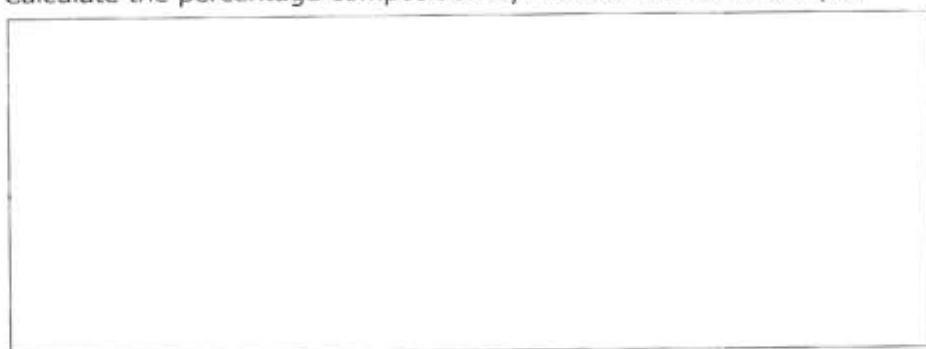
..... [1]

- (b) What mass of zinc was present in the 10.00g of brass powder?



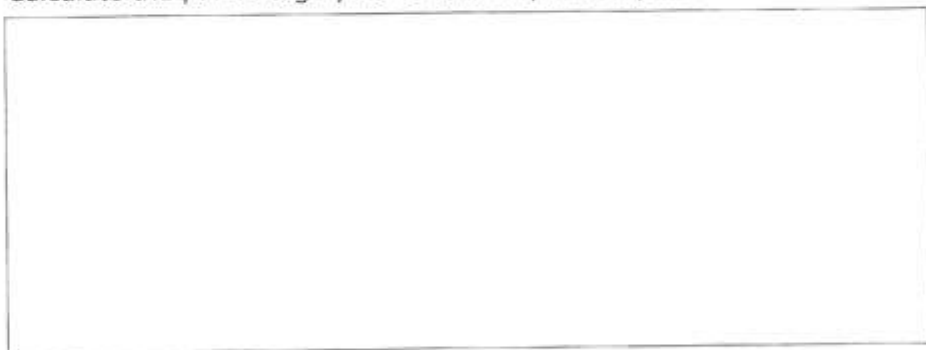
[2]

- (c) Calculate the percentage composition by mass of the brass sample.



[2]

- (d) Calculate the percentage yield of zinc sulphate crystals.



[3]

[Total 8]

A5 (a) Fluorine, chlorine, bromine and iodine are placed in the same Group of the Periodic Table.

(i) State the common name used to describe elements in this Group.

.....

(ii) State the Group in which the elements are placed and explain why they are placed in that Group.

.....

(iii) Which of the above named elements is a solid at room temperature and pressure?

..... [4]

(b) Chlorine reacts with sodium bromide to give sodium chloride and bromine according to the equation below.



(i) Explain why the above reaction is possible.

.....
.....

(ii) What would be observed during this reaction?

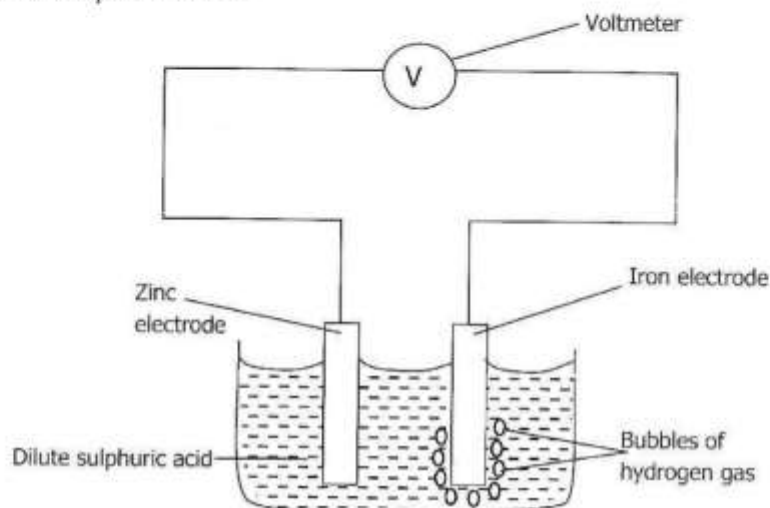
.....
.....

(iii) Construct an ionic equation for the reaction above.

..... [4]

[Total 8]

- A6** The diagram below shows an electrochemical cell made using zinc and iron dipped in dilute sulphuric acid.



- (a)** What is the overall energy change which occurs in the electrochemical cell? Does this represent an endothermic or an exothermic process?

.....

[2]

- (b)** To increase the voltage of the above cell, either the zinc rod or the iron rod can be replaced by another metal rod. Name a suitable metal which can be used in place of the

- (i)** zinc rod.

.....

- (ii)** iron rod.

.....

[2]

- (c)** Write an equation for the reaction occurring at the iron electrode.

.....

[1]

[Total 5]



The equation above shows a redox reaction used to prepare chlorine gas in the laboratory.

(a) What is meant by a redox reaction?

..... [1]

(b) Calculate the oxidation number of chlorine in HCl and explain why a change from HCl to Cl_2 is an oxidation process.

.....

 [2]

(c) (i) Calculate the oxidation number of manganese, Mn in KMnO_4 and MnCl_2 .

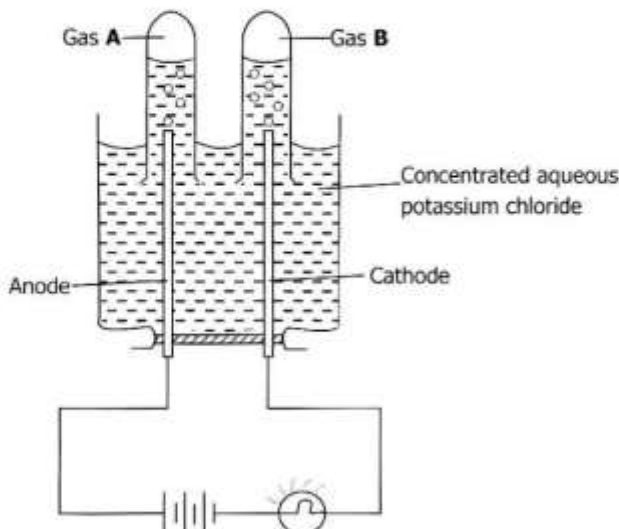
.....

(ii) Is a change from KMnO_4 to MnCl_2 oxidation or reduction?

..... [3]

[Total 6]

A8 The diagram below shows apparatus used to electrolyse concentrated potassium chloride.



- (a) Suggest a suitable material for the electrodes
 [1]
- (b) Write an ionic equation to show the formation of gas
 (i) A.....
 (ii) B..... [2]
- (c) Explain why potassium metal is not formed at the cathode in this electrolysis.

 [1]
- (d) Write the overall equation for the electrolysis of concentrated aqueous potassium chloride.
 [1]

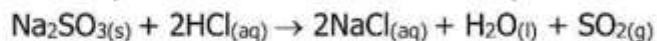
[Total 5]

Section B (30 marks)**Answer three questions from this section.****Write your answers in the Answer Booklet provided.**

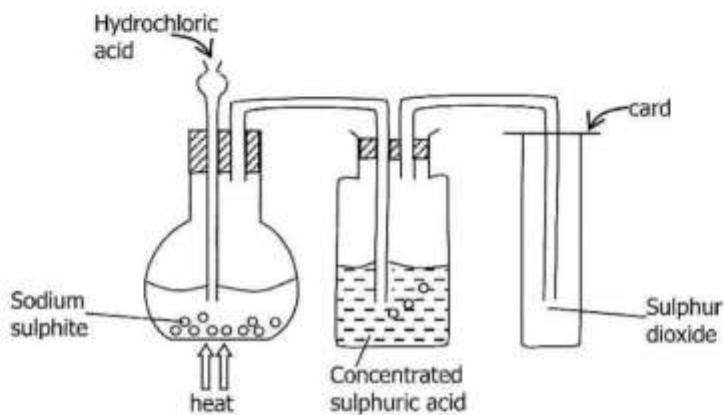
- B9 (a)** Copper (II) sulphate crystals can be prepared in the laboratory by reacting copper (II) carbonate with a dilute acid.
- (i) Name the dilute acid which reacts with copper (II) carbonate to form copper (II) sulphate.
- (ii) Write a balanced chemical equation with state symbols for the reaction.
- (iii) Describe the procedure for the preparation of copper (II) sulphate solution from copper (II) carbonate and the named acid in (i) above. [5]
- (b) Describe what is observed when an excess of sodium hydroxide solution is added to a solution containing copper(II) ions and name one product formed. [3]
- (c) Describe a chemical test to show the presence of sulphate ions in the solution and state what would be observed. [2]

[Total 10]

B10 A student prepared a sample of sulphur dioxide in the laboratory by the action of dilute hydrochloric acid on sodium sulphite according to the equation below



The diagram below shows the apparatus used.



- (a) (i) What is the purpose of concentrated sulphuric acid?
- (ii) Describe a chemical test for sulphur dioxide.
- (iii) Sulphur dioxide is one of the major pollutant gases of air. It dissolves in rain water in the presence of oxygen to form sulphuric acid making the rain acidic.

Write a balanced chemical equation for the formation of sulphuric acid by reaction of water with sulphur dioxide and atmospheric oxygen.

State one hazardous effect of acid rain on the environment. [5]

- (b) One of the uses of sulphur dioxide is in the manufacture of sulphuric acid. Sulphur dioxide is reacted with oxygen to form sulphur trioxide according to the equation $2\text{SO}_{2(s)} + \text{O}_{2(g)} \rightleftharpoons 2\text{SO}_{3(g)}$ $\Delta H = -385 \text{ kJ/mol}$

- (i) State the conditions used in the Contact process to get a good yield of sulphur trioxide.
- (ii) Describe how the sulphur trioxide is safely converted into sulphuric acid.
- (iii) State one commercial use of sulphuric acid. [5]

[Total 10]

B11 Common metals extracted in industry include aluminium, copper and zinc.

- (a) Copy the table below and complete it by naming the main ore and method of extraction of the metal from the ore.

Element	Name of ore	Method of extraction
Aluminium		
Copper		
Zinc		

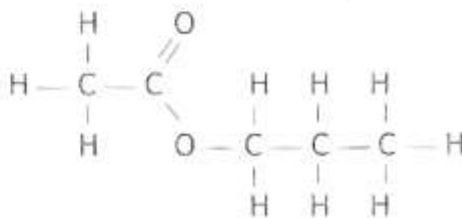
[3]

- (b) (i) Which of the metals in the table is quickly coated with an oxide layer when exposed to air making it unreactive?
- (ii) Bronze is an alloy. Which two metals are alloyed to produce bronze?
- (c) State two reasons why alloys are preferred to pure metals.
- (d) Two of the metals in the table form oxides which react with acids and alkalis.
- (i) What products are formed when the metal oxides react with an acid and an alkali?
- (ii) Write an equation for the reaction when one of the metal oxides reacts with dilute hydrochloric acid.

[3]

[Total 10]

B12 The structural formula of an ester is given below



- (a) (i) Describe how the above ester can be prepared in the laboratory by naming the reagents and the conditions needed for successful reaction.
- (ii) What observation will confirm that an ester has been formed in the reaction?
- (b) Terylene is a polyester formed from carboxylic acid and alcohol units.
- (i) Name two monomers used to make terylene.
- (ii) Draw the structural formula of terylene showing only four (4) monomer units.
- (iii) State one use of terylene.

[5]

[Total 10]

Turnover

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
<div><div>1</div><div>H</div><div>Hydrogen</div></div>																	
<div><div><div><div>7</div><div>Li</div><div>Lithium</div><div>3</div></div><div><div>23</div><div>Na</div><div>Sodium</div><div>11</div></div><div><div>39</div><div>K</div><div>Potassium</div><div>19</div></div><div><div>85</div><div>Rb</div><div>Rubidium</div><div>37</div></div><div><div>133</div><div>Cs</div><div>Cesium</div><div>55</div></div><div><div>226</div><div>Fr</div><div>Francium</div><div>87</div></div></div><div><div><div>8</div><div>Be</div><div>Beryllium</div><div>4</div></div><div><div>24</div><div>Mg</div><div>Magnesium</div><div>12</div></div><div><div>40</div><div>Ca</div><div>Calcium</div><div>20</div></div><div><div>88</div><div>Sr</div><div>Strontium</div><div>38</div></div><div><div>137</div><div>Ba</div><div>Barium</div><div>56</div></div><div><div>226</div><div>Ra</div><div>Radium</div><div>88</div></div></div><div><div><div>45</div><div>Sc</div><div>Scandium</div><div>21</div></div><div><div>51</div><div>V</div><div>Vanadium</div><div>23</div></div><div><div>59</div><div>Co</div><div>Cobalt</div><div>27</div></div><div><div>69</div><div>Y</div><div>Yttrium</div><div>39</div></div><div><div>139</div><div>La</div><div>Lanthanum</div><div>57</div></div><div><div>227</div><div>Ac</div><div>Actinium</div><div>89</div></div></div><div><div><div>52</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>78</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>86</div><div>Ru</div><div>Ruthenium</div><div>44</div></div><div><div>101</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>106</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>195</div><div>Os</div><div>Osmium</div><div>76</div></div><div><div>223</div><div>W</div><div>Tungsten</div><div>74</div></div></div><div><div><div>53</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>55</div><div>Mn</div><div>Manganese</div><div>25</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>54</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>55</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>56</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>57</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>58</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>59</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>60</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>61</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>62</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>63</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>64</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>65</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>66</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>67</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>68</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>69</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>70</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>71</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>72</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>73</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>74</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>75</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>76</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>77</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>78</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>79</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>80</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>81</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>82</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>83</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>84</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>85</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</div></div><div><div>79</div><div>Cu</div><div>Copper</div><div>29</div></div><div><div>91</div><div>Ni</div><div>Nickel</div><div>28</div></div><div><div>103</div><div>Rh</div><div>Rhodium</div><div>45</div></div><div><div>108</div><div>Pd</div><div>Palladium</div><div>46</div></div><div><div>135</div><div>Ag</div><div>Silver</div><div>47</div></div><div><div>196</div><div>Pt</div><div>Platinum</div><div>78</div></div><div><div>224</div><div>Re</div><div>Rhenium</div><div>75</div></div><div><div>261</div><div>Mo</div><div>Molybdenum</div><div>42</div></div></div><div><div><div>86</div><div>Cr</div><div>Chromium</div><div>24</div></div><div><div>56</div><div>Fe</div><div>Iron</div><div>26</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*58-71 Lanthanoid series
+90-103 Actinoid series

Key
 a = relative atomic mass
 x = atomic symbol
 b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).
 $N_A = 6.0 \times 10^{23} / \text{mol}$; $1 \text{ F} = 96500 \text{ C}$.

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