New Zealand Chemistry Olympiad Trust

Training Group Selection Examination

Monday 31 October 2016

TIME ALLOWED: 120 minutes

Answer **ALL** questions on this examination booklet.

Calculators may be used.

A periodic table with atomic masses is also provided.

NOTE - This paper is in two sections. Complete both sections.

Section A Multichoice: **Total marks 50/100**

There are 25 questions. **EACH answer is worth 2 marks**

Answer ALL questions — circle the letter of the correct answer.

Section B Long Answers: **Total marks 50/100**

The mark value for each question is shown.

All answers must be written in the space provided.

In questions involving numerical calculations show all reasoning and work.

STUDENT'S NAME: ____

STUDENT'S EMAIL: ____

SCHOOL: ____

	Section A Multichoice	Section B Long Answers						Total /100
	/2 × 25= 50	/9	/6	/10	/9	/8	/8	
Mark								

SECTION A - Multichoice

For each question circle the letter of the correct answer.

Question 1
What is the oxidant (oxidising agent) in the reaction for which the equation is shown below?

$$2HAsO_2(aq) + 3Sn^{2+}(aq) + 6H^+(aq) \rightarrow 2As(s) + 3Sn^{4+}(aq) + 4H_2O(l)$$

A. $HAsO_2$
B. Sn^{2+}
C. H^+
D. Sn^{4+}
E. H_2O

Question 2
In which compound does manganese have an oxidation number of +3?

A. $KMnO_4$ B. $K_2[Mn(CN)_6]$ C. $K_5[Mn(CN)_6]$

D. $MnSO_4$ E. $CsMn(SO_4)_2.12H_2O$

Question 3
0.0005 moles of metal chloride were dissolved in water. 60.0 mL of 0.025 mol L^{-1} silver nitrate solution were required to complete precipitation of silver chloride from the solution of the metal chloride. Choose the formula of the metal chloride that is consistent with these results.

A. MCl B. M_2Cl C. MCl_2 D. MCl_3 E. M_2Cl_3

Question 4
A sample has a mass of 54 mg and contains 3.01×10^{20} molecules of SF_n.
What is the value of n?

A. 1 B. 2 C. 4 D. 6 E. 8

Question 5
What is the Na^+ ion concentration in the solution formed by mixing 20 mL of 0.10 mol L^{-1} Na_2SO_4 solution with 50 mL of 0.30 mol L^{-1} Na_3PO_4 solution?

A. 0.09 mol L^{-1}
B. 0.15 mol L^{-1}
C. 0.24 mol L^{-1}
D. 0.48 mol L^{-1}
E. 0.70 mol L^{-1}

Question 6

Which species has the same shape as the NO_3^- ion?

A. SO_3 B. SO_3^{2-} C. NH_3 D. ClF_3 E. ClO_3^-

Question 7

Consider the following reaction and the associated value for $\Delta_r H^o$:

$2H_2(g) + 2Cl_2(g) \rightarrow 4HCl(g)$ $\Delta_r H^o = -92.3$ kJ mol^{-1}

Which statement about this information is **incorrect**?

A. $\Delta_r H^o$ will be –92.3 kJ mol^{-1} if the HCl is produced as a liquid.
B. The four HCl bonds are stronger than the four bonds in $2H_2$ and $2Cl_2$.
C. If the equation is reversed, $\Delta_r H^o$ equals +92.3 kJ mol^{-1}.
D. 23.1 kJ of heat will be evolved when 1 mol of HCl(g) is produced.
E. The reactants are in their standard states.

Question 8

In which reaction will an increase in the volume of the container favour the formation of products?

A. $H_2(g) + I_2(g) \rightarrow 2HI(g)$
B. $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(l)$
C. $C(s) + H_2O(g) \rightarrow CO(g) + H_2(g)$
D. $3O_2(g) \rightarrow 2O_3(g)$
E. $2NO(g) + O_2(g) \rightarrow 2NO_2(g)$

Question 9

Which pair of changes describes the effect of a catalyst on a chemical reaction?

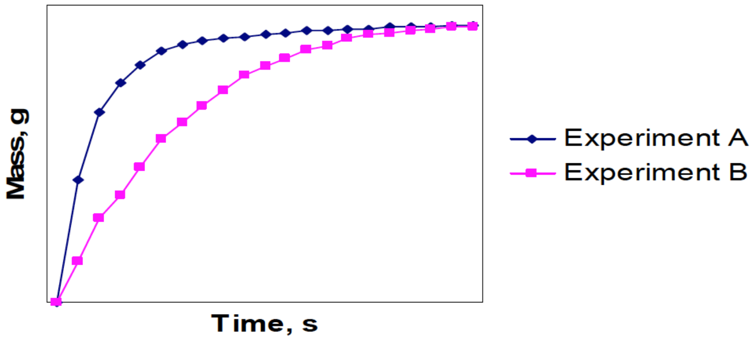
	Activation energy	**Enthalpy change of reaction**
A	Decreased	Decreased
B	Decreased	No change
C	Decreased	Increased
D	No change	Decreased
E	Increased	No change

Question 10

The average bond enthalpy (bond energy) of a C—F bond is 485 kJ mol^{-1}.
For which of the following processes is $\Delta_r H$ approximately + 1940 kJ mol^{-1}?

A. $CF_4\ (l) \rightarrow C(s) + 2F_2\ (g)$
B. $CF_4\ (g) \rightarrow C(s) + 2F_2\ (g)$
C. $CF_4\ (g) \rightarrow C(g) + 2F_2\ (g)$
D. $CF_4\ (g) \rightarrow C(s) + 4F(g)$
E. $CF_4\ (g) \rightarrow C(g) + 4F(g)$

Question 11
The graph below shows student data from two trials in which he studied the rate of a particular reaction, changing just one of the reaction conditions in the second trial.



Which one of the following statements MUST be **INCORRECT**?

A. Exactly the same amounts of reactants were used in the two experiments
B. The reaction temperature was higher in Experiment A than in Experiment B
C. The mass of one of the products was being measured in the two experiments
D. The final rate of reaction was greater in experiment A than in Experiment B
E. The initial rate of reaction was greater in Experiment A than in Experiment B

Question 12
A lemon-flavoured drink contains citric acid as the only acidic component. 10.00 mL of the drink is diluted with 15.00 mL of distilled water and titrated with NaOH solution using phenolphthalein as indicator. Under these conditions citric acid behaves as a diprotic (or dibasic) acid.

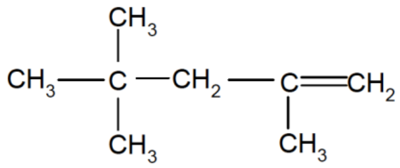
25.00 mL of 0.100 mol L^{-1} sodium hydroxide solution is used to reach the endpoint of the titration. Which is the concentration of the citric acid in the drink?

A. 0.100 mol L^{-1}
B. 0.125 mol L^{-1}
C. 0.200 mol L^{-1}
D. 0.250 mol L^{-1}
E. 0.500 mol L^{-1}

Question 13
Lattices of ionic compounds are more stable if the ions are small and highly-charged and combined in a simple 1:1. On the basis of this information, choose the pair of ions that are likely to form crystals with the highest melting (or decomposition) temperature.

A. Li, O
B. Ag, O
C. Li, F
D. Mg, F
E. Mg, O

Question 14.
The following compound is used as an additive in gasoline to improve its octane value.



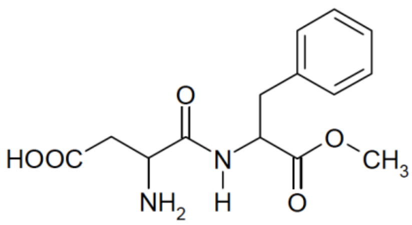
Which of the following is a correct IUPAC name for this compound?

A. 2,2,4-trimethylpent-1-ene
B. 2,2,4-trimethylpent-2-ene
C. 2,2,4-trimethylpent-5-ene
D. 2,4,4-trimethylpent-1-ene
E. 2,4,4-trimethylpent-2-ene

Question 15
Which molecular formula could NOT represent a compound containing a hydroxyl (-OH) group?

A. H_2O B. CH_4O C. CH_2O D. H_2SO_4 E. C_6H_6O

Question 16
Aspartame has the structure given below. This compound is used as a sweetener in diet drink.



Choose the number of carbon atoms in one molecule of aspartame.

A. 12 B. 13 C. 14 D. 15 E. 16

Question 17
A substance melts at 681°C and conducts electricity when molten but not when solid. Choose the most likely type of attractive forces between the particles of this substance.

A. Ionic bonding
B. Metallic bonding
C. Dipole-dipole interactions
D. Covalent bonding
E. Intermolecular forces

Question 18
The pH of an aqueous solution is 6.0 at 50 °C. Which is the hydroxide ion concentration in mol L^{-1}?
($K_w = 5.5 \times 10^{-14}$ at this temperature)

A. 1.0×10^{-6}
B. 2.3×10^{-7}
C. 1.0×10^{-8}
D. 5.5×10^{-8}
E. 7.8×10^{-8}

Question 19
An equal volume of 0.5 mol L^{-1} NaOH is added to each of the following solutions.
In which case(s) does the pH of the solution decrease?

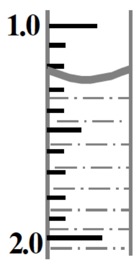
1. H_2O **2.** 0.25 mol L^{-1} Na_2CO_3 **3.** 0.5 mol L^{-1} HCl **4.** 0.6 mol L^{-1} KOH

A. 1, 2 and 3 only
B. 1 and 2 only
C. 1 and 3 only
D. 2 and 4 only
E. 4 only

Question 20
Choose the conjugate acid of glycine (aminoethanoic acid).

A. H_3O^+
B. H_2NCH_2COOH
C. $H_3N^+\text{-}CH_2COOH$
D. $H_2NCH_2CO_2^-$
E. $H_3N^+\text{-}CH_2CO_2^-$

Question 21



The diagram shows the cross section of a burette that is partially filled with a solution.
Which is the burette reading?

A. 1.20 mL B. 1.26 mL C. 2.70 mL D. 2.74 mL E. 2.80 mL

Question 22

Which steps in the formation of NaF(s) are exothermic?

I. $Na(g) \rightarrow Na^{+}(g) + e^{-}$

II. $F(g) + e^{-} \rightarrow F^{-}(g)$

III. $Na^{+}(g) + F^{-}(g) \rightarrow NaF(s)$

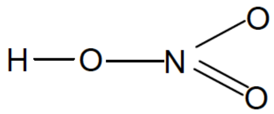
A. I only B. II only C. III only

D. I and III only E. II and III only

Question 23

Which one of the following substances has one unpaired electron in its Lewis structure?

A. NH_3 B. $N \equiv N$ C. $N = O$ D. $H—C \equiv N$ E.



Questions 24

Which one of the following reactions is NOT a redox reaction?

A. $Br_2 + H_2O \rightarrow HBr + HBrO$

B. $I_2 + 2Na_2S_2O_3 \rightarrow 2NaI + Na_2S_4O_6$

C. $Na_3AsO_3 + H_2O_2 \rightarrow H_2O + Na_3AsO_4$

D. $I_2 + 6NaOH \rightarrow NaIO_3 + 5NaI + 3H_2O$

E. $2K_2CrO_4 + H_2SO_4 \rightarrow K_2Cr_2O_7 + K_2SO_4 + H_2O$

Question 25

A colourless aqueous solution contains a single ionic compound. Use the following experimental information to deduce the identity of the compound.

When a small amount of dilute NaOH solution is added to the solution, a precipitate forms. This precipitate dissolves when excess NaOH is added.

Addition of $AgNO_3$ (silver nitrate) to another sample of the original solution gives a white precipitate.

A. $AlCl_3$

B. $Ba(NO_3)_2$

C. $CuSO_4$

D. FeI_2

E. $PbSO_4$

SECTION B – Long Answers

QUESTION ONE (9 marks)
A compound contains only C, H, and N.
Combustion of 0.125 g of the compound produces 0.172 g of H_2O and 0.279 g of CO_2.

a) Calculate the mass of H and C in 0.125 g of the compound. (2 marks)

1 mark each correct mass

Answer 9.56 x 10^{-3}mol H_2O or 0.0191 g and 6.34 x 10^{-3} mol CO_2 or 0.0761 g

b) Show that the empirical formula of this compound is C_3H_9N. (2 marks)

1 mark for mass of N and 1 mark for showing calculation of EF

Answer –0.0761 g C= 60.9%; H 0.0191 g H or 15.3%.
Hence 0.0298 g N or 23.8%. Empirical formula C_3H_9N

c) Assume the empirical formula of the compound is also the molecular formula. Draw structures for the four different isomers that are possible for a compound with this formula. (2 marks)

½ mark each correct structure

Propan-1-amine, propan-2-amine, ethyl methyl amine, trimethyl amine

d) The boiling point of molecular substances depends on the strength of attractive forces between the molecules. These depend on the polarity and also on the size and the shape of the molecule. When considering isomeric compounds, one type of intermolecular attractive force is stronger for linear molecules than for branched ones because in linear molecules, the surface area over which the interaction can occur is larger.
Electronegativity: C = 2.6; N = 3.0; O = 3.4; H = 2.2

The four isomers in part c) have boiling points that range from 3 °C to 48 °C. The Identify the isomers that have the **lowest** and **highest** boiling points. Explain your answers in terms of the intermolecular forces.
(3 marks)

The presence of an N-H bond involves atoms with the greatest difference in electronegativity in these molecules ie the most polar bond (and possibility of hydrogen bonding between the molecules. On its own this would result in stronger intermolecular forces and therefore a higher BP
The trimethyl amine is a branched molecule with no N-H bond. In addition its shape is branched and the molecules cannot pack as closely together. This also reduces the strength of intermolecular forces and means trimethyl amine will have the lowest BP.
The molecule with the highest BP is propan-1-amine as it has two N-H bonds and also is not a branched molecule.

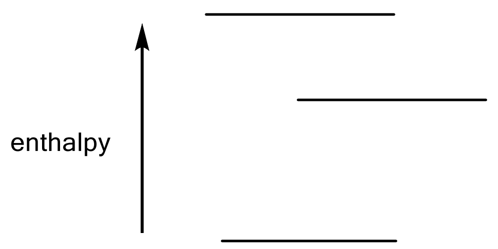
1 mark for correct molecule with highest BP and 1 mark for lowest BP and 1 for correct discussion

QUESTION TWO (6 marks)

a) (2 marks)The standard enthalpy change for the reaction in which one mole of CO_2 is formed from its elements is -394 kJ mol^{-1}. The standard enthalpy change for the combustion of one mole of CO is -283 kJ mol^{-1}.

For each of the reactions above, complete the diagram by writing the reactants of the balanced equation for the reaction on one line and the product on a different line.
Show all states.

2 marks all lines correct –
½ mark 1 line correct but 1.5 marks total if correct species but not balanced
if totally reversed (top to bottom) give 1 mark



b) (2 marks)Use the information above to calculate the enthalpy change for formation of one mole of CO from its elements. Show how you arrived at your answer.

2 marks including correct unit and negative sign -

d) (2 marks) Iron is prepared from Fe_2O_3 by reaction with CO as shown in the equation given below.

$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$ $\Delta_r H^o$ = -22 kJ mol^{-1}

Calculate ΔH for the reaction that produces 100 g iron.

1 mark for correct moles Fe
1 mark final answer – accept either kJ or kJ mol^{-1}

QUESTION THREE (10 marks)

Part A (5 marks)

This question is concerned with solutions of the reactants and the product of the reaction given below:

$NH_3(aq) + HNO_3(aq) \rightarrow NH_4NO_3(aq)$

a) As shown below, H_3O^+ and OH^- are present in all of these solutions. Complete the table by firstly giving, for each solution, formulae for any other species (molecules or ions excluding H_2O) that are present. These species may arise either by dissolving or by reaction with water. Then identify species which fit descriptions given in the column at the left.

½ mark each correct box plus ½ for part (b)

	NH_3	HNO_3	NH_4NO_3
All species in each solution (not H_2O)	H_3O^+ and OH^-	H_3O^+ and OH^-	H_3O^+ and OH^-
Species present in equal concentration			
Species in lowest concentration			

b) Circle the solute in the solution with the lowest conductivity. NH_3 HNO_3 NH_4NO_3

Part B (5 marks)

Write net equations for the reaction of each of the combinations of reactants below. Use appropriate ionic and molecular formulae, omitting any ions or molecules that do not take part in the reaction. You need not balance the equations. All reactions occur in aqueous solution unless otherwise indicated.

1 mark each eqn correct.
1/2 mark if $Zn(OH)_2$ for answer (iii)
½ mark if only 1 product in (i), (ii) or (v)

(i) Solutions of magnesium sulfate and barium hydroxide are mixed.

$MgSO_4 + Ba(OH)_2 \rightarrow Mg(OH)_2 + BaSO_4$

(ii) Water is added to magnesium nitride (an acid base reaction).

$Mg_3N_2 + H_2O \rightarrow Mg(OH)_2 + NH_3$

(iii) Excess concentrated sodium hydroxide is added to a solution of zinc nitrate.

$Zn^{2+} + 4OH^- \rightarrow Zn(OH)_4^{2-}$ OR $Zn(OH)_2 + 2OH^- \rightarrow Zn(OH)_4^{2-}$

(iv) Excess concentrated ammonia is added to aqueous copper(II) nitrate.

$Cu^{2+} + 4NH_3 \rightarrow Cu(NH_3)_4^{2+}$

(v) Excess carbon dioxide is bubbled through a solution of calcium hydroxide.

$Ca^{2+} + OH^- + CO_2 \rightarrow CaCO_3 + H_2O$

OR $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

QUESTION FOUR (9 marks)

Part A (5 marks)

Consider two flasks in which the reaction system below is at equilibrium. CO_2 is added to one flask. The temperature of the other flask is increased. In both cases the mixture is allowed to stand until equilibrium is restored.

$$CH_4(g) + 2O_2(g) \rightleftharpoons CO_2(g) + 2H_2O(g) \qquad \Delta_r H° = -802.3 \text{ kJ mol}^{-1}$$

Compare the final equilibrium concentration with that prior to the change being applied. Describe the direction of change (if any) in the concentrations of species and in K_c (the equilibrium constant) by writing **increase, decrease or no change** in the boxes below. *½ mark each box correct*

Change	$[CH_4(g)]$	$[O_2(g)]$	$[CO_2(g)]$	$[H_2O(g)]$	K_c
Add CO_2	increase	increase	increase	decrease	No change
Increase in temperature	increase	increase	decrease	decrease	decrease

Part B (4 marks)

Ammonium thiocyanate is a reagent used to test for iron(III) ions in solution. The equation for the reaction forming the complex is given below.

$$Fe^{3+}(aq) + SCN^{-}(aq) \rightleftharpoons Fe(SCN)^{2+}(aq)$$

In an experiment to find the equilibrium constant (K_c) for the reaction at this temperature, 45.00 mL of a solution containing 0.200 mol L^{-1} Fe^{3+} is mixed with 5.00 mL of a solution containing 0.00200 mol L^{-1} SCN^-. Colorimetric analysis shows that the equilibrium concentration of $Fe(SCN)^{2+}$ is 1.99×10^{-4} mol L^{-1}.

a) Complete the table below to show, for each of the species involved in the reaction, the initial concentration (after mixing, before reaction occurs), the change in concentration (due to reaction to reach equilibrium) and equilibrium concentration.

Reaction	$Fe^{3+}(aq) + SCN^{-}(aq) \rightleftharpoons Fe(SCN)^{2+}(aq)$		
	Fe^{3+}	SCN^-	$Fe(SCN)^{2+}$
Initial conc/mol L^{-1}	0.180	2.00×10^{-4}	0.00
Change in conc/mol L^{-1}	-1.99×10^{-4}	-1.99×10^{-4}	$+1.99 \times 10^{-4}$
Equilibrium conc / mol L^{-1}	0.180 or 0.1798	1.00×10^{-6}	1.99×10^{-4}

½ mark each box correct = total 3.5 marks BUT if initial concs are not diluted (ie 0.200 and 0.002) then follow-on correct give 2.5 total

b) Calculate K_c at the temperature at which the experiment is carried out.

$$K_c = \frac{1.99 \times 10^{-4}}{0.180 \times 1.00 \times 10^{-6}} = 1.11 \times 10^{3}$$

½ mark but allow follow on eg K_c = 0.553

QUESTION FIVE (8 marks)

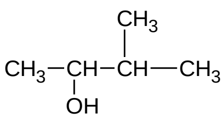
Compound **A** ($C_5H_{12}O$) reacts with $SOCl_2$ to form compound **B** ($C_5H_{11}Cl$) which, on heating with alcoholic KOH, forms two alkenes (C_5H_{10}), compounds **C** and **D**. Neither of compounds **D** and **E** can exist as *cis-trans* isomers. Addition of HCl to compound **C** forms compound **E**, an isomer of **B**, as the major product, while addition of HCl to compound **D** gives **B**.

a) Deduce the structures and names of compounds **A** to **E**.

Space for working

*5 marks for all correct structures plus 2 marks for correct names (-1/2 for each one wrong) = total **7 marks***
*BUT if 2-methylbutan-2-ol and all names and structure follow correctly total **6 marks***
*cpd A is pentan-2-ol and all names and structures follow correctly then **5 marks** total (not 7)*
*ALSO if cpd A is pentan-1-ol the maximum **4 marks** for names and structure*

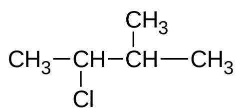
Compound A



Name of A ___________________

3-methylbutan-2-ol

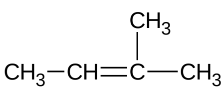
Compound B



Name of B _______________________

2-chloro-3-methylbutane

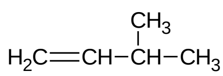
Compound C



Name of C _____________________

2-methylbut-2-ene

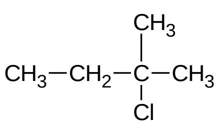
Compound D



Name of D _________________________

3-methylbut-1-ene

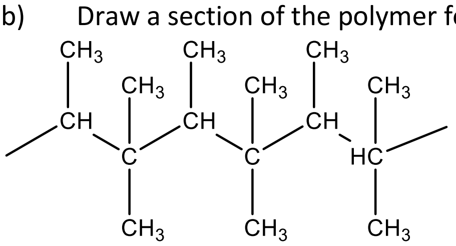
Compound E



Name of E _____________________________

2-chloro-2-methylbutane

b) Draw a section of the polymer formed by addition polymerisation of compound **C**.

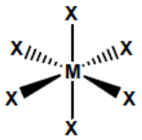


1 mark – allow follow on from structure C above

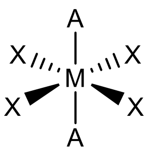
QUESTION SIX (8 marks)

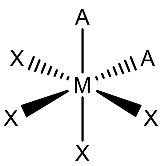
Part A (4 marks)

The octahedral compound MX_6 has X in six equivalent positions.



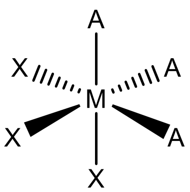
a) Sketch the two possible isomers for the octahedral compound MA_2X_4 in which two groups are different from the other four. (2 marks)

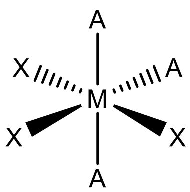




1 mark each structure

b) Sketch the two possible isomers for the octahedral compound MA_3X_3 in which three groups are different from the other three. (2marks)   *ANS in one the three are mutally cis; in the other one pair is trans*





1 mark each structure

Part B (4 marks)

A salt of vanadium(V) contains vanadium in the +5 oxidation state.

A **one litre** solution contains **2.55 g** of vanadium as a vanadium(V) salt.
25.0 mL of the solution was treated with acidified aqueous SO_2 to reduce the vanadium (V).
The vanadium ion formed was reoxidised to vanadium(V) by acidified $KMnO_4$ solution.
12.5 mL of 0.0200 mol L^{-1} $KMnO_4$ solution was required for complete reaction.

Deduce the oxidation state to which vanadium was reduced by SO_2.

$n(MnO_4^-)$ = 0.0125 x 0.0200 = 0.00025 mol L^{-1} *1 mark*

n(V) in 1 litre = 2.55g/50.9 g mol^{-1} = 0.0501 mol or in 25.0 mL = 0.00125 mol *1 mark*

Ratio V : MnO_4^- = 0.00125/ 0.00025 = 5:1 *1 mark*

Since reduction of MnO_4^- to Mn^{2+} requires 5 e^- then **each** vanadium ion must lose 1 e^-.

This means vanadium ion was reduced to the +4 oxidation state. *1 mark*

PERIODIC TABLE OF THE ELEMENTS

				Atomic Number		1 **H** 1.0	Molar Mass / g mol^{-1}										18
1	2											13	14	15	16	17	2 **He** 4.0
3 **Li** 6.9	4 **Be** 9.0											5 **B** 10.8	6 **C** 12.0	7 **N** 14.0	8 **O** 16.0	9 **F** 19.0	10 **Ne** 20.2
11 **Na** 23.0	12 **Mg** 24.3	3	4	5	6	7	8	9	10	11	12	13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar** 40.0
19 **K** 39.1	20 **Ca** 40.1	21 **Sc** 45.0	22 **Ti** 47.9	23 **V** 50.9	24 **Cr** 52.0	25 **Mn** 54.9	26 **Fe** 55.9	27 **Co** 58.9	28 **Ni** 58.7	29 **Cu** 63.5	30 **Zn** 65.4	31 **Ga** 69.	32 **Ge** 72.6	33 **As** 74.9	34 **Se** 79.0	35 **Br** 79.9	36 **Kr** 83.8
37 **Rb** 85.5	38 **Sr** 87.6	39 **Y** 88.9	40 **Zr** 91.2	41 **Nb** 92.9	42 **Mo** 95.9	43 **Tc** 98.9	44 **Ru** 101	45 **Rh** 103	46 **Pd** 106	47 **Ag** 108	48 **Cd** 112	49 **In** 115	50 **Sn** 119	51 **Sb** 122	52 **Te** 128	53 **I** 127	54 **Xe** 131
55 **Cs** 133	56 **Ba** 137	57−71 Lanthanide Series	72 **Hf** 179	73 **Ta** 181	74 **W** 184	75 **Re** 186	76 **Os** 190	77 **Ir** 192	78 **Pt** 195	79 **Au** 197	80 **Hg** 201	81 **Tl** 204	82 **Pb** 207	83 **Bi** 209	84 **Po** 210	85 **At** 210	86 **Rn** 222
87 **Fr** 223	88 **Ra** 226	89−103 Actinide Series	104 **Rf** 261	105 **Db** 262	106 **Sg** 263	107 **Bh** 262	108 **Hs** 265	109 **Mt** 266									

Lanthanide Series	57 **La** 139	58 **Ce** 140	59 **Pr** 141	60 **Nd** 144	61 **Pm** 145	62 **Sm** 150	63 **Eu** 152	64 **Gd** 157	65 **Tb** 159	66 **Dy** 163	67 **Ho** 165	68 **Er** 167	69 **Tm** 169	70 **Yb** 173	71 **Lu** 175
Actinide Series	89 **Ac** 227	90 **Th** 232	91 **Pa** 231	92 **U** 238	93 **Np** 237	94 **Pu** 244	95 **Am** 243	96 **Cm** 247	97 **Bk** 247	98 **Cf** 251	99 **Es** 252	100 **Fm** 257	101 **Md** 258	102 **No** 255	103 **Lr** 262