
Student Number

2018
YEAR 11 FINAL EXAMINATION

Saint Ignatius' College
RIVERVIEW

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 2 hours
- Write using black or blue pen
- Draw diagrams using pencil
- NESA-approved calculators may be used
- Use the Data Sheets and Periodic Table provided
- Use the Multiple-Choice Answer Sheet provided
- Write your Student Number at the top of this page, on page 11 and on the Multiple-Choice Answer Sheet

Total marks – 70

This paper has two sections:

Section I – 20 marks
- Attempt Questions 1-20
- Allow about 35 minutes for this section

Section II – 50 marks
- Attempt Questions 21-29
- Allow about 1 hour and 25 minutes for this section

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Section I – 20 marks
Attempt Questions 1-20
Allow about 35 minutes for this section

Use the multiple-choice answer sheet provided for Questions 1-20.

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ● B ⊗ C ○ D ○

If you have changed your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows:

A ⊗ B ⊗ *correct* C ○ D ○

1 Consider the chemical reaction:

$Zn\ (s) + CuSO_4\ (aq) \rightarrow Cu\ (s) + ZnSO_4\ (aq)$

Which atom undergoes a change in oxidation number (state) from 0 to +2?

(A) Zn
(B) Cu
(C) S
(D) O

2 When sodium reacts with water

(A) sodium loses electrons.
(B) hydroxide ions are produced.
(C) hydrogen gas is produced.
(D) all of the above occur.

3 Which of the following correctly describes an ionic solid?

(A) An ordered lattice structure with cations and free valence electrons

(B) A crystalline form that is hard and has a lustre

(C) A high melting point solid, due to its strong intermolecular bonding

(D) A solid where the valence electrons are free to conduct charge

4 Which of the following substances contains only covalent bonds?

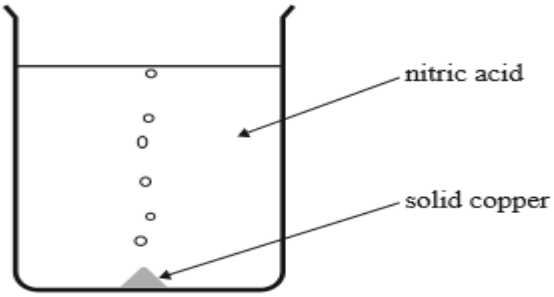
(A) MgO

(B) NH_4NO_3

(C) SiO_2

(D) NaCl

5 The following diagram shows a reaction between solid copper and concentrated nitric acid, HNO_3.



Which of the following would NOT increase the rate of the reaction?

(A) Decreasing the size of the solid copper particles

(B) Increasing the temperature of the HNO_3 solution

(C) Stirring the solution

(D) Decreasing the concentration of HNO_3

6 Down Group 4 of the Periodic Table

(A) elements become more metallic.

(B) elements become more electronegative.

(C) elements become more reactive in water.

(D) the atomic radius decreases.

7 Which of the following is a non-polar linear molecule?

(A) CO

(B) CO_2

(C) CH_4

(D) H_2O

8 Use the information in this table to answer the question.

Some solubility Rules:

ION	
Nitrates	All soluble
Chlorides	All soluble except Ag^+, Pb^{2+}, Hg_2^{2+}
Sulfates	All soluble except Ag^+, Pb^{2+}, Ba^{2+}, Ca^{2+}
Carbonates	All insoluble except Group I ions and NH_4^+

When a solution of sodium carbonate was added to solution X, known to be a soluble salt, a white solid precipitate was formed. Solution X could be

(A) calcium nitrate.

(B) potassium chloride.

(C) copper sulfate.

(D) sodium sulfate.

9 and 10 ***This data relates to questions 9 and 10 below.***

Consider the following chemical reactions:

I	$2H_2$ *(g)* + O_2 *(g)* → $2H_2O$ *(l)*
II	$2Mg$ *(s)* + O_2 *(g)* → $2MgO$ *(s)*
III	$CaCO_3$ *(s)* → CaO *(s)* + CO_2 *(g)*
IV	CH_4 *(g)* + $2O_2$ *(g)* → CO_2 *(g)* + $2H_2O$ (*l*)
V	$2H_2O$ *(l)* → $2H_2$ *(g)* + O_2 *(g)*

9 Which of the above chemical reactions can be classified both as combustion and as synthesis?

(A) I only

(B) I and II only

(C) I, II and IV only

(D) IV only

10 Which of the above chemical reactions would be classified as endothermic?

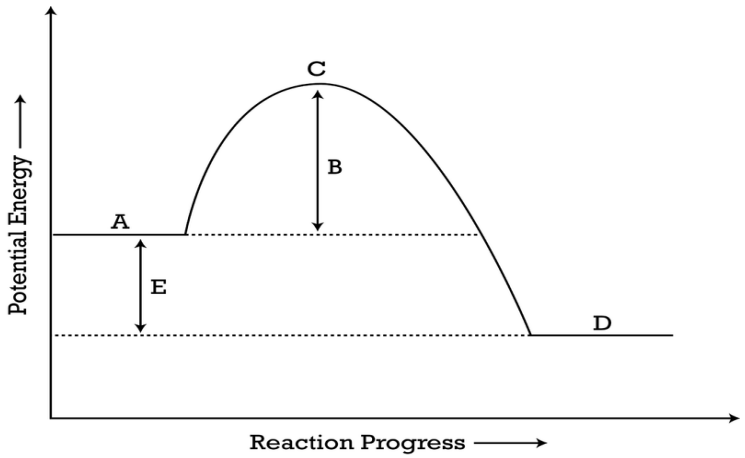
(A) I and II

(B) III and IV

(C) III only

(D) III and V

11 The changes during a chemical reaction are summarised in the following diagram:



Which of the following statements is INCORRECT?

(A) The enthalpy change for the reaction is E and is negative.
(B) The product D is more stable than the reactant A.
(C) The activation energy for the reaction is equal to (E + B) and is positive.
(D) The chemical present in the transition state is C.

12 When magnesium reacts with dilute sulfuric acid, the following reaction occurs:

$Mg\ (s) + 2H^+\ (aq) \rightarrow Mg^{2+}\ (aq) + H_2\ (g)$

During this reaction

(A) hydrogen gas gains electrons.
(B) sulfate ions gain protons.
(C) hydrogen ions gain electrons.
(D) magnesium is reduced.

13 Graphite and diamond are classified as allotropes of the element carbon because their atoms

(A) are the same but are bonded together in different ways.

(B) have the same number of protons but differ in the number of neutrons.

(C) have the same number of electron shells.

(D) form solids which have the same crystal structure.

14 A sample of petrol was burnt in air. The products emitted were analysed by chemists who concluded that incomplete combustion had occurred. Evidence for this could have been

(A) a yellow flame due to residual carbon found in the emitted gases.

(B) less energy emitted per litre of petrol than in other experiments.

(C) carbon monoxide detected in the emitted gases.

(D) all of the above.

15 How many grams of NaCl are there in 23.6 mL of 0.145 mol/L sodium chloride solution?

(A) 0.00342 g

(B) 0.200 g

(C) 3.42 g

(D) 20.0 g

16 Analysis of a 1.02 g sample of a compound showed that it contained 0.60 g carbon, 0.10 g hydrogen, with the balance being oxygen. The empirical formula of the compound is

(A) $C_6H_{10}O$

(B) CH_2O_2

(C) $C_3H_5O_2$

(D) $C_5H_{10}O_2$

17 The following reaction occurs when potassium iodide is added to a solution containing excess lead ions:

$2KI\ (aq) + Pb(NO_3)_2\ (aq) \rightarrow PbI_2\ (s) + 2KNO_3\ (aq)$

The mass of lead iodide formed when 25 mL of a 0.421 mol/L solution of potassium iodide is added to a solution containing excess lead ions is closest to

(A) 0.1 g

(B) 1.2 g

(C) 2.4 g

(D) 4.8 g

18 Which of the alternatives below identifies the electron configuration of the cation and anion present in the compound *aluminium chloride*?

	Cation	**Anion**
(A)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$
(B)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$
(C)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$	$1s^2\ 2s^2\ 2p^6$
(D)	$1s^2\ 2s^2\ 2p^6$	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

19 Which of the following indicates the correct enthalpy and entropy changes when ice melts at 0°C?

	Enthalpy change	***Entropy change***
(A)	$\Delta H < 0$	$\Delta S > 0$
(B)	$\Delta S > 0$	$\Delta H < 0$
(C)	$\Delta H > 0$	$\Delta S > 0$
(D)	$\Delta H > 0$	$\Delta S < 0$

20 A sample of an anticancer drug, $C_{47}H_{51}NO_{14}$, contains 0.157 g of carbon.
The mass of oxygen in the sample is

(A) 0.0468 g
(B) 0.0623 g
(C) 0.209 g
(D) 0.703 g

End of Section I

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Chemistry

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Section II – 50 marks
Attempt Questions 21-29
Allow about 1 hour and 25 minutes for this section

Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.
Extra writing space is provided on pages 23 and 24. If you use this space, clearly indicate which question you are answering.

Question 21 (3 marks)

Iodine -131 is a radioactive tracer emitting beta (β) and gamma (γ) radiation. It can be used as a tracer in the study of human iodine metabolism.

(a) Explain why alpha (α) emitters are usually **not** suitable for such tracer experiments.

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(b) Write down the composition of an I-131 nucleus.

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(c) What new nucleus is formed from the decay of I-131?

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Question 22 (6 marks)

(a) Compare the physical properties of graphite and diamond, in terms of their structures. **3**

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(b) Explain whether a 0.50 mol L^{-1} solution of glucose ($C_6H_{12}O_6$) or a 0.50 mol L^{-1} solution of potassium sulfate (K_2SO_4) would be a better electrical conductor. **3**

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Question 23 (5 marks)

6.54 g of zinc metal was reacted with excess hydrochloric acid at 25°C and 100 kPa pressure.

(a) Write the equation for this reaction. **1**

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(b) Calculate the number of moles of hydrogen gas formed. **1**

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(c) Calculate the volume that this number of moles of hydrogen gas would occupy at 25°C and 100 kPa pressure. **1**

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(d) Calculate the volume that this same number of moles of hydrogen gas would occupy, if the pressure were changed to 220 kPa and the temperature were changed to 35°C. **2**

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Question 24 (5 marks)

(a) Calculate the concentration of nitrate ions present in an 800.0 mL aqueous solution containing 22.5 g of dissolved aluminium nitrate. **3**

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(b) 40.0 mL of a 0.950 mol L^{-1} solution of Na_3PO_4 was diluted to a new concentration of 0.150 mol L^{-1}. How much water was added to the original solution? **2**

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Question 25 (5 marks) Student Number

(a) The reaction of iron ore (Fe_2O_3) with carbon follows the equation:

$$2\ Fe_2O_{3(s)} + 3\ C_{(s)} \rightarrow 4\ Fe_{(s)} + 3\ CO_{2(g)}.$$

How many grams of Fe will be produced if 120 g of iron (III) oxide and 144 g of C are heated together? **3**

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(b) Carbon dioxide in the air of a spacecraft can be removed by reacting it with lithium hydroxide, according to the balanced equation:

$$CO_{2(g)} + 2\ LiOH_{(aq)} \rightarrow Li_2CO_{3(aq)} + H_2O_{(l)}.$$

What volume of 2.00 mol L^{-1} LiOH is needed to remove 50.0 grams of CO_2 **2**

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Question 26 (7 marks)

(a) Draw a diagram for a galvanic cell formed using Zn and Ag electrodes. **3**

Label the anode, cathode, electrolytes, direction of electron flow and direction of ion movement in the salt bridge.

(b) Write equations for the half-cell reactions and for the overall reaction. **1**

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(c) Predict the voltage of this cell under standard conditions. **1**

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(d) What changes would you expect to see after the galvanic cell had operated for a few minutes? **2**

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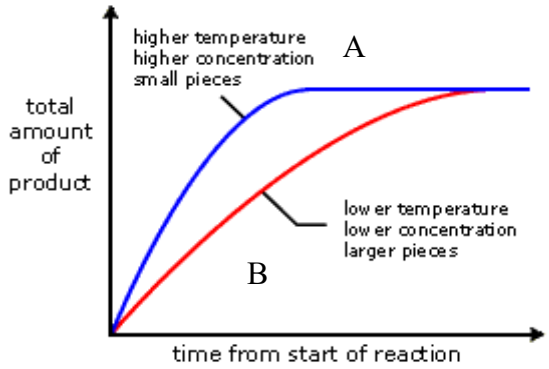
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Question 27 (6 marks)

The diagram shows 2 rate graphs (A and B) for the same reaction under different conditions.



(a) Which graph (A or B) shows the faster rate of reaction? **1**

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(b) Explain, in terms of the collision theory and energy considerations, how a catalyst affects the rate of a chemical reaction. **3**

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Question 27 continues on the next page

Question 27 (continued)

(c) Identify TWO ways (other than the use of a catalyst) by which the rate of a reaction can be increased. **2**

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Student Number

Question 28 (8 marks)

(a) State Hess' Law of Constant Heat Summation. **1**

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(b) The standard heat of formation of a compound is the enthalpy change when mole of a substance in its standard state is formed from its elements in their standard states. Given the following heats of formation:

$\Delta H^\circ_f\ CO_{2\ (g)} = -393.5$ kJ/mol
$\Delta H^\circ_f\ H_2O_{\ (l)} = -285.8$ kJ/mol
$\Delta H^\circ_f\ CH_{4\ (g)} = -74.8$ kJ/mol

Using the above information, determine the enthalpy change for this reaction:

$CH_{4\ (g)} + 2O_{2\ (g)} \rightarrow CO_{2\ (g)} + 2\ H_2O_{\ (l)}$ **2**

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(c) Use the bond energies from the data pages at the back of this question paper to calculate the enthalpy change for the reaction below. Show all working. **2**

$H_2\ (g) + Br_2\ (g) \rightarrow 2HBr\ (g)$

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(d) "Combustion reactions require activation, yet all combustion reactions are exothermic."

Discuss this statement, using the combustion of octane as an example in your response. **3**

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Question 29 (5 marks)

(a) When solid sodium hydroxide dissolves in water, the temperature rises. However, when solid ammonium nitrate dissolves in water, the temperature falls. Both these reactions occur spontaneously. **3**

In terms of enthalpy and entropy, discuss the driving forces of both reactions.

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(b) Determine the Gibbs energy change for a reaction at 25°C which has **1**
$\Delta H = -128$ kJ mol^{-1}
$\Delta S = -26$ J mol^{-1} K^{-1}

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(c) What can you conclude about the spontaneity of the reaction in part (b) above? **1**
Explain.

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Section II - Extra writing space

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Section II - Extra writing space

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Student Number

CHEMISTRY – MULTIPLE-CHOICE ANSWER SHEET

ATTEMPT ALL QUESTIONS

Question	**1**	A ⬭	B ⬭	C ⬭	D ⬭
	2	A ⬭	B ⬭	C ⬭	D ⬭
	3	A ⬭	B ⬭	C ⬭	D ⬭
	4	A ⬭	B ⬭	C ⬭	D ⬭
	5	A ⬭	B ⬭	C ⬭	D ⬭
	6	A ⬭	B ⬭	C ⬭	D ⬭
	7	A ⬭	B ⬭	C ⬭	D ⬭
	8	A ⬭	B ⬭	C ⬭	D ⬭
	9	A ⬭	B ⬭	C ⬭	D ⬭
	10	A ⬭	B ⬭	C ⬭	D ⬭
	11	A ⬭	B ⬭	C ⬭	D ⬭
	12	A ⬭	B ⬭	C ⬭	D ⬭
	13	A ⬭	B ⬭	C ⬭	D ⬭
	14	A ⬭	B ⬭	C ⬭	D ⬭
	15	A ⬭	B ⬭	C ⬭	D ⬭
	16	A ⬭	B ⬭	C ⬭	D ⬭
	17	A ⬭	B ⬭	C ⬭	D ⬭
	18	A ⬭	B ⬭	C ⬭	D ⬭
	19	A ⬭	B ⬭	C ⬭	D ⬭
	20	A ⬭	B ⬭	C ⬭	D ⬭

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DATA SHEET

Avogadro constant, N_A	6.022×10^{23} mol^{-1}
Ideal gas constant, R (when V in litres, P in atm) Ideal gas constant, R (when V in litres, P in kPa)	0.082057 L atm mol^{-1} K^{-1} 8.314 J mol^{-1} K^{-1}
Molar volume of an ideal gas, at 25°C and 101.3 kPa pressure (exact 1 atm = 760 mm Hg)	24.5 L
Molar volume of an ideal gas, at 0°C and 101.3 kPa pressure (exact 1 atm = 760 mm Hg)	22.4 L
Molar volume of an ideal gas, at 25°C and 100 kPa pressure (approx. 1 atm pressure = 750 mm Hg)	24.79 L
Molar volume of an ideal gas, at 0°C and 100 kPa pressure (approx. 1 atm pressure = 750 mm Hg)	22.71 L
Specific heat capacity of water	4.18×10^3 J kg^{-1} K^{-1}

Some useful formulae

PV = nRT	n = m/MM	$\boldsymbol{q = mC\Delta T}$	$\Delta G^o = \Delta H^o - T\Delta S^o$

Some standard potentials

$K^+ + e^-$	$\rightleftharpoons$	$K(s)$	−2.94 V
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	$Ba(s)$	−2.91 V
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	$Ca(s)$	−2.87 V
$Na^+ + e^-$	$\rightleftharpoons$	$Na(s)$	−2.71 V
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	$Mg(s)$	−2.36 V
$Al^{3+} + 3e^-$	$\rightleftharpoons$	$Al(s)$	−1.68 V
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	$Mn(s)$	−1.18 V
$H_2O + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g) + OH^-$	−0.83 V
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	$Zn(s)$	−0.76 V
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	$Fe(s)$	−0.44 V
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	$Ni(s)$	−0.24 V
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	$Sn(s)$	−0.14 V
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	$Pb(s)$	−0.13 V
$H^+ + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g)$	0.00 V
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(aq) + 2H_2O$	0.16 V
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	$Cu(s)$	0.34 V
$\frac{1}{2}O_2(g) + H_2O + 2e^-$	$\rightleftharpoons$	$2OH^-$	0.40 V
$Cu^+ + e^-$	$\rightleftharpoons$	$Cu(s)$	0.52 V
$\frac{1}{2}I_2(s) + e^-$	$\rightleftharpoons$	I^-	0.54 V
$\frac{1}{2}I_2(aq) + e^-$	$\rightleftharpoons$	I^-	0.62 V
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	0.77 V
$Ag^+ + e^-$	$\rightleftharpoons$	$Ag(s)$	0.80 V
$\frac{1}{2}Br_2(l) + e^-$	$\rightleftharpoons$	Br^-	1.08 V
$\frac{1}{2}Br_2(aq) + e^-$	$\rightleftharpoons$	Br^-	1.10 V
$\frac{1}{2}O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O	1.23 V
$\frac{1}{2}Cl_2(g) + e^-$	$\rightleftharpoons$	Cl^-	1.36 V
$\frac{1}{2}Cr_2O_7^{2-} + 7H^+ + 3e^-$	$\rightleftharpoons$	$Cr^{3+} + \frac{7}{2}H_2O$	1.36 V
$\frac{1}{2}Cl_2(aq) + e^-$	$\rightleftharpoons$	Cl^-	1.40 V
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	1.51 V
$\frac{1}{2}F_2(g) + e^-$	$\rightleftharpoons$	F^-	2.89 V

T. Average Bond Enthalpies (kJ/mol)

Single Bonds

C—H	413	N—H	391	O—H	463	F—F	155
C—C	348	N—N	163	O—O	146		
C—N	293	N—O	201	O—F	190	Cl—F	253
C—O	358	N—F	272	O—Cl	203	Cl—Cl	242
C—F	485	N—Cl	200	O—I	234		
C—Cl	328	N—Br	243			Br—F	237
C—Br	276			S—H	339	Br—Cl	218
C—I	240	H—H	436	S—F	327	Br—Br	193
C—S	259	H—F	567	S—Cl	253		
		H—Cl	431	S—Br	218	I—Cl	208
Si—H	323	H—Br	366	S—S	266	I—Br	175
Si—Si	226	H—I	299			I—I	151
Si—C	301						
Si—O	368						

Multiple Bonds

C=C	614	N=N	418	O_2	495
C≡C	839	N≡N	941		
C=N	615	N=O	607	S=O	523
C≡N	891			S=S	418
C=O	799				
C≡O	1072				

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number
Symbol
Standard Atomic Weight
Name

79 Au 197.0 Gold

1 H 1.008 Hydrogen																	2 He 4.003 Helium
3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.38 Zinc	31 Ga 69.72 Gallium	32 Ge 72.64 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.61 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.96 Molybdenum	43 Tc Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanoids	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.9 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89–103 Actinoids	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium						

Lanthanoids

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.1 Ytterbium	71 Lu 175.0 Lutetium

Actinoids

89 Ac Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

Elements with atomic numbers 113 and above have been reported but not fully authenticated.
Standard atomic weights are abridged to four significant figures.
Elements with no reported values in the table have no stable nuclides.
The International Union of Pure and Applied Chemistry Periodic Table of the Elements (February 2010 version) is the principal source of data. Some data may ha ve been modified.