CRANBROOK
SCHOOL

YEAR 12 TERM 1 EXAMINATION ASSESSMENT

2 UNIT HSC COURSE
2013

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time - 2 hours
- Board-approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil
- A data sheet and formulae sheets are provided at the back of this paper
  - Write your Student Number where indicated

Total marks - 75
There are two parts, Part A and Part B

Part A – 20 marks
- Attempt Questions 1 – 20

Leave about 35 minutes for this part

Part B – 55 marks
- Attempt Questions 21 – 30

Leave about 1 hour and 25 minutes for this part

THERE IS ONE BOOKLET AND ONE MULTIPLE CHOICE ANSWER SHEET IN THIS EXAMINATION

NO EXTRA PAPER/BOOKLETS ARE REQUIRED IN ADDITION TO THE WRITTEN EXAMINATION BOOKLETS

The content and format of this paper do not necessarily reflect the content and format of the HSC examination paper.

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Part A – 20 marks
Attempt Questions 1-20
Allow about 35 minutes for this part

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.

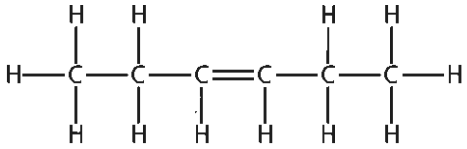
A ● B ⊗ C ○ D ○

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:

correct ↙

A ⊗ B ⊗ C ○ D ○

1 A student was asked to compare the reactions with bromine water of alkanes and alkenes. She decided to use the compound below as one of the two hydrocarbons being investigated.



The other hydrocarbon investigated should be

(A) hex-1-ene.

(B) hexane.

(C) pent-2-ene.

(D) pentane.

2 The combustion of ethanol can be represented by the following equation:

$C_2H_6O\ (l) + 3O_2\ (g) \rightarrow 2CO_2\ (g) + 3H_2O\ (l)$

The number of moles of water released into the atmosphere from the burning of 100 g of ethanol is closest to

(A) 117 mol

(B) 40 mol

(C) 6.5 mol

(D) 2.2 mol

3 A polymer formed by the addition reaction of chloroethene monomers has a common name of

(A) polystyrene.

(B) poly(vinyl chloride).

(C) cellulose.

(D) poly(chloroethene).

4 When powdered zinc is warmed with a purple solution containing permanganate ions (MnO_4^-), the solution changes colour due to the formation of almost colourless Mn^{2+}.

During this reaction, manganese has

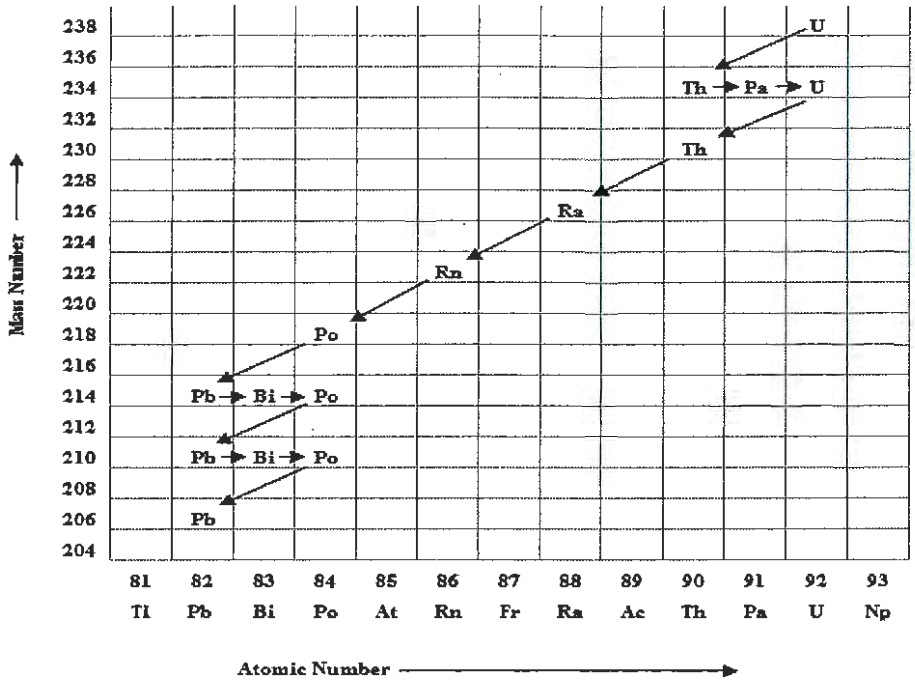
(A) lost electrons and has reached a lower oxidation state.

(B) gained electrons and has reached a lower oxidation state.

(C) lost electrons and has reached a higher oxidation state.

(D) gained electrons and has reached a higher oxidation state.

5 The diagram below shows the radioactive decay series for uranium-238.



The products of decay of lead-210 are

(A) bismuth-214 and alpha particles.

(B) bismuth-210 and beta particles.

(C) bismuth-214 and beta particles.

(D) bismuth-84 and alpha particles.

6 The reversible reaction to form ethylene from ethanol is represented:

$C_2H_6O\ (l) \rightleftharpoons C_2H_4\ (g) + H_2O\ (g) \qquad \Delta H = +45\ kJ\ mol^{-1}$

Identify the CORRECT statement.

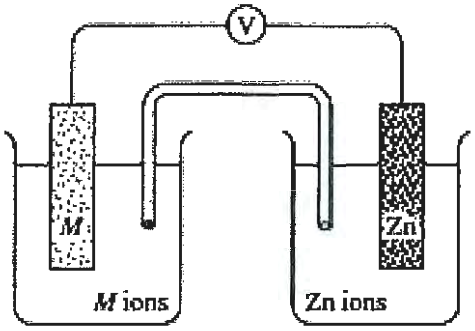
(A) The backward reaction is known as dehydration.

(B) The highest yield of ethylene is achieved at high temperature and high pressure.

(C) An excess of water favours the formation of ethylene.

(D) Sulfuric acid acts as a catalyst both for the backward and forward reactions.

7 The diagram shows a galvanic cell set up with zinc and another metal (M) as electrodes.



Which of the following metals would you place as M to produce the highest theoretical voltage under standard conditions for this cell?

(A) Silver

(B) Iron

(C) Magnesium

(D) Lead

8 The molar heat of combustion of pentan-1-ol is 3329 kJ mol^{-1}.

A quantity of pentan-1-ol was combusted, generating 79.5 kJ of heat energy.

What mass of pentan-1-ol was combusted?

(A) 1.44 g

(B) 1.77 g

(C) 2.11 g

(D) 2.45 g

9 Some salts when dissolved in water, produce acidic or alkaline solutions, while others produce neutral solutions. Which of the following is the CORRECT statement?

(A) when sodium chloride is added to water, the pH increases slightly.

(B) when sodium ethanoate is added to water, the concentration of hydrogen ions increases.

(C) when sodium carbonate is added to water, the pH decreases.

(D) when ammonium nitrate is added to water, the concentration of hydroxide ions decreases.

10 Which of the following substances would form an aqueous solution with a pH above 7?

(A) Calcium hydroxide

(B) Ammonium nitrate

(C) Sodium chloride

(D) Vinegar

11 Which of the following pairs would form a buffer solution?

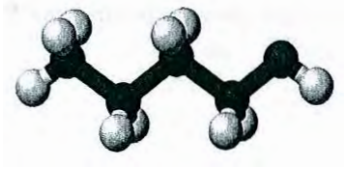
(A) HNO_3 *(aq)* / NO_3^- *(aq)*

(B) $H_2PO_4^-$ *(aq)* / HPO_4^{2-} *(aq)*

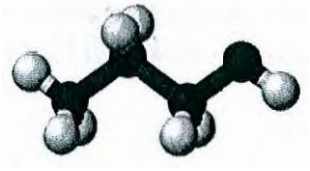
(C) H_3O^+ *(aq)* / H_2O *(l)*

(D) HCl *(aq)* / NaOH *(aq)*

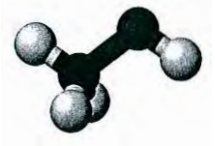
12 The models represent compounds of carbon, hydrogen and oxygen.



Compound 1



Compound 2



Compound 3

Compound 4

Compound 5

Which of the following statements about these compounds is INCORRECT?

(A) All the compounds exist as molecules

(B) Compound 4 would have a lower boiling point than compound 1

(C) Compounds 1, 2, 3 and 5 all belong to the same homologous series

(D) Compounds 1 and 4 have different names and different molecular weights

13 Identify the conjugate base of the acid $HCrO_4^-$.

(A) $HCrO_3^-$

(B) CrO_4^{2-}

(C) CrO_4^-

(D) H_2CrO_4

14 The pH of sulfuric acid was found to be 3.40. Assuming the sulfuric acid to be completely ionised, the concentration of sulfate ions (in mol L^{-1}) in the solution would be closest to

(A) 4.0×10^{-4}

(B) 8.0×10^{-4}

(C) 2.0×10^{-3}

(D) 2.0×10^{-4}

15 When 25 mL of 0.0858 mol L^{-1} sodium carbonate solution was titrated with a solution of hydrochloric acid, the volume of the acid needed to reach the equivalence point was 37.8 mL. The concentration of the hydrochloric acid solution, in mol L^{-1} is

(A) 0.0567

(B) 0.0284

(C) 0.130

(D) 0.113

16 Definitions of acids have changed over the past two centuries as chemical knowledge developed. Which scientist(s) defined an acid as a compound containing replaceable hydrogen?

(A) Davy

(B) Lavoisier

(C) Arrhenius

(D) Lowry and Bronsted

17 Sodium hydrogen carbonate was titrated with standardised hydrochloric acid in order to determine the concentration of the sodium hydrogen carbonate solution. Which of the following shows the correct information about the equivalence point of the titration and the most suitable indicator for use in the titration?

	Equivalence point	***Suitable indicator***
(A)	pH < 7	methyl orange
(B)	pH < 7	phenolphthalein
(C)	pH > 7	methyl orange
(D)	pH > 7	phenolphthalein

18 Which of the following species is the strongest reductant?

(A) Iron

(B) Copper

(C) Iron (III)

(D) Copper (II)

19 An acidic oxide which dissolves in water to form a strong acid is

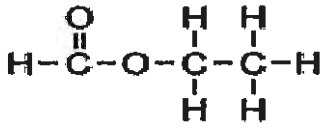
(A) SO_3

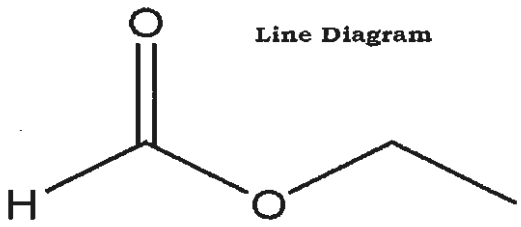
(B) CO_2

(C) SO_2

(D) NO

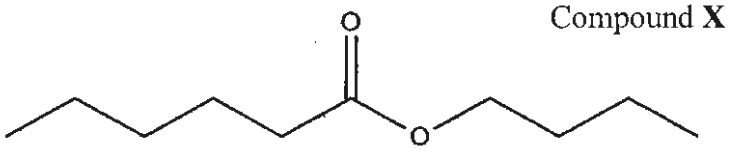
20 The ester, ethyl ethanoate, can be represented by a structural formula or by a line diagram as shown below.





Methyl Ethanoate (Ester)

Another ester, **X**, is represented by the line diagram below.



Compound **X**

Which pair of organic compounds can combine to form compound **X**?

(A) butan-1-ol and hexanoic acid

(B) hexan-1-ol and butanoic acid

(C) butan-1-ol and pentanoic acid

(D) hexan-1-ol and propanoic acid

Exam Number: _____

Part B – 55 marks
Attempt Questions 21-30
Allow about 1 hour and 25 minutes for this part

Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Question 21 (5 marks) **Marks**

A student performed a first-hand investigation, to determine the heat of combustion of methanol. The SI data book lists the heat of combustion of methanol as 715 kJ mol^{-1}.

(a) Identify the measurements the student would have recorded. **2**

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(b) Write an equation for the combustion of methanol at 25°C, including the energy term. **1**

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(c) By considering the bonds broken and formed during combustion reactions, explain why the heat of combustion increases as the length of the carbon chain of an alkanol increases. **2**

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Question 22 (6 marks) **Marks**

You have studied the chemistry and construction of a galvanic cell **other** than a lead-acid battery or a dry cell.

Identify the cell you have studied. .....

(a) Describe the construction of the cell. Include a diagram in your response. **3**

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(b) Write half-equations for the electrode reactions. **1**

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(c) Outline a use for society and assess the environmental impact associated with use of the identified cell. **2**

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Question 23 (7 marks) **Marks**

(a) Discuss the future use of ethanol as replacements for fossil fuels. **4**

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(b) Compare the suitability of ethanol and cellulose as potential future replacements for fossil fuels. **3**

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Question 24 (5 marks) **Marks**

Raw materials such as crude oil and biomass are used in the manufacture of polymers. The chemical reactions involved in the formation of polymers can be classified as addition or condensation reactions. **5**

Explain the difference between addition and condensation reactions by discussing an example of each type of polymerisation to form a polymer. Include equations in your response.

Question 25 (4 marks) **Marks**

(a) A student classified thorium as a radioactive metal, as an actinide and as a transuranic element. Is the student's classification of thorium correct? Explain your answer. **2**

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(b) Name an isotope used in medicine. Describe the properties that make it suitable for that application. **2**

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Question 26 (8 marks) **Marks**

(a) Write an equation for the reaction of potassium oxide with water and explain why potassium oxide is classified as basic. **2**

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(b) Citric acid is a triprotic weak acid. Draw the structural formula for citric acid and explain why it is classified as a triprotic weak acid. **2**

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(c) Describe the problems associated with the release of oxides of nitrogen and sulfur into the atmosphere. **4**

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Question 27 (5 marks) **Marks**

The terms amphiprotic and amphoteric are used to describe chemicals involved in acid-base reactions.

(a) Explain why the hydrogencarbonate ion is described as amphiprotic. **2**

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(b) Compare the suitability of sodium hydrogencarbonate as a neutralising agent for both acidic and basic spills. **3**

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Question 28 (3 marks) **Marks**

Calculate the pH of the resulting solution when 75.0 mL of 0.15 mol L^{-1} potassium hydroxide solution and 150 mL of 0.10 mol L^{-1} sulfuric acid are mixed. **3**

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Question 29 (5 marks) **Marks**

Oxalic acid dihydrate, $H_2C_2O_4.2H_2O$, a diprotic acid, can be used to standardise sodium hydroxide solutions.

In an experiment, 0.456 g oxalic acid dihydrate was measured out and dissolved in water. One drop of phenolphthalein indicator was added and the solution titrated with the sodium hydroxide solution which needed to be standardised. 38.7 mL was needed to reach the equivalence point.

(a) Justify the need for sodium hydroxide to be standardised by the oxalic acid solution. **2**

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(b) Describe steps you would take to prepare the burette for dispensing the sodium hydroxide solution. **1**

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(c) Calculate the concentration of the sodium hydroxide solution. **2**

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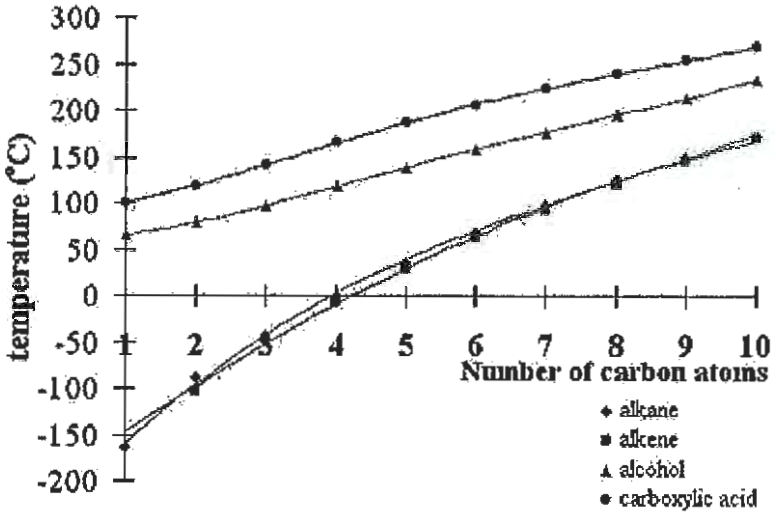
Question 30 (7 marks) **Marks**

Most esters prepared in school laboratories have relatively low boiling points.

(a) Explain the trends in boiling points shown in the graph. **4**



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(b) Explain how this factor impacts on the method of preparation of esters. **2**

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(c) Explain how this factor impacts on the method of separation of the ester from an equilibrium mixture containing alkanoic acid, alkanol, water and ester. **1**

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End of Paper

DATA SHEET

Avogadro constant, N_A ..... 6.022×10^{23} mol^{-1}

Volume of 1 mole ideal gas: at 100 kPa and

at 0°C (273.15 K) ..... 22.71 L

at 25°C (298.15 K) ..... 24.79 L

Ionisation constant for water at 25°C (298.15 K), K_w ..... 1.0×10^{-14}

Specific heat capacity of water ..... 4.18×10^3 J kg^{-1} K^{-1}

Some useful formulae

$$pH = -\log_{10}[H^+] \qquad \Delta H = -mC\Delta T$$

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

Aylward and Findlay, *SI Chemical Data* (5th Edition) is the principal source of data for this examination paper. Some data may have been modified for examination purposes.

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number — 79 — Symbol of element
Atomic Weight — 197.0 — Name of element
Au — 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 65.41 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 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc [97.91] 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 183.8 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 [209.0] Polonium	85 At [210.0] Astatine	86 Rn [222.0] Radon
87 Fr [223] Francium	88 Ra [226] Radium	89–103 Actinoids	104 Rf [261] Rutherfordium	105 Db [262] Dubnium	106 Sg [266] Seaborgium	107 Bh [264] Bohrium	108 Hs [277] Hassium	109 Mt [268] Meitnerium	110 Ds [271] Darmstadtium	111 Rg [272] Roentgenium							

Lanthanoids

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm [145] 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 173.0 Ytterbium	71 Lu 175.0 Lutetium

Actinoids

89 Ac [227] Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np [237] Neptunium	94 Pu [244] Plutonium	95 Am [243] Americium	96 Cm [247] Curium	97 Bk [247] Berkelium	98 Cf [251] Californium	99 Es [252] Einsteinium	100 Fm [257] Fermium	101 Md [258] Mendelevium	102 No [259] Nobelium	103 Lr [262] Lawrencium

For elements that have no stable or long-lived nuclides, the mass number of the nuclide with the longest confirmed half-life is listed between square brackets.

The International Union of Pure and Applied Chemistry Periodic Table of the Elements (October 2005 version) is the principal source of data. Some data may have been modified.