



**UNIVERSITI KUALA LUMPUR**  
**KAMPUS CAWANGAN MALAYSIAN SPANISH INSTITUTE**

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**FINAL EXAMINATION**  
**JULY 2023 SEMESTER**

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**COURSE CODE** : SSP 01504  
**COURSE NAME** : CHEMISTRY 1  
**PROGRAMME NAME** : FOUNDATION IN SCIENCE AND ARTS  
**DATE** : 2 JANUARY 2024  
**TIME** : 09.00 AM – 11.00 AM  
**DURATION** : 2 HOURS

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**INSTRUCTIONS TO CANDIDATES**

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1. Please **CAREFULLY** read the instructions given in the question paper.
2. This question paper has information printed on both sides of the paper.
3. This question paper consists of **TWO (2)** sections; Section A and Section B.
4. For Section A, answer **ALL** questions on the OMR form provided.
5. For Section B, answer only **THREE (3)** questions from **FOUR (4)** questions on the answer booklet provided.
6. Answer all questions in English language **ONLY**.
7. Appendix has been appended for your reference.

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**THERE ARE 10 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.**

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## SECTION A (Total: 25 marks)

**INSTRUCTION: Answer ALL the questions.**

**Please use the OMR form provided.**

1. What does the relative atomic mass of an element represent?
  - A. The mass of one mole of the element
  - B. The mass of one nucleus of the element
  - C. The mass of one proton in the element
  - D. The mass of one electron in the element
2. Which term represents the simplest whole-number ratio of different atoms in a compound?
  - A. Molecular formula
  - B. Atomic number
  - C. Empirical formula
  - D. Avogadro's number
3. What unit is commonly used to express the concentration of a solution in chemistry?
  - A. Grams
  - B. Liters
  - C. Molarity
  - D. Kilowatts
4. The molecular formula for a compound reveals
  - A. the arrangement of atoms in the molecule
  - B. the types and numbers of atoms in a molecule
  - C. the mass of the compound
  - D. the state of the compound at room temperature
5. Which statement regarding stoichiometry is correct?
  - A. Stoichiometry deals with the study of ions in a solution.
  - B. Stoichiometry focuses solely on gas reactions.
  - C. Stoichiometry is the calculation of reactants and products in chemical reactions based on the mole ratio.
  - D. Stoichiometry only involves physical changes.

6. The reactant that is entirely consumed in a chemical reaction is called the
- excess reagent
  - primary reagent
  - limiting reagent
  - facilitator reagent
7. What forces are responsible for the attraction between different molecules?
- Intramolecular forces
  - Ionic bonds
  - Intermolecular forces
  - Covalent bonds
8. Which type of intermolecular force is caused by temporary dipoles in molecules?
- London dispersion forces
  - Hydrogen bonding
  - Dipole-dipole interactions
  - Van der Waals forces
9. What determines the shape of a molecule?
- Number of valence electrons
  - Type of chemical bond
  - Electron arrangement around the central atom
  - Molecular weight
10. In covalent bonding, what does hybridization refer to?
- Mixing of atomic orbitals to form new hybrid orbitals
  - Separation of valence electrons
  - Transfer of electrons between atoms
  - Formation of ionic bonds
11. Which of the following statement describes Bohr's atomic postulate?
- Electrons emit energy at ground state.
  - Electrons are very stable at excited state.
  - Electrons radiate energy while orbiting around nucleus.
  - Electrons radiate energy when fall back to lower energy levels.

12. Which of the following statement is incorrect about the ionization energy of hydrogen atom?
- A. Ionization energy is the energy required to remove 1 mole of electrons from 1 mole of hydrogen atoms.
  - B. Ionization process involves the transition of an electron from ground state to  $n = \infty$ .
  - C. The second ionization energy of hydrogen atom is always greater than the first one.
  - D. Energy is absorbed during the ionization process.
13. Which of the following combinations of quantum number is not allowed?
- A.  $n = 2, l = 1, m = 0$
  - B.  $n = 3, l = 4, m = -3$
  - C.  $n = 4, l = 3, m = +3$
  - D.  $n = 5, l = 4, m = -4$
14. Choose the correct postulate from de Broglie.
- A. Small particles like electrons process wave properties.
  - B. Small particles like electrons move in circular orbits.
  - C. Small particles like electrons were confined in a specific orbit.
  - D. Small particles like electrons emitting light when circling nucleus.
15. Line emission spectrum of hydrogen is formed when
- I. electrons gain energy and excited to higher energy levels.
  - II. electrons jump back from higher energy levels to lower energy levels.
  - III. radiation emits photons at specific frequencies.
- A. I only
  - B. I & II
  - C. II & III
  - D. I, II, III
16. How many orbitals can be accommodated in an atom with a maximum quantum number of  $n = 3$ ?
- A. 3
  - B. 9
  - C. 10
  - D. 14

17. Which of the following electronic configuration violates Pauli Exclusion Principle?
- A.  $\uparrow\downarrow \uparrow\downarrow \uparrow \uparrow$
  - B.  $\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow$
  - C.  $\uparrow\uparrow \uparrow\downarrow \uparrow\downarrow \uparrow$
  - D.  $\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow\downarrow$
18. Which of the following is/are factor(s) affecting ionization energy?
- I. Atomic size
  - II. Effective nuclear charge
  - III. Shielding effect
- A. I only
  - B. I & II
  - C. II & III
  - D. I, II & III
19. The ions  $P^{3-}$ ,  $S^{2-}$  and  $Cl^{-}$  have a radius of 0.212 nm, 0.184 nm and 0.181 nm respectively. This decrease in radius from  $P^{3-}$  to  $Cl^{-}$  is due to
- A. an increase in the total number of electrons and the nuclear charge.
  - B. an increase in the total number of electrons while the nuclear charge remains constant
  - C. an increase in the nuclear charge while the number of electrons is the same.
  - D. a decrease in negative charge while the total number of electrons and the nuclear charge remains constant.
20. Determine the correct period and group with the highest ionization energy.
- A. Period 2, Group 13
  - B. Period 2, Group 16
  - C. Period 3, Group 13
  - D. Period 3, Group 16
21. Which one of the following element in the third period has the highest boiling point?
- A. Sodium (Na)
  - B. Magnesium (Mg)
  - C. Aluminium (Al)
  - D. Phosphorus (P)

22. Pick the correct order of the increasing size for the following species.
- A.  $P^{5+}$ ,  $P^{3+}$ , P,  $P^{3-}$
  - B.  $P^{5+}$ , P,  $P^{3+}$ ,  $P^{3-}$
  - C.  $P^{3-}$ ,  $P^{3+}$ ,  $P^{5+}$ , P
  - D.  $P^{3-}$ , P,  $P^{3+}$ ,  $P^{5+}$
23. Select the best one that describes the noble gas family.
- A. The first ionization energy of each element is the same as they have the same valence electronic configuration.
  - B. They have an outermost electronic configuration of  $ns^2 np^6$  (except helium) where  $n$  is the period number.
  - C. All orbitals that correspond to the principal energy level,  $n$  at a particular period are completely filled.
  - D. Some element are gases and others are solids at room temperature.
24. Which of the following element has the highest second ionization energy?
- A. Sodium (Na)
  - B. Aluminum
  - C. Magnesium
  - D. Silicon
25. Three elements, X, Y, and Z are located in the same period of the Periodic Table. We can conclude that the three elements have
- I. Same proton number
  - II. Same number of valence orbitals
  - III. different atomic size and different ionization energy
- A. I only
  - B. I & II
  - C. II & III
  - D. I, II & III

## SECTION B (Total: 75 marks)

INSTRUCTION: Answer THREE questions ONLY.

Please use the answer booklet provided.

## Question 1

(a) Chlorine has proton number of 17. Figure 1 shows a mass spectrum of chlorine.

(i) Write the notation for all isotopes of chlorine.

(2 marks)

(ii) Calculate the relative atomic mass of chlorine.

(3 marks)

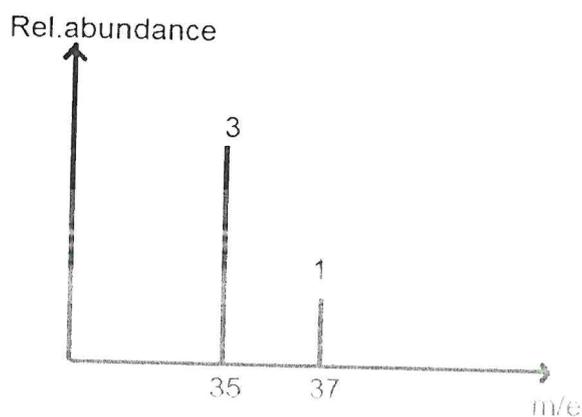


Figure 1

(b) A cyclic alkane has a molecular weight of  $128 \text{ g mol}^{-1}$ . It consists of 7.85 mol C and 6.29 mol H.

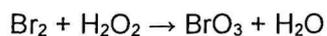
(i) Determine its empirical and molecular formula.

(5 marks)

(ii) Hydrogen peroxide  $\text{H}_2\text{O}_2$  is a powerful oxidizing agent used in concentrated solution in rocket fuels and in dilute solution as hair bleach. An aqueous solution of  $\text{H}_2\text{O}_2$  is 30.0% by mass and has a density of  $1.11 \text{ g mL}^{-1}$ . Calculate its molality.

(5 marks)

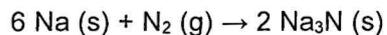
- (c) The following reaction takes place in an acidic condition.



Write a balance equation for the above reaction.

(3 marks)

- (d) Sodium nitride can be formed by heating the sodium metal under nitrogen gas.



In a reaction between 38.0 g of sodium with an excess of 0.30 mol nitrogen gas, the percentage yield of  $\text{Na}_3\text{N}$  produced is 75.1%.

(Given Molar mass in  $\text{g mol}^{-1}$ : Na = 23.0, N = 14.0)

- (i) What is the actual amount of the  $\text{Na}_3\text{N}$  produced in gram?

(5 marks)

- (ii) Determine the mole of nitrogen gas remained after the reaction completed?

(2 marks)

## Question 2

- (a) By using Phosphorus ( $Z = 15$ ) as an example, explain when Hund's rule is applied in the filling of electrons into atomic orbitals. (6 marks)
- (b) Calculate the frequency and wavelength that corresponds to the second line of the Brackett series of hydrogen spectrum. (8 marks)
- (c) Write the electronic configuration for the following element and ions: (6 marks)
- (i) Fluorine (F)
  - (ii)  $\text{Ca}^{2+}$
  - (iii)  $\text{N}^{3-}$
- (d) Figure 2 below shows the Lyman series of hydrogen emission spectrum.
- (i) Define photon. (1 marks)
  - (ii) Identify the line with the longest wavelength. (2 marks)
  - (iii) Identify the line with the highest frequency. (2 marks)

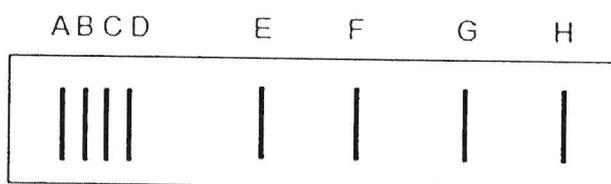


Figure 2

## Question 3

(a) The following Table 1 shows 5 elements. With their respective proton numbers, state the element that:

- (i) belong to the same group
- (ii) has the highest first ionization energy
- (iii) is the biggest in size

(3 marks)

Table 1

Element	Proton number
A	9
B	11
C	12
D	17
E	18

(b) Balance the following equations and write its equilibrium constant expression,  $K_c$ .

- (i)  $\text{SO}_2(g) + \text{O}_2(g) \rightarrow \text{SO}_3(g)$
- (ii)  $\text{C}_3\text{H}_8(g) + \text{O}_2(g) \rightarrow \text{CO}_2(g) + \text{H}_2\text{O}(l)$
- (iii)  $\text{NaHCO}_3(s) \rightarrow \text{Na}_2\text{CO}_3(s) + \text{CO}_2(g) + \text{H}_2\text{O}(l)$
- (iv)  $\text{I}_2(s) + \text{F}_2(g) \rightarrow \text{IF}_7(g)$

(16 marks)

(c) Nitrogen gas and oxygen gas react at high temperature to form nitrogen monoxide gas. The equilibrium constant for the reaction,  $K_c$  is  $4.1 \times 10^{-4}$  at  $2000^\circ\text{C}$ . Given the equilibrium concentration of  $\text{N}_2$  gas and  $\text{O}_2$  gas are  $0.25 \text{ mol dm}^{-3}$  and  $1.2 \text{ mol dm}^{-3}$ , respectively.

- (i) Write a balance chemical reaction for the system.

(2 marks)

- (ii) Calculate the equilibrium concentration of NO gas.

(2 marks)

- (iii) Does the reaction favour the reactants or the product at this temperature?

(2 marks)

## Question 4

- (a) Acetone is a colourless, volatile and flammable liquid. It is miscible with water and serves as an important solvent typically for cleaning purposes in the laboratory.
- (i) Draw the overlapping orbitals of acetone and label sigma ( $\sigma$ ) and pi ( $\pi$ ) bond in the molecule.
- (ii) State the bond angle between H-C-H and C-C-O

(10 marks)

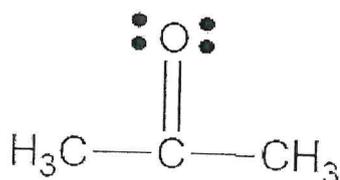


Figure 3. Acetone

- (b) Carbon disulphide is a neurotoxic, colorless, volatile liquid with the formula  $\text{CS}_2$ . Draw two Lewis structures of  $\text{CS}_2$  and determine the most plausible Lewis structure of  $\text{CS}_2$ .
- (c) Magnesium, Mg and Aluminium, Al are metals.
- (i) Draw the electron sea model diagram for Magnesium.
- (ii) Why Aluminum has higher boiling point than Magnesium?
- (iii) By using band theory of solid, explain how Magnesium conducts electricity.

(5 marks)

(10 marks)

END OF EXAMINATION PAPER

## APPENDICES

TABLE OF RELATIVE ATOMIC MASSES

Element	Symbol	Proton number	Relative atomic mass
Aluminium	Al	13	27.0
Silver	Ag	47	107.9
Argon	Ar	18	40.0
Arsenic	As	33	74.9
Gold	Au	79	197.0
Barium	Ba	56	137.3
Beryllium	Be	4	9.0
Bismuth	Bi	83	209.0
Boron	B	5	10.8
Bromine	Br	35	79.9
Iron	Fe	26	55.9
Fluorine	F	9	19.0
Phosphorus	P	15	31.0
Helium	He	2	4.0
Mercury	Hg	80	200.6
Hydrogen	H	1	1.0
Iodine	I	53	126.9
Cadmium	Cd	48	112.4
Potassium	K	19	39.1
Calcium	Ca	20	40.1
Carbon	C	6	12.0
Chlorine	Cl	17	35.5
Cobalt	Co	27	58.9
Krypton	Kr	36	83.8
Chromium	Cr	24	52.0
Copper	Cu	29	63.6
Lithium	Li	3	6.9
Magnesium	Mg	12	24.3
Manganese	Mn	25	54.9
Sodium	Na	11	23.0
Neon	Ne	10	20.2
Nickel	Ni	28	58.7
Nitrogen	N	7	14.0
Oxygen	O	8	16.0
Platinum	Pt	78	195.1
Lead	Pb	82	207.2
Protactinium	Pa	91	231.0
Radium	Ra	88	226.0
Radon	Rn	86	222.0
Rubidium	Rb	37	85.5
Selenium	Se	34	79.0
Cerium	Ce	58	140.1
Caesium	Cs	55	132.9
Silicon	Si	14	28.1
Scandium	Sc	21	45.0
Tin	Sn	50	118.7
Antimony	Sb	51	121.8
Strontium	Sr	38	87.6
Sulphur	S	16	32.1
Uranium	U	92	238.0
Tungsten	W	74	183.9
Zinc	Zn	30	65.4

LIST OF SELECTED CONSTANT VALUES

Ionization constant for water at 25 °C	$K_w$	$= 1.0 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-16}$
Molar volume of gases	$V_m$	$= 22.4 \text{ dm}^3 \text{ mol}^{-1}$ at STP $= 24 \text{ dm}^3 \text{ mol}^{-1}$ at room temperature
Speed of light in a vacuum	$c$	$= 3.0 \times 10^8 \text{ m s}^{-1}$
Specific heat of water		$= 4.18 \text{ kJ kg}^{-1} \text{ K}^{-1}$ $= 4.18 \text{ J g}^{-1} \text{ K}^{-1}$ $= 4.18 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$
Avogadro's number	$N_A$	$= 6.02 \times 10^{23} \text{ mol}^{-1}$
Faraday constant	$F$	$= 96500 \text{ C mol}^{-1}$
Planck constant	$h$	$= 6.6256 \times 10^{-34} \text{ J s}$ $= 6.6256 \times 10^{-34} \text{ Kg m}^2 \text{ s}^{-1}$
Rydberg constant	$R_H$	$= 1.097 \times 10^7 \text{ m}^{-1}$ $= 2.18 \times 10^{-18} \text{ J}$
Ideal gas constant	$R$	$= 8.314 \text{ m}^3 \text{ Pa mol}^{-1} \text{ K}^{-1}$ $= 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$ $= 0.08206 \text{ L atm mol}^{-1} \text{ K}^{-1}$ $= 62.36 \text{ L mmHg mol}^{-1} \text{ K}^{-1}$
Density of water at 25 °C	$\rho$	$= 1 \text{ g cm}^{-3}$
Freezing point of water		$= 0.00 \text{ }^\circ\text{C}$ $= 273.15 \text{ K}$
Vapour pressure of water at 25 °C	$P_{H_2O}$	$= 23.8 \text{ torr}$

UNIT AND CONVERSION FACTOR

VOLUME	1 L	=	1 dm <sup>3</sup>
	1 mL	=	1 cm <sup>3</sup>
ENERGY	1 J	=	1 kg m <sup>2</sup> s <sup>-2</sup>
		=	1 N m
		=	1 × 10 <sup>7</sup> erg
	1 calorie	=	4.184 J
	1 eV	=	1.602 × 10 <sup>-19</sup> J
PRESSURE	1 atm	=	760 mmHg
		=	760 torr
		=	101 325 Pa
		=	101.325 kPa
		=	101 325 N m <sup>-2</sup>

**JULY 2023**

**CONFIDENTIAL**

TEMPERATURE	0°C	=	273.15 K
OTHERS	1 faraday (F)	=	96 500 C
	1 newton (N)	=	1 kg m s <sup>-2</sup>

LIST OF FORMULA

- **Relative atomic mass**

$$A_r = \frac{\text{Average mass of one atom of the element}}{\frac{1}{12} \times \text{mass of one atom C} - 12}$$

- **Average atomic mass**

$$\frac{\sum(\text{isotopic mass} \times \text{abundance})}{\sum \text{abundance}}$$

- **Mole**

$$n = \frac{\text{Mass, g}}{\text{Molar mass, gmol}^{-1}}$$

- **Mole**

$$n = \frac{\text{No particles}}{\text{Avogadro's constant}}$$

- **Planck's Quantum Theory**

Energy of one photon

$$= hv = \frac{hc}{\lambda}$$

- **Bohr's Model for Hydrogen like atoms**

Quantization of angular momentum

$$mvr = n \frac{h}{2\pi}$$

$$E_n = -\frac{E_1}{n^2} z^2 = 2.178 \times 10^{-18} \frac{z^2}{n^2} \frac{J}{\text{atom}} = 13.6 \frac{z^2}{n^2} \text{eV}; E_1 = \frac{-2\pi^2 m e^4}{n^2}$$

$$r_n = \frac{n^2}{z} \times \frac{n^2}{4\pi^2 e^2 m} = \frac{0.529 \times n^2}{z} \text{A}$$

$$v = \frac{2\pi ze^2}{nh} = \frac{2.18 \times 10^6 \times z}{n} \text{ m/s}$$

Energy of an electron in its level

$$E_n = -R_H \left( \frac{1}{n^2} \right)$$

Energy for the electron transition

$$\Delta E = R_H \left( \frac{1}{n_i^2} - \frac{1}{n_f^2} \right)$$

Ionization energy

$$E = \Delta E \times N_A$$

- **De-Broglie wavelength**

$$\lambda = \frac{h}{mc} = \frac{h}{p}$$

(for photon)

- **Wavelength of emitted photon**

$$\frac{1}{\lambda} = \bar{\nu} = RZ^2 \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

- Heisenberg's Uncertainty Principle

$$\Delta x \cdot \Delta p > \frac{h}{4\pi} \text{ or } m\Delta x \cdot \Delta v \geq \frac{h}{4\pi} \text{ or } \Delta x \cdot \Delta v \geq \frac{h}{4\pi m}$$

- **Quantum numbers**

Principal quantum number

$$(n) = 1, 2, 3, 4 \dots \text{to } \infty$$

Orbital angular momentum of electron in any orbit

$$= \frac{nh}{2\pi}$$

Azimuthal quantum number (l) = 0, 1, ... to (n-1)

Number of orbitals in a subshell = 2l + 1

Maximum number of electrons in particular subshell  $2 \times (2\ell + 1)$

Orbital angular momentum

$$L = \frac{h}{2\pi} \sqrt{\ell(\ell + 1)} = \hbar \sqrt{\ell(\ell + 1)} \left[ \hbar = \frac{h}{2\pi} \right]$$

- **Law Of Chemical Equilibrium**

$$\frac{[C]^c [D]^d}{[A]^a [B]^b} = K$$

- **Law Of Chemical Equilibrium Partial Pressure**

$$\frac{(P_C)^c (P_D)^d}{(P_A)^a (P_B)^b} = K_p$$

- **Constants**

Rydberg's constant:  $R_H = 2.18 \times 10^{-18} J$

Rydberg's constant :  $R_H = 1.097 \times 10^7 m^{-1}$

Avogadro's number:  $N_A = 6.023 \times 10^{23} J mol^{-1}$

Speed of light:  $c = 3 \times 10^8 m/s$

Planck's constant:  $h = 6.625 \times 10^{-34} J$

The Periodic Table of Elements

1	2	3	4	5	6	7	0 (8)										
(1) 6.9 Li lithium 3	(2) 9.0 Be beryllium 4	(3) 45.0 Sc scandium 21	(4) 47.9 Ti titanium 22	(5) 50.9 V vanadium 23	(6) 52.0 Cr chromium 24	(7) 54.9 Mn manganese 25	(8) 55.8 Fe iron 26	(9) 58.9 Co cobalt 27	(10) 58.7 Ni nickel 28	(11) 63.5 Cu copper 29	(12) 65.4 Zn zinc 30	(13) 10.8 B boron 5	(14) 12.0 C carbon 6	(15) 14.0 N nitrogen 7	(16) 16.0 O oxygen 8	(17) 19.0 F fluorine 9	(18) 4.0 He helium 2
23.0 Na sodium 11	24.3 Mg magnesium 12	39.1 K potassium 19	88.9 Y yttrium 39	87.6 Sr strontium 38	40.1 Ca calcium 20	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	112.4 Cd cadmium 48	114.8 In indium 49	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hasium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						
* Lanthanide series		140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	163 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71			
* Actinide series		232 Th thorium 90	[231] Pa protactinium 91	238 U uranium 92	[242] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[245] Bk berkelium 97	[251] Cf californium 98	[254] Es einsteinium 99	[253] Fm fermium 100	[256] Md mendelevium 101	[254] No nobelium 102	[257] Lr lawrencium 103			

1.0 H hydrogen 1
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Key
relative atomic mass
atomic symbol
name
atomic (proton) number

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