UNIVERSITY OF ESWATINI

RE-SIT EXAMINATION 2020/2021

TITLE OF PAPER: INTRODUCTORY CHEMISTRY I

COURSE NUMBER: CHE151

TIME ALLOWED: THREE (3) HOURS

INSTRUCTIONS: THERE ARE TWO (2) SECTIONS: SECTION A AND SECTION B. ANSWER ALL THE QUESTIONS IN SECTION A AND ANY TWO (2) QUESTIONS FROM SECTION B.

SECTION A IS WORTH 50 MARKS AND EACH QUESTION IN SECTION B IS WORTH 25 MARKS.

THE ANSWER SHEET FOR SECTION A IS ATTACHED TO THE QUESTION PAPER. GIVE YOUR ANSWERS TO THE QUESTIONS IN THIS SECTION BY MAKING A CROSS IN THE GRID PROVIDED, SEE EXAMPLES BELOW. THERE CAN ONLY BE ONE CORRECT ANSWER.

Question	A	B	C	D	E
1			X		
2	X				

AT THE END OF THE EXAM, BEFORE YOU LEAVE, PLACE THE ANSWER SHEET FOR SECTION A INSIDE THE UNESWA ANSWER BOOKLET CONTAINING YOUR ANSWERS TO SECTION B

A PERIODIC TABLE AND OTHER USEFUL DATA HAVE BEEN PROVIDED WITH THIS EXAMINATION PAPER.

PLEASE DO NOT OPEN THIS EXAMINATION PAPER UNTIL PERMISSION HAS BEEN GRANTED BY THE CHIEF INVIGILATOR.

SECTION A

MULTIPLE CHOICE [50 MARKS]

Indicate the best option for each of the following multiple choice questions:

1. How many picometers would be equivalent to 5 cm?
   (A) 5×10^{12} pm (B) 5×10^{6} pm (C) 5×10^{14} pm
   (D) 5×10^{10} pm (E) 5×10^{8} pm

2. All of the following are extensive properties of a substance except
   (A) colour (B) length (C) mass
   (D) volume (E) internal energy

3. What is the symbol of the element potassium?
   (A) Po (B) Pt (C) K
   (D) P (E) Kr

4. A lead ball with a mass of 36.0 g is placed in exactly 100 ml of water in a graduated cylinder. If 3.2 ml of water are displaced from the cylinder, what is the density of the ball?
   (A) 41.5 g/ml (B) 11.3 g/ml (C) 8.9 g/ml
   (D) 1.2 g/ml (E) 32.8 g/ml

5. What is the Fahrenheit temperature that corresponds to 298 K?

   Useful Equations: $^{\circ}C = \frac{5}{9}(^{\circ}F - 32^{\circ})$; $K = {}^{\circ}C + 273$

   (A) 57°F (B) 32°F (C) 43°F (D) 77°F (E) 45°F

6. A combination of salt and water is an example of a _____.
   (A) homogeneous mixture (B) compound (C) solid
   (D) pure substance (E) heterogeneous mixture

7. What is oxidation number of S in H_2SO_4?
   (A) 2 (B) 4 (C) 5 (D) 8 (E) 6

8. Of the following, only _____ is a chemical reaction.
   (A) melting of copper (B) dissolving salt in water (C) burning sugar
   (D) crushing of stones (E) dropping 5 cents into a glass of water

9. Which of the measured numbers below has the greatest number of significant figures?
   (A) 6.02350 (B) 0.0060235 (C) 0.00060235
   (D) 6.0235×10^{3} (E) 60235

10. Which of the following has the same number of significant figures as the number 1.030?

(A) 1×10^6 (B) 199.791 (C) 8.66
(D) 5.119 (E) 100

11. Which atom has the smallest number of neutrons?

(A) chlorine-35 (B) chlorine-37 (C) potassium-39
(D) sulphur-33 (E) calcium-40

12. An atom of an isotope of bromine, ^{79}Br, has _____ protons, _____ neutrons and _____ electrons.

(A) 79, 35, 35 (B) 35, 35, 79 (C) 35, 44, 35
(D) 44, 35, 44 (E) 35, 79, 35

13. Which species has 16 electrons?

(A) ^{31}P (B) ^{34}S (C) $^{36}Cl^-$
(D) $^{80}Br^-$ (E) ^{16}O

14. The element X has two naturally occurring isotopes. The masses (g/mol) and % abundances of the isotopes are given in the table below. The average atomic mass of the element is _____ g/mol.

Isotope	Abundance (%)	Mass (g/mol)
^{35}X	75.53	34.9688
^{37}X	24.47	36.9651

(A) 35.97 (B) 71.93 (C) 35.45
(D) 36.55 (E) 36.00

15. Which of the following is a non-metal?

(A) Pb (B) Ba (C) Ru
(D) Se (E) Sc

16. An element that appears in the top right corner of the periodic table is _____.

(A) either a metal or metalloid (B) definitely a metal
(C) either a metalloid or a non-metal (D) definitely a non-metal
(E) definitely a metalloid

17. How many grams of $NaNO_3$ are required to prepare 125 mL of 3.00 M $NaNO_3$?

(A) 31.9 g (B) 46.1 g (C) 227 g (D) 3.54 g (E) 28.3 g

18. Which of the following compounds would you expect to be ionic?

(A) H_2O (B) CO_2 (C) K_2O
(D) SO_2 (E) Cl_2O

19. Which species below is the sulphate ion?
(A) SO_2^{2-} (B) SO_3^{2-} (C) S^{2-}
(D) SO_4^{2-} (E) HS^-

20. Which formula/name pair is **incorrect**?
(A) $MnCl_2$/manganese(II) chloride (B) $MgCl_2$/magnesium chloride
(C) KNO_3/potassium nitrate (D) $Mg(ClO_4)_2$/magnesium perchlorate
(E) $Mn(ClO_3)_2$/manganese(IV) chlorate

21. When the following equation is balanced, the coefficients are _____.

$$Al(NO_3)_3 + Na_2S \rightarrow Al_2S_3 + NaNO_3$$

(A) 4, 6, 3, 2 (B) 2, 1, 3, 2 (C) 2, 3, 1, 6
(D) 1, 1, 1, 1 (E) 2, 3, 2, 3

22. There are _____ carbon atoms in 25 molecules of $C_4H_4S_2$.
(A) 100 (B) 9.6×10^{25} (C) 3.0×10^{25}
(D) 50 (E) 6.02×10^{23}

23. What is the formula weight in g/mol of potassium permanganate, $KMnO_4$?
(A) 155.06 (B) 158.04 (C) 108.00
(D) 185.04 (E) 142.04

24. What is the mass % of C in methane, CH_4?
(A) 25.13 (B) 133.6 (C) 74.87
(D) 92.26 (E) 7.743

25. How many moles of sodium carbonate, Na_2CO_3 contains 3.01×10^{19} carbon atoms?
(A) 2.83×10^{17} (B) 4.17×10^{-7} (C) 1.43×10^{-7}
(D) 5.00×10^{-5} (E) 9.817×10^{-8}

26. Lithium and nitrogen react to produce lithium nitride:

$$6Li\,(s) + N_2\,(g) \rightarrow 2Li_3N\,(s)$$

How many moles of Li are needed to react with 0.500 moles of N_2?
(A) 3.00 (B) 0.500 (C) 0.167
(D) 1.50 (E) 0.0833

27. The molarity of a solution prepared by diluting 43.72 mL of 5.005 M aqueous NaOH to 500.0 mL is _____ M.
(A) 57.2 (B) 0.0044 (C) 0.438
(D) 0.0879 (E) 0.870

28. All of the orbitals in a given electron shell have the same value of the _____ quantum number.
(A) principal (B) azimuthal (C) magnetic
(D) spin (E) psi

29. Which of the subshells below do **not** exist due to the constraints upon the azimuthal quantum number?
(A) 3d (B) 3f (C) 3p
(D) all of the above (E) none of the above

30. Which set of three quantum numbers (n, l, m_l) corresponds to a 3p orbital?
(A) 3, 0, 1 (B) 3, 0, 0 (C) 3, 1, 0
(D) 3, 2, 0 (E) 3, 3, 1

31. The _____ orbital is degenerate with $4p_x$ in a many-electron atom.
(A) 5s (B) $5p_x$ (C) $4p_y$
(D) $5d_{xy}$ (E) 4s

32. Which of the following is **not** a valid set of four quantum numbers (n, l, m_l, m_s)?
(A) 3, 0, 0, +½ (B) 3, 1, 0, +½ (C) 3, 1, −1, −½
(D) 3, 2, 1, +½ (E) 3, 3, 2, +½

33. What is the ground state electron configuration of Co?
(A) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$ (B) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$ (C) $1s^2 2s^2 3s^2 3p^{10}$
(D) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 4s^2$ (E) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4d^7$

34. What element has a valence configuration of $4s^1$?
(A) Cl (B) Na (C) K
(D) Rb (E) Sr

35. What is the electron configuration for the Ti^{2+} ion?
(A) $[Ar]3d^4$ (B) $[Ar]4s^2 3d^2$ (C) $[Ar]3d^2$
(D) $[Ar]4s^2 3d^8$ (E) $[Ar]4s^2$

36. What wavelength of light in meters has a frequency of $1.20 \times 10^{13} s^{-1}$?
(A) 25.0 (B) 2.50×10^{-5} (C) 0.0400
(D) 12.0 (E) 2.5

37. Atomic radius generally increases as we move _____.
(A) down a group and from right to left across a period
(B) up a group and from left to right across a period
(C) down a group and from left to right across a period
(D) up a group and from right to to left across a period
(E) down a group; the period position has no effect

38. Which ion below has the largest radius?
(A) Cl^- (B) K^+ (C) Br^-
(D) Ca^{2+} (E) Na^+

39. Which one of the following compounds would produce an acidic solution when dissolved in water?

(A) Na_2O (B) CaO (C) MgO
(D) SO_3 (E) SrO

40. Consider the following reactions:

$ZrC + 4Cl_2 \rightarrow ZrCl_4 + CCl_4$
$ZrCl_4 + 2Mg \rightarrow Zr + 2MgCl_2$

How many moles of Zr are produced from 9.00 moles of chlorine gas?

(A) 0.444 moles (B) 2.00 moles (C) 1.00 moles
(D) 9.00 moles (E) 2.25 moles

41. Which of the following would have to lose **<u>two electrons</u>** in order to achieve a noble gas configuration?

S Ca Na Se Br

(A) S, Se (B) Ca (C) Na
(D) Br (E) Ca, S, Se

42. What colour of visible light has the longest wavelength?

(A) blue (B) violet (C) red
(D) yellow (E) green

43. Which one of the following compounds would produce an acidic solution when dissolved in water?

(A) Na_2O (B) CaO (C) MgO
(D) CO_2 (E) SrO

44. Na reacts with element X to form an ionic compound with the formula Na_3X. What compound is formed when Ca reacts with X?

(A) CaX_2 (B) CaX (C) Ca_2X_3
(D) Ca_3X_2 (E) Ca_3X

45. How many unpaired electrons are there in the ground state of the ion Cr^{2+}?

(A) 0 (B) 4 (C) 1 (D) 5 (E) 3

46. Consider the following reaction:

$3NO_2(g) + H_2O(l) \rightarrow 2HNO_3(l) + NO(g)$

How many moles of $NO_2(g)$ are required to react with 1.50 moles of water to produce 4.00 moles of nitric acid?

(A) 8.00 moles (B) 6.00 moles
(C) 1.33 moles (D) 3.00 moles
(E) Not enough water is available to produce 4.00 moles of nitric acid.

47. Calculate the volume of 1.00 M HNO_3 needed to react completely with 25.0 ml of 1.84 M $Ca(OH)_2$.

(A) 368 ml (B) 46.0 ml (C) 21.7 ml (D) 92.0 ml (E) 184 ml

48. A 20.0 ml sample of sulphuric acid from a lake near a mine was titrated to the stoichiometric point with 9.92 ml of 0.0120 M NaOH. What is the molarity of the sulphuric acid in the sample?

(A) 0.00398 M (B) 0.0119 M (C) 0.00238 M
(D) 0.00298 M (E) 0.00595 M

49. Consider the following reaction:

$$6\,Na + Al_2O_3 \rightarrow 2Al + 3Na_2O$$

When 5.52 g of sodium react with excess Al_2O_3, 1.50 g of Al is produced. What is the percent yield?

(A) 69.4% (B) 27.2% (C) 81.5% (D) 34.7% (E) 23.1%

50. Which hydrocarbon pair below have identical mass percentage of C?

(A) C_3H_4 and C_3H_6 (B) C_2H_4 and C_3H_4 (C) C_2H_4 and C_4H_2
(D) C_2H_4 and C_3H_6 (E) none of the above

SECTION B

ANSWER ANY TWO OF THE THREE QUESTIONS [50 MARKS]

QUESTION ONE [25 Marks]

(a) An element has three naturally occurring isotopes with the following masses and abundances:

Isotopic Mass (g/mol)	Fractional Abundance
38.964	0.9326
39.964	1.000×10^{-4}
40.962	0.0673

(i) Calculate the atomic weight of this element. [2]

(ii) What is the identity of the element? [1]

(b) (i) How many possible values for l and m_l are there when $n = 4$? [2]

(ii) Give the values for n, l, and m_l for

(1) each orbital in the $3s$ subshell. [1½]

(2) each orbital in the $4f$ subshell. [1½]

(c) Which of the following are permissible sets of quantum numbers for an electron in a hydrogen atom? For those combinations that are permissible, write the appropriate designation for the subshell to which the orbital belongs (e.g. $1s$, and so on). For those that are not permissible briefly explain why they are not permissible.

(i) $n = 3, l = 1, m_l = -2$; [2]

(ii) $n = 4, l = 3, m_l = -2$; [2]

(iii) $n = 6, l = 2, m_l = 0$? [2]

(d) Write the condensed electron configurations for the following atoms, using the appropriate noble-gas core abbreviations and indicate how many unpaired electrons each has:

(i) P [2]

(ii) Ge [2]

(e) (i) An experiment calls for the addition to a reaction vessel of 0.184 g of sodium hydroxide, NaOH, in aqueous solution. How many milliliters of 0.150 M NaOH should be added? [2]

(ii) A flask contains a solution with an unknown amount of HCl. This solution is titrated with 0.207 M NaOH. It takes 4.47 mL of the NaOH solution to complete the reaction. What is the mass of the HCl? [3]

(iii) Label each of the following as a substance, a heterogeneous mixture or a solution

(1) Seawater. [1]

(2) Sulphur. [1]

QUESTION TWO [25 Marks]

(a) (i) Arrange the following atoms in order of increasing first ionization energy:
F, P, Cl, As [1]

(ii) Arrange the following atoms in order of increasing radius:
Ca, Mg, Be [1]

(iii) Why does N have a larger first ionization energy than O? [3]

(b) Give systematic names to the following binary compounds:

(i) HI [1]

(ii) P_2O_5 [1]

(c) (i) A compound composed of 2.12% H, 29.8% N and 68.1% O has a molar mass of 47.0 g/mol. Determine the molecular formula of the compound. [5]

(ii) Calcium oxide reacts with water in a combination reaction to produce calcium hydroxide:

$$CaO\ (s) + H_2O\ (l) \rightarrow Ca(OH)_2\ (s)$$

A 4.00-g sample of CaO is reacted with 3.86 g of H_2O. How many grams of water remains after completion of reaction? [4]

(d) Give the name and formula of the acid corresponding to each of the following oxoanions:

(i) sulphite ion, SO_3^{2-} [2]

(ii) arsenate ion, AsO_4^{3-} [2]

(e) (i) A 1.680 g sample of coal contains 1.584 g C. Calculate the mass percentage of C in the coal. [1]

(ii) For each of the following binary compounds, decide whether the compound is expected to be ionic or molecular.

(1) SeF_4 [1]

(2) LiBr [1]

(iii) Washing soda has the formula $Na_2CO_3 \cdot 10H_2O$. What is the chemical name of this substance? [1]

(iv) The mineral gypsum has the chemical name calcium sulphate dihydrate. What is the chemical formula of this substance? [1]

QUESTION THREE [25 Marks]

(a) A sample of 5.53 g of $Mg(OH)_2$ is added to 25.0 mL of 0.200 M HNO_3.

(i) Write the chemical equation for the reaction that occurs. [2]

(ii) Which is the limiting reactant in the reaction? [3]

(iii) How many moles of $Mg(OH)_2$, and $Mg(NO_3)_2$ are present after the reaction is complete? [3]

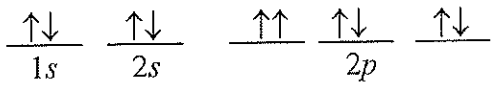
(b) Write the electron configurations of

(i) Mn^{2+} [1]

(ii) N^{3-} [1]

(iii) Look at the following orbital diagrams and electron configurations. Which are possible and which are not, according to the Pauli exclusion principle? Explain.

(1)  [2]

(2)  [2]

(3) $1s^2 2s^4 2p^2$ [2]

(c) (i) Write the chemical formula of cobalt(III) hydrogen phosphate tetrahydrate. [1]

(ii) Consider the following separations of materials. State whether a physical process or chemical reaction is involved in each separation.

(1) Sodium chloride is obtained from seawater by evaporation of the water. [1]

(2) Mercury is obtained by heating the substance mercury(II) oxide; oxygen is also obtained. [1]

(3) Iron is produced from an iron ore that contains the substance iron(III) oxide. [1]

(d) (i) The following table gives the number of protons and neutrons in the nuclei of various atoms.

	Protons	*Neutrons*
Atom A	18	19
Atom B	16	19
Atom C	18	18
Atom D	17	20

(1) Which atom is the isotope of atom A? [1]

(2) Which atom has the same mass number as atom A? [1]

(ii) A fertiliser is advertised as containing 14.0% nitrogen (by mass). How much nitrogen is there in 4.15 kg of fertiliser? [1]

(iii) What is the name of the element represented by the atomic symbol, He? [1]

(iv) Give the atomic symbol for the element potassium. [1]

Periodic Table of the Elements

Groups

PERIODS	1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9	10 VIIIB	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1.008 **H** 1																	4.003 **He** 2
2	6.941 **Li** 3	9.012 **Be** 4											10.811 **B** 5	12.011 **C** 6	14.007 **N** 7	15.999 **O** 8	18.998 **F** 9	20.180 **Ne** 10
3	22.990 **Na** 11	24.305 **Mg** 12											26.982 **Al** 13	28.086 **Si** 14	30.974 **P** 15	32.06 **S** 16	35.453 **Cl** 17	39.948 **Ar** 18
4	39.098 **K** 19	40.078 **Ca** 20	44.956 **Sc** 21	47.88 **Ti** 22	50.942 **V** 23	51.996 **Cr** 24	54.938 **Mn** 25	55.847 **Fe** 26	58.69 **Co** 27	58.69 **Ni** 28	63.546 **Cu** 29	65.39 **Zn** 30	69.723 **Ga** 31	72.61 **Ge** 32	74.922 **As** 33	78.96 **Se** 34	79.904 **Br** 35	83.80 **Kr** 36
5	85.468 **Rb** 37	87.62 **Sr** 38	88.906 **Y** 39	91.24 **Zr** 40	92.906 **Nb** 41	95.94 **Mo** 42	98.907 **Tc** 43	101.07 **Ru** 44	102.91 **Rh** 45	106.42 **Pd** 46	107.87 **Ag** 47	112.41 **Cd** 48	114.82 **In** 49	118.71 **Sn** 50	121.75 **Sb** 51	127.60 **Te** 52	126.90 **I** 53	131.29 **Xe** 54
6	132.91 **Cs** 55	137.33 **Ba** 56	138.91 ***La** 57	178.49 **Hf** 72	180.95 **Ta** 73	183.85 **W** 74	186.21 **Re** 75	190.2 **Os** 76	192.22 **Ir** 77	195.08 **Pt** 78	196.97 **Au** 79	200.59 **Hg** 80	204.38 **Tl** 81	207.2 **Pb** 82	208.98 **Bi** 83	(209) **Po** 84	(210) **At** 85	(222) **Rn** 86
7	223 **Fr** 87	226.03 **Ra** 88	(227) ****Ac** 89	(261) **Rf** 104	(262) **Ha** 105	(263) **Unh** 106	(262) **Uns** 107	(265) **Uno** 108	(266) **Une** 109	(267) **Uun** 110								

Atomic Mass → 10.811
Symbol → **B**
Atomic No. → 5

TRANSITION ELEMENTS

140.12 **Ce** 58	140.91 **Pr** 59	144.24 **Nd** 60	[145] **Pm** 61	150.36 **Sm** 62	151.96 **Eu** 63	157.93 **Gd** 64	158.93 **Tb** 65	162.50 **Dy** 66	164.93 **Ho** 67	167.26 **Er** 68	168.93 **Tm** 69	173.04 **Yb** 70	174.97 **Lu** 71
232.04 **Th** 90	231.04 **Pa** 91	238.03 **U** 92	237.05 **Np** 93	(244) **Pu** 94	(243) **Am** 95	(247) **Cm** 96	(247) **Bk** 97	(251) **Cf** 98	(252) **Es** 99	(257) **Fm** 100	(258) **Md** 101	(259) **No** 102	(260) **Lr** 103

***Lanthanide Series**

****Actinide Series**

( ) *indicates the mass number of the isotope with the longest half-life*

UNIVERSITY OF ESWATINI

CHE151 RESIT EXAMINATION ANSWER SHEET	ACADEMIC YEAR 2020/2021
Course Title: Introductory Chemistry I ANSWER SHEET FOR SECTION A OF EXAM	Stud. ID No.
Programme:	
INSTRUCTION: Place an X over the "box" corresponding to the correct answer	

Q. No.					
1	A	B	C	D	E
2	A	B	C	D	E
3	A	B	C	D	E
4	A	B	C	D	E
5	A	B	C	D	E
6	A	B	C	D	E
7	A	B	C	D	E
8	A	B	C	D	E
9	A	B	C	D	E
10	A	B	C	D	E
11	A	B	C	D	E
12	A	B	C	D	E
13	A	B	C	D	E
14	A	B	C	D	E
15	A	B	C	D	E
16	A	B	C	D	E
17	A	B	C	D	E
18	A	B	C	D	E
19	A	B	C	D	E
20	A	B	C	D	E
21	A	B	C	D	E
22	A	B	C	D	E
23	A	B	C	D	E
24	A	B	C	D	E
25	A	B	C	D	E

Q. No.					
26	A	B	C	D	E
27	A	B	C	D	E
28	A	B	C	D	E
29	A	B	C	D	E
30	A	B	C	D	E
31	A	B	C	D	E
32	A	B	C	D	E
33	A	B	C	D	E
34	A	B	C	D	E
35	A	B	C	D	E
36	A	B	C	D	E
37	A	B	C	D	E
38	A	B	C	D	E
39	A	B	C	D	E
40	A	B	C	D	E
41	A	B	C	D	E
42	A	B	C	D	E
43	A	B	C	D	E
44	A	B	C	D	E
45	A	B	C	D	E
46	A	B	C	D	E
47	A	B	C	D	E
48	A	B	C	D	E
49	A	B	C	D	E
50	A	B	C	D	E

TABLE 4.1 Solubility Guidelines for Common Ionic Compounds in Water

Soluble Ionic Compounds		Important Exceptions
Compounds containing	NO_3^-	None
	CH_3COO^-	None
	Cl^-	Compounds of Ag^+, Hg_2^{2+}, and Pb^{2+}
	Br^-	Compounds of Ag^+, Hg_2^{2+}, and Pb^{2+}
	I^-	Compounds of Ag^+, Hg_2^{2+}, and Pb^{2+}
	SO_4^{2-}	Compounds of Sr^{2+}, Ba^{2+}, Hg_2^{2+}, and Pb^{2+}
Insoluble Ionic Compounds		**Important Exceptions**
Compounds containing	S^{2-}	Compounds of NH_4^+, the alkali metal cations, Ca^{2+}, Sr^{2+}, and Ba^{2+}
	CO_3^{2-}	Compounds of NH_4^+ and the alkali metal cations
	PO_4^{3-}	Compounds of NH_4^+ and the alkali metal cations
	OH^-	Compounds of NH_4^+, the alkali metal cations, Ca^{2+}, Sr^{2+}, and Ba^{2+}

TABLE 4.2 Activity Series of Metals in Aqueous Solution

Metal	Oxidation Reaction
Lithium	$Li(s) \longrightarrow Li^+(aq) + e^-$
Potassium	$K(s) \longrightarrow K^+(aq) + e^-$
Barium	$Ba(s) \longrightarrow Ba^{2+}(aq) + 2e^-$
Calcium	$Ca(s) \longrightarrow Ca^{2+}(aq) + 2e^-$
Sodium	$Na(s) \longrightarrow Na^+(aq) + e^-$
Magnesium	$Mg(s) \longrightarrow Mg^{2+}(aq) + 2e^-$
Aluminum	$Al(s) \longrightarrow Al^{3+}(aq) + 3e^-$
Manganese	$Mn(s) \longrightarrow Mn^{2+}(aq) + 2e^-$
Zinc	$Zn(s) \longrightarrow Zn^{2+}(aq) + 2e^-$
Chromium	$Cr(s) \longrightarrow Cr^{3+}(aq) + 3e^-$
Iron	$Fe(s) \longrightarrow Fe^{2+}(aq) + 2e^-$
Cobalt	$Co(s) \longrightarrow Co^{2+}(aq) + 2e^-$
Nickel	$Ni(s) \longrightarrow Ni^{2+}(aq) + 2e^-$
Tin	$Sn(s) \longrightarrow Sn^{2+}(aq) + 2e^-$
Lead	$Pb(s) \longrightarrow Pb^{2+}(aq) + 2e^-$
Hydrogen	$H_2(g) \longrightarrow 2H^+(aq) + 2e^-$
Copper	$Cu(s) \longrightarrow Cu^{2+}(aq) + 2e^-$
Silver	$Ag(s) \longrightarrow Ag^+(aq) + e^-$
Mercury	$Hg(l) \longrightarrow Hg^{2+}(aq) + 2e^-$
Platinum	$Pt(s) \longrightarrow Pt^{2+}(aq) + 2e^-$
Gold	$Au(s) \longrightarrow Au^{3+}(aq) + 3e^-$

Ease of oxidation increases

Fundamental Physical Constants (six significant figures)

Avogadro's number	$N_A = 6.02214\times10^{23}$/mol
atomic mass unit	amu $= 1.66054\times10^{-27}$ kg
charge of the electron (or proton)	$e = 1.60218\times10^{-19}$ C
Faraday constant	$F = 9.64853\times10^{4}$ C/mol
mass of the electron	$m_e = 9.10939\times10^{-31}$ kg
mass of the neutron	$m_n = 1.67493\times10^{-27}$ kg
mass of the proton	$m_p = 1.67262\times10^{-27}$ kg
Planck's constant	$h = 6.62607\times10^{-34}$ J·s
speed of light in a vacuum	$c = 2.99792\times10^{8}$ m/s
standard acceleration of gravity	$g = 9.80665$ m/s^2
universal gas constant	$R = 8.31447$ J/(mol·K)
	$= 8.20578\times10^{-2}$ (atm·L)/(mol·K)

Rydberg constant = 1.097×10^{7} m^{-1}

SI Unit Prefixes

p	n	μ	m	c	d	k	M	G
pico-	nano-	micro-	milli-	centi-	deci-	kilo-	mega-	giga-
10^{-12}	10^{-9}	10^{-6}	10^{-3}	10^{-2}	10^{-1}	10^{3}	10^{6}	10^{9}

Conversions and Relationships

Length
SI unit: meter, m

1 km = 1000 m
= 0.62 mile (mi)
1 inch (in) = 2.54 cm
1 m = 1.094 yards (yd)
1 pm = 10^{-12} m = 0.01 Å

Volume
SI unit: cubic meter, m^3

1 dm^3 = 10^{-3} m^3
= 1 liter (L)
= 1.057 quarts (qt)
1 cm^3 = 1 mL
1 m^3 = 35.3 ft^3

Pressure
SI unit: pascal, Pa

1 Pa = 1 N/m^2
= 1 kg/m·s^2
1 atm = 1.01325×10^{5} Pa
= 760 torr
1 bar = 1×10^{5} Pa

Mass
SI unit: kilogram, kg

1 kg = 10^{3} g
= 2.205 lb
1 metric ton (t) = 10^{3} kg

Energy
SI unit: joule, J

1 J = 1 kg·m^2/s^2
= 1 coulomb·volt (1 C·V)
1 cal = 4.184 J
1 eV = 1.602×10^{-19} J

Math relationships

$\pi = 3.1416$
volume of sphere = $\frac{4}{3}\pi r^3$
volume of cylinder = $\pi r^2 h$

Temperature
SI unit: kelvin, K

0 K = −273.15°C
mp of H_2O = 0°C (273.15 K)
bp of H_2O = 100°C (373.15 K)
T (K) = T (°C) + 273.15
T (°C) = $[T\,(°F) - 32]\frac{5}{9}$
T (°F) = $\frac{9}{5}T$ (°C) + 32