UNIVERSITY OF ESWATINI

FINAL EXAMINATIONS ACADEMIC - November/December 2018

TITLE OF PAPER: INTRODUCTORY CHEMISTRY I

COURSE NUMBER: CHE151
TIME ALLOWED: THREE (3) HOURS

INSTRUCTIONS:

THERE ARE TWO SECTIONS: SECTION A AND SECTION B. ANSWER ALL THE QUESTIONS IN SECTION A AND ANY TWO 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 SECTION A QUESTIONS BY RECORDING ON THE ANSWER SHEET THE LETTER CORRESPONDING TO THE CORRECT ANSWER.

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

A PERIODIC TABLE AND A TABLE OF CONSTANTS HAVE BEEN PROVIDED WITH THIS EXAMINATION PAPER.

PLEASE DO NOT OPEN THIS PAPER UNTIL AUTHORISED TO DO SO BY THE CHIEF INVIGILATOR.

SECTION A (ANSWER ALL THE QUESTIONS FOR 50 POINTS)

1) Which one of the following is often easily separated into its components by simple techniques such as filtering or decanting?

A) heterogeneous mixture B) compounds C) homogeneous mixture

D) elements E) solutions

2) In the following list, only _____ is not an example of a chemical reaction.

A) dissolution of a penny in nitric acid
B) the condensation of water vapor
C) a burning candle
D) the formation of polyethylene from ethylene
E) the rusting of iron

3) Of the following, _____ is the largest mass.

A) 25 kg B) 2.5×10^{-2} mg C) 2.5×10^{15} pg D) 2.5×10^{9} fg E) 2.5×10^{10} ng

4) Osmium has a density of 22.6 g/cm^3. What volume (in cm^3) would be occupied by a 21.8 g sample of osmium?

A) 0.965 B) 1.04 C) 493 D) 2.03×10^{-3} E) 2.03×10^{3}

5) How many significant figures should be retained in the result of the following calculation?

$$12.00000 \times 0.9893 + 13.00335 \times 0.0107$$

A) 2 B) 3 C) 4 D) 5 E) 6

6) One angstrom, symbolized Å, is 10^{-10} m. 1 cm^3 = _____ Å^3.

A) 10^{24} B) 10^{-24} C) 10^{30} D) 10^{-30} E) 10^{-9}

7) 1 picometer = _____ centimeters

A) 1×10^{10} B) 1×10^{-10} C) 1×10^{8} D) 1×10^{-8} E) 1×10^{-12}

8) Cathode rays are _____.

A) neutrons B) X-rays C) electrons D) protons E) atoms

9) Which isotope has 36 electrons in an atom?

A) $^{80}_{36}Kr$ B) $^{80}_{35}Br$ C) $^{78}_{34}Se$ D) $^{34}_{17}Cl$ E) $^{36}_{80}Hg$

10) The element X has three naturally occurring isotopes. The masses (amu) and % abundances of the isotopes are given in the table below. The average atomic mass of the element is _____ amu.

Isotope	Abundance	Mass
^{221}X	74.22	220.9
^{220}X	12.78	220.0
^{218}X	13.00	218.1

A) 219.7 B) 220.4 C) 220.42 D) 218.5 E) 221.0

11) Which pair of elements below should be the most similar in chemical properties?

A) C and O B) B and As C) I and Br D) K and Kr E) Cs and He

12) Which of the following compounds would you expect to be ionic?

A) H_2O B) CO_2 C) $SrCl_2$ D) SO_2 E) H_2S

13) Which one of the following is the formula of hydrochloric acid?

A) $HClO_3$ B) $HClO_4$ C) HClO D) HCl E) $HClO_2$

14) The correct name for $Ni(CN)_2$ is _____.

A) nickel (I) cyanide B) nickel cyanate C) nickel carbonate D) nickel (II) cyanide

E) nickel (I) nitride

15) Chromium and chlorine form an ionic compound whose formula is $CrCl_3$. The name of this compound is _____.

A) chromium chlorine B) chromium (III) chloride C) monochromium trichloride

D) chromium (III) trichloride E) chromic trichloride

16) The formula for aluminum hydroxide is _____.

A) AlOH B) Al_3OH C) $Al_2(OH)_3$ D) $Al(OH)_3$ E) Al_2O_3

17) The correct name for HIO_2 is _____.

A) hypoiodic acid B) hydriodic acid C) periodous acid D) iodous acid

E) periodic acid

18) Of the reactions below, which one is a decomposition reaction?

A) $NH_4Cl \rightarrow NH_3 + HCl$ B) $2Mg + O_2 \rightarrow 2MgO$

C) $2N_2 + 3H_2 \rightarrow 2NH_3$ D) $2CH_4 + 4O_2 \rightarrow 2CO_2 + 4H_2O$

E) $Cd(NO_3)_2 + Na_2S \rightarrow CdS + 2NaNO_3$

19) Calculate the percentage by mass of hydrogen in $PtCl_2(NH_3)_2$.

A) 1.558 B) 1.008 C) 0.672 D) 0.034 E) 2.016

20) A nitrogen oxide is 63.65% by mass nitrogen. The molecular formula could be _____.

A) NO B) NO_2 C) N_2O D) N_2O_4 E) either NO_2 or N_2O_4

21) There are _____ mol of carbon atoms in 4 mol of $C_4H_8O_2$.

A) 4 B) 8 C) 16 D) 20 E) 32

22) What is the maximum mass in grams of NH_3 that can be produced by the reaction of 1.0 g of N_2 with 3.0 g of H_2 via the equation below?

$$N_2\,(g) + 3H_2\,(g) \rightarrow 2NH_3\,(g)$$

A) 2.0 B) 1.2 C) 0.61 D) 17 E) 4.0

23) What is the maximum amount in grams of SO_3 that can be produced by the reaction of 1.0 g of S with 1.0 g of O_2 via the equation below?

$$2S\,(s) + 3O_2\,(g) \rightarrow 2SO_3\,(g)$$

A) 0.27 B) 1.7 C) 2.5 D) 3.8 E) 2.0

24) Solid aluminum and gaseous oxygen react in a combination reaction to produce aluminum oxide:

$$4Al\,(s) + 3O_2\,(g) \rightarrow 2Al_2O_3\,(s)$$

The maximum amount of Al_2O_3 that can be produced from 2.5 g of Al and 2.5 g of O_2 is _____ g.

A) 9.4 B) 7.4 C) 4.7 D) 5.3 E) 5.0

25) Sulfur and fluorine react in a combination reaction to produce sulfur hexafluoride:

$$S\,(s) + 3F_2\,(g) \rightarrow SF_6\,(g)$$

The maximum amount of SF_6 that can be produced from the reaction of 3.5 g of sulfur with 4.5 g of fluorine is _____ g.

A) 12 B) 3.2 C) 5.8 D) 16 E) 8.0

26) Solid aluminum and gaseous oxygen react in a combination reaction to produce aluminum oxide:

$$4Al\,(s) + 3O_2\,(g) \rightarrow 2Al_2O_3\,(s)$$

In a particular experiment, the reaction of 2.5 g of Al with 2.5 g of O_2 produced 3.5 g of Al_2O_3. The % yield of the reaction is _____.

A) 74 B) 37 C) 47 D) 66 E) 26

27) Sulfur and oxygen react in a combination reaction to produce sulfur trioxide, an environmental pollutant:

$$2S\,(s) + 3O_2\,(g) \rightarrow 2SO_3\,(g)$$

In a particular experiment, the reaction of 1.0 g S with 1.0 g O_2 produced 0.80 g of SO_3. The % yield in this experiment is _____.

A) 30 B) 29 C) 21 D) 88 E) 47

28) Sulfur and fluorine react in a combination reaction to produce sulfur hexafluoride:

$$S\,(s) + 3F_2\,(g) \rightarrow SF_6\,(g)$$

In a particular experiment, the percent yield is 79.0%. This means that in this experiment, a 7.90-g sample of fluorine yields _____ g of SF_6.

A) 30.3 B) 10.1 C) 7.99 D) 24.0 E) 0.110

29) The balanced molecular equation for complete neutralization of H_2SO_4 by KOH in aqueous solution is _____.

A) $2H^+\,(aq) + 2OH^-\,(aq) \rightarrow 2H_2O\,(l)$

B) $2H^+\,(aq) + 2KOH\,(aq) \rightarrow 2H_2O\,(l) + 2K^+\,(aq)$

C) $H_2SO_4\,(aq) + 2OH^-\,(aq) \rightarrow 2H_2O\,(l) + SO_4^{2-}\,(aq)$

D) $H_2SO_4\,(aq) + 2KOH\,(aq) \rightarrow 2H_2O\,(l) + K_2SO_4\,(s)$

E) $H_2SO_4\,(aq) + 2KOH\,(aq) \rightarrow 2H_2O\,(l) + K_2SO_4\,(aq)$

30) The spectator ions in the reaction between aqueous hydrofluoric acid and aqueous barium hydroxide are _____.

A) OH^-, F^-, and Ba^{2+} B) F^- and Ba^{2+} C) OH^- and F^- D) Ba^{2+} only
E) H^+, OH^-, F^-, and Ba^{2+}

31) The spectator ions in the reaction between aqueous hydrochloric acid and aqueous ammonia are _____.

A) H^+ and NH_3 B) H^+, Cl^-, NH_3, and NH_4^+ C) Cl^- and NH_4^+
D) H^+, Cl^-, and NH_4^+ E) Cl^- only

32) Pure acetic acid ($HC_2H_3O_2$) is a liquid and is known as glacial acetic acid. Calculate the molarity of a solution prepared by dissolving 20.00 mL of glacial acetic acid at 25 °C in sufficient water to give 500.0 mL of solution. The density of glacial acetic acid at 25 °C is 1.05 g/mL.

A) 2.52×10^3 B) 42.0 C) 0.0420 D) 0.699 E) 6.99×10^{-4}

33) A solution is prepared by mixing 15.0 mL of 0.100 M HCl and 5.00 mL of 0.200 M NaCl. What is the molarity of chloride ion in this solution?

A) 0.175 B) 8.00 C) 1.25 D) 0.0250 E) 0.125

34) A 31.5 mL aliquot of H_2SO_4 (aq) of unknown concentration was titrated with 0.0134 M NaOH (aq). It took 23.9 mL of the base to reach the endpoint of the titration. The concentration (M) of the acid was _____.

A) 0.0102 B) 0.00508 C) 0.0204 D) 0.102 E) 0.227

35) An electron cannot have the quantum numbers n = _____, l = _____, m_l = _____.

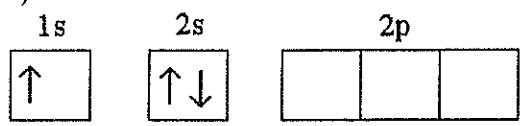
A) 6, 1, 0 B) 3, 2, 3 C) 3, 2, -2 D) 1, 0, 0 E) 3, 2, 1

36) Which one of the following is an <u>incorrect</u> orbital notation?

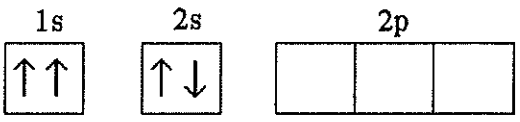
A) 2s B) $3p_y$ C) 3f D) $4d_{xy}$ E) 4s

37) Which electron configuration represents a violation of the Pauli exclusion principle?

A)



B)



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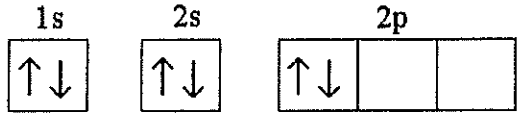
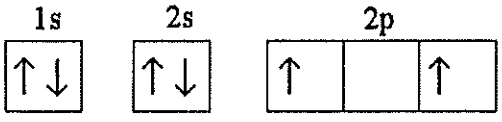
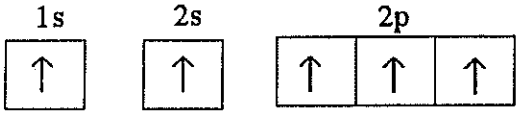


D)



E)



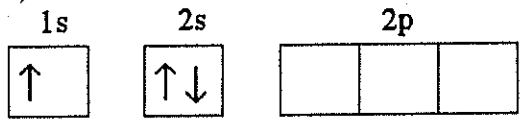
38) Which one of the following configurations depicts an excited oxygen atom?

A) $1s^2 2s^2 2p^2$ B) $1s^2 2s^2 2p^2 3s^2$ C) $1s^2 2s^2 2p^1$ D) $1s^2 2s^2 2p^4$

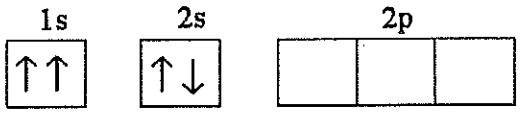
E) $[He]2s^2 2p^4$

39) Which electron configuration represents a violation of Hund's rule for an atom in its ground state?

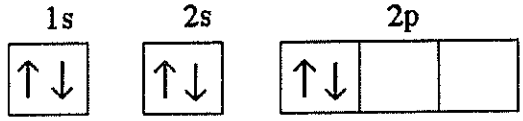
A)



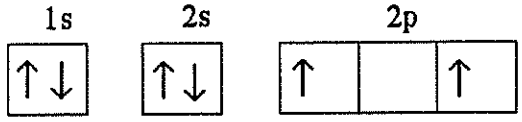
B)



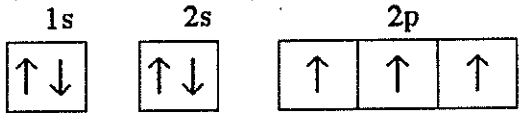
C)



D)



E)



40) The lowest energy shell that contains f orbitals is the shell with n = _____.

A) 3 B) 2 C) 4 D) 1 E) 5

41) All of the _____ have a valence shell electron configuration ns^1.

A) noble gases B) halogens C) chalcogens

D) alkali metals E) alkaline earth metals

42) How many p-orbitals are occupied (by at least one electron) in a O atom?

A) 5 B) 6 C) 0 D) 3 E) 1

43) There are _____ unpaired electrons in a ground state chlorine atom.
A) 4 B) 3 C) 2 D) 1 E) 0

44) In which set of elements would all members be expected to have very similar chemical properties?

A) P, Se, I B) Cl, Br, Na C) Si, As, Te D) Ne, Na, Mg E) Br, I, At

45) Of the following, which gives the correct order for atomic radius for Mg, Na, P, Si and Ar?

A) Mg > Na > P > Si > Ar B) Ar > Si > P > Na > Mg C) Si > P > Ar > Na > Mg
D) Na > Mg > Si > P > Ar E) Ar > P > Si > Mg > Na

46) Of the choices below, which gives the order for first ionization energies?
A) Kr > Se > Br > Ga > Ge B) Kr > Br > Se > Ge > Ga C) Ga > Br > Ge > Kr > Se

D) Ga > Ge > Se > Br > Kr E) Br > Se > Ga > Kr > Ge

47) Of the following oxides, _____ is the most acidic.
A) CaO B) CO_2 C) Al_2O_3 D) Li_2O
E) Na_2O

48) Oxides of most nonmetals combine with base to form _____.
A) hydrogen gas B) an acid C) a base D) water E) water and a salt

49) An alkaline earth metal forms a compound with oxygen with the formula _____.
(The symbol M represents any one of the alkaline earth metals.)
A) MO B) M_2O C) MO_2 D) M_2O_2 E) MO_3

50) The most common and stable allotrope of sulfur is _____.
A) S B) S_2 C) S_4 D) S_8 E) Sulfur does not form allotropes.

SECTION B (ANSWER ANY TWO QUESTIONS FOR 50 POINTS)

Question One

(a) (**i**) How many picometers are there in one meter? **[1]**

(**ii**) Express 6.0×10^3 m using a prefix to replace the power of ten. **[1]**

(**iii**) Use exponential notation to express 4.22 mg in grams. **[1]**

(**iv**) Use scientific notation to express 4.22 mg in grams. **[1]**

(b) A sample that has a mass of about 0.5 g is placed on a balance that has a precision of ± 0.001 g. How many significant figures should be reported for this measurement? **[1]**

(c) How many significant figures are in each of the following numbers (assume that each number is a measured quantity): (**i**) 4.003,

(**ii**) 6.023×10^{23} **[2]**

(d) Three isotopes of an element X occur in nature: ^{28}X (92.23%), atomic mass 27.97693 amu; ^{29}X (4.68%), atomic mass 28.97649 amu; and ^{30}X (3.09%), atomic mass 29.97377 amu. Calculate the atomic weight of the element. **[5]**

(e) Locate Na (sodium) Se (selenium), and Br (bromine) in the periodic table. Give the atomic number of each and classify each as metal, metalloid, or nonmetal. **[3]**

(f) Predict the charge expected for the most stable ion of (i) aluminum and (ii) nitrogen. **[2]**

(g) Which of these compounds are molecular: IBr_5, FeS, P_4O_6, PbF_2? **[2]**

(h) Write the formulas for the hypoiodite and periodite ions

[2]

(i) Name the following compounds **(i)** Cr_2O_3, **(ii)** P_2S_5. **[2]**

(j) Name the acids **(a)** HIO, **(b)** HNO_2. **[2]**

Question Two

a) A stock solution of HNO_3 is prepared and found to contain 12.7 M of HNO_3. If 25.0 mL of the stock solution is diluted to a final volume of 0.500 L, what is the concentration of the diluted solution. [Show how you get to the answer].

[3]

b) In order to analyze a mineral for the quantity of sodium sulphate, Na_2SO_4, the sample is crushed and then dissolved in water in order to form a solution of the salt. Next the aqueous solution is treated with aqueous barium chloride, $BaCl_2$, to give solid $BaSO_4$.

$Na_2SO_4(aq) + BaCl_2(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$

Suppose a sample of the mineral weighing 0.498 g produces 0.541 g of $BaSO_4$. What is the mass percent of Na_2SO_4 in the sample? **[4]**

c) To determine the molar mass of an unknown organic acid, HA, 1.056 g of the acid is dissolved in water and titrated with a standard aqueous solution of NaOH. Calculate the molar mass of HA if the titration requires 33.78 mL of 0.256 M NaOH to reach end-point according to the equation

$HA(aq) + NaOH(aq) \rightarrow NaA(aq) + H_2O(\ell)$

[4]

d) Write the molecular equation, complete ionic equation and the net ionic equation for the reaction of an aqueous solution of sodium phosphate, Na_3PO_4, with an aqueous solution of nickel(II) nitrate, $Ni(NO_3)_2$.

[4]

e) Methanol, CH_3OH, which can be used as a fuel in racing cars and in fuel cells, can be made by the reaction of carbon monoxide and hydrogen.

$$CO(g) + 2H_2(g) \rightarrow CH_3OH(\ell)$$

Suppose 356 g of CO and 65.0 g of H_2 are mixed and allowed to react.

i) Determine which one of the two reactants is the limiting reactant
ii) What is the maximum mass of methanol that can be produced?

[4]

f) Caproic acid, responsible for the odor of dirty socks, is composed of C, H, and O atoms. Combustion of a 0.225-g sample of this compound produces 0.512 g CO_2 and 0.209 g H_2O. What is the empirical formula of caproic acid? **[6]**

Question Three

(a) Determine the oxidation state of the boldfaced element in the following:

(i) $\mathbf{P}_2O_5$, ii) $\mathbf{Cr}_2O_7^{2-}$

[2]

(b) Write the balanced molecular and net ionic equations for the reaction between magnesium and cobalt(II) sulfate. What is oxidized and what is reduced in the reaction? **[4]**

(c) Based on activity series, which of the following metals will be oxidized by $Pb(NO_3)_2$: Zn, Cu, Fe? Explain your answer. **[2]**

d) Consider an orbital designated by nd_{xy}. (i) What is the smallest possible value of the principal quantum number, n? (ii) What is the value of the angular momentum quantum number, ℓ? What is the largest possible value of the magnetic quantum number, m_ℓ? **[3]**

e) Identify the group of elements that correspond to the generalized electron configuration [noble gas]ns^2np^3 and indicate the number of unpaired electrons. **[3]**

f) Would you expect barium oxide to be a solid, liquid or gas? Explain. Write the balanced chemical equation for the reaction of barium oxide with nitric acid. **[4]**

g) The hypochlorite ion, $[ClO]^-$, is the main ingredient in bleach. The perchlorate ion, $[ClO_4]^-$, is a main component of rocket propellant.

i) Draw Lewis structures for both ions

ii) For each ion, determine the oxidation state and formal charge of Cl

[7]

CHE151 SECTION A EXAM ANSWER SHEET – 2018. Stud ID No. Programme:

Ques No.	Letter corresponding to the correct answer	Ques No.	Letter corresponding to the correct answer
1		26	
2		27	
3		28	
4		29	
5		30	
6		31	
7		32	
8		33	
9		34	
10		35	
11		36	
12		37	
13		38	
14		39	
15		40	
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18		43	
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20		45	
21		46	
22		47	
23		48	
24		49	
25		50	

TABLE 4.5 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	$H_2(g) \longrightarrow 2\,H^+(aq) + 2e^-$
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	$Au(s) \longrightarrow Au^{3+}(aq) + 3e^-$

Commonly Used Physical Constants

Constant	Symbol	Value
acceleration due to gravity	g	$9.8\ m\ s^{-2}$
atomic mass unit	amu, m_u or u	1.66×10^{-27} kg
Avogadro's Number	**N**	**$6.022 \times 10^{23}\ mol^{-1}$**
Bohr radius	a_0	0.529×10^{-10} m
Boltzmann constant	k	$1.38 \times 10^{-23}\ J\ K^{-1}$
electron charge to mass ratio	$-e/m_e$	$-1.7588 \times 10^{11}\ C\ kg^{-1}$
electron classical radius	r_e	2.818×10^{-15} m
electron mass energy (J)	m_ec^2	8.187×10^{-14} J
electron mass energy (MeV)	m_ec^2	0.511 MeV
electron rest mass	m_e	9.109×10^{-31} kg
Faraday constant	F	$9.649 \times 10^{4}\ C\ mol^{-1}$
fine-structure constant	α	7.297×10^{-3}
gas constant	R	$8.314\ J\ mol^{-1}\ K^{-1}$
gravitational constant	G	$6.67 \times 10^{-11}\ Nm^2kg^{-2}$
neutron mass energy (J)	m_nc^2	1.505×10^{-10} J
neutron mass energy (MeV)	m_nc^2	939.565 MeV
neutron rest mass	m_n	1.675×10^{-27} kg
neutron-electron mass ratio	m_n/m_e	1838.68
neutron-proton mass ratio	m_n/m_p	1.0014
permeability of a vacuum	μ_0	$4\pi \times 10^{-7}\ N\ A^{-2}$
permittivity of a vacuum	ε_0	$8.854 \times 10^{-12}\ F\ m^{-1}$
Planck constant	h	$6.626 \times 10^{-34}\ J\ s$
proton mass energy (J)	m_pc^2	1.503×10^{-10} J
proton mass energy (MeV)	m_pc^2	938.272 MeV
proton rest mass	m_p	1.6726×10^{-27} kg
proton-electron mass ratio	m_p/m_e	1836.15
Rydberg constant	R_H	$1.0974 \times 10^{7}\ m^{-1}$
speed of light in vacuum	C	2.9979×10^{8} m/s
Electronic Charge	e	1.602×10^{-19} C

Periodic Table of the Elements

	Main Group Representative Elements												Main Group Representative Elements					
	1A[a] 1												3A 13	4A 14	5A 15	6A 16	7A 17	8A 18
1	1 H 1.00794	2A 2																2 He 4.002602
2	3 Li 6.941	4 Be 9.012182											5 B 10.811	6 C 12.0107	7 N 14.0067	8 O 15.9994	9 F 18.998403	10 Ne 20.1797
3	11 Na 22.989770	12 Mg 24.3050	3B 3	4B 4	5B 5	6B 6	7B 7	8B 8	8B 9	8B 10	1B 11	2B 12	13 Al 26.981538	14 Si 28.0855	15 P 30.973761	16 S 32.065	17 Cl 35.453	18 Ar 39.948
4	19 K 39.0983	20 Ca 40.078	21 Sc 44.955910	22 Ti 47.867	23 V 50.9415	24 Cr 51.9961	25 Mn 54.938049	26 Fe 55.845	27 Co 58.933200	28 Ni 58.6934	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.64	33 As 74.92160	34 Se 78.96	35 Br 79.904	36 Kr 83.80
5	37 Rb 85.4678	38 Sr 87.62	39 Y 88.90585	40 Zr 91.224	41 Nb 92.90638	42 Mo 95.94	43 Tc [98]	44 Ru 101.07	45 Rh 102.90550	46 Pd 106.42	47 Ag 107.8682	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.90447	54 Xe 131.293
6	55 Cs 132.90545	56 Ba 137.327	71 Lu 174.967	72 Hf 178.49	73 Ta 180.9479	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.078	79 Au 196.96655	80 Hg 200.59	81 Tl 204.3833	82 Pb 207.2	83 Bi 208.98038	84 Po [208.98]	85 At [209.99]	86 Rn [222.02]
7	87 Fr [223.02]	88 Ra [226.03]	103 Lr [262.11]	104 Rf [261.11]	105 Db [262.11]	106 Sg [266.12]	107 Bh [264.12]	108 Hs [269.13]	109 Mt [268.14]	110 Ds [281.15]	111 Rg [272.15]	112 Cn [285]	113 [284]	114 Fl [289.2]	115 [288]	116 Lv [293]	117 ** [294]	118 [294]

Metals Metalloids Nonmetals

Transition metals

Lanthanide series	57 La 138.9055	58 Ce 140.116	59 Pr 140.90765	60 Nd 144.24	61 Pm [145]	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.92534	66 Dy 162.50	67 Ho 164.93032	68 Er 167.259	69 Tm 168.93421	70 Yb 173.04
Actinide series	89 Ac [227.03]	90 Th 232.0381	91 Pa 231.03588	92 U 238.02891	93 Np [237.05]	94 Pu [244.06]	95 Am [243.06]	96 Cm [247.07]	97 Bk [247.07]	98 Cf [251.08]	99 Es [252.08]	100 Fm [257.10]	101 Md [258.10]	102 No [259.10]

[a]The labels on top (1A, 2A, etc.) are common American usage. The labels below these (1, 2, etc.) are those recommended by the International Union of Pure and Applied Chemistry (IUPAC).

Except for elements 114 and 116, the names and symbols for elements above 113 have not yet been decided.

Atomic weights in brackets are the names of the longest-lived or most important isotope of radioactive elements.

Further information is available at http://www.webelements.com

** Discovered in 2010, element 117 is currently under review by IUPAC.

Useful Conversion Factors and Relationships

Length

SI unit: meter (m)

1 km = 0.62137 mi
1 mi = 5280 ft
= 1.6093 km
1 m = 1.0936 yd
1 in. = 2.54 cm (exactly)
1 cm = 0.39370 in.
1 Å = 10^{-10} m

Mass

SI unit: kilogram (kg)

1 kg = 2.2046 lb
1 lb = 453.59 g
= 16 oz
1 u = $1.660538921 \times 10^{-27}$ kg

Temperature

SI unit: Kelvin (K)

0 K = −273.15 °C
= −459.67 °F
K = °C + 273.15
°C = $\frac{5}{9}$ (°F − 32°)
°F = $\frac{9}{5}$ °C + 32°

Energy (derived)

SI unit: Joule (J)

1 J = 1 kg-m^2/s^2
= 0.2390 cal
= 1C-V
1 cal = 4.184 J
1 eV = 1.602×10^{-19} J

Pressure (derived)

SI unit: Pascal (Pa)

1 Pa = 1 N/m^2
= 1 kg/m-s^2
1 atm = 1.01325×10^5 Pa
= 760 torr
= 14.70 lb/in^2
1 bar = 10^5 Pa
1 torr = 1 mm Hg

Volume (derived)

SI unit: cubic meter (m^3)

1 L = 10^{-3} m^3
= 1 dm^3
= 10^3 cm^3
= 1.0567 qt
1 gal = 4 qt
= 3.7854 L
1 cm^3 = 1 mL
1 in^3 = 16.4 cm^3

Common Ions

Positive Ions (Cations)

1+

ammonium (NH_4^+)
cesium (Cs^+)
copper(I) or cuprous (Cu^+)
hydrogen (H^+)
lithium (Li^+)
potassium (K^+)
silver (Ag^+)
sodium (Na^+)

2+

barium (Ba^{2+})
cadmium (Cd^{2+})
calcium (Ca^{2+})
chromium(II) or chromous (Cr^{2+})
cobalt(II) or cobaltous (Co^{2+})
copper(II) or cupric (Cu^{2+})
iron(II) or ferrous (Fe^{2+})
lead(II) or plumbous (Pb^{2+})
magnesium (Mg^{2+})
manganese(II) or manganous (Mn^{2+})
mercury(I) or mercurous (Hg_2^{2+})
mercury(II) or mercuric (Hg^{2+})
strontium (Sr^{2+})
nickel(II) (Ni^{2+})
tin(II) or stannous (Sn^{2+})
zinc (Zn^{2+})

3+

aluminum (Al^{3+})
chromium(III) or chromic (Cr^{3+})
iron(III) or ferric (Fe^{3+})

Negative Ions (Anions)

1−

acetate (CH_3COO^- or $C_2H_3O_2^-$)
bromide (Br^-)
chlorate (ClO_3^-)
chloride (Cl^-)
cyanide (CN^-)
dihydrogen phosphate ($H_2PO_4^-$)
fluoride (F^-)
hydride (H^-)
hydrogen carbonate or bicarbonate (HCO_3^-)
hydrogen sulfite or bisulfite (HSO_3^-)
hydroxide (OH^-)
iodide (I^-)
nitrate (NO_3^-)
nitrite (NO_2^-)
perchlorate (ClO_4^-)
permanganate (MnO_4^-)
thiocyanate (SCN^-)

2−

carbonate (CO_3^{2-})
chromate (CrO_4^{2-})
dichromate ($Cr_2O_7^{2-}$)
hydrogen phosphate (HPO_4^{2-})
oxide (O^{2-})
peroxide (O_2^{2-})
sulfate (SO_4^{2-})
sulfide (S^{2-})
sulfite (SO_3^{2-})

3−

arsenate (AsO_4^{3-})
phosphate (PO_4^{3-})