

## APPENDIX -1

### Atomic Number and Molar Mass of Elements

Element	Symbol	Atomic Number	Molar mass(g mol <sup>-1</sup> )
Actinium	Ac	89	227.03
Aluminium	Al	13	26.98
Americium	Am	95	(243)
Antimony	Sb	51	121.75
Argon	Ar	18	39.95
Arsenic	As	33	74.92
Astatine	At	85	210
Barium	Ba	56	137.34
Berkelium	Bk	97	(247)
Beryllium	Be	4	9.01
Bismuth	Bi	83	208.98
Bohrium	Bh	107	(264)
Boron	B	5	10.81
Bromine	Br	35	79.91
Cadmium	Cd	48	112.40
Caesium	Cs	55	132.91
Calcium	Ca	20	40.08
Californium	Cf	98	251.08
Carbon	C	6	12.01
Cerium	Ce	58	140.12
Chlorine	Cl	17	35.45
Chromium	Cr	24	52.00
Cobalt	Co	27	58.93
Copper	Cu	29	63.54
Curium	Cm	96	247.07
Dubnium	Db	105	(263)
Dysprosium	Dy	66	162.50

Element	Symbol	Atomic Number	Molar mass(g mol <sup>-1</sup> )
Einsteinium	Es	99	(252)
Erbium	Er	68	167.26
Europium	Eu	63	151.96
Fermium	Fm	100	(257.10)
Fluorine	F	9	19.00
Francium	Fr	87	(223)
Gadolinium	Gd	64	157.25
Gallium	Ga	31	69.72
Germanium	Ge	32	72.61
Gold	Au	79	196.97
Hafnium	Hf	72	178.49
Hassium	Hs	108	(269)
Helium	He	2	4.00
Holmium	Ho	67	164.93
Hydrogen	H	1	1.0079
Indium	In	49	114.82
Iodine	I	53	126.90
Iridium	Ir	77	192.2
Iron	Fe	26	55.85
Krypton	Kr	36	83.80
Lanthanum	La	57	138.91
Lawrencium	Lr	103	(262.1)
Lead	Pb	82	207.19
Lithium	Li	3	6.94
Lutetium	Lu	71	174.96
Magnesium	Mg	12	24.31
Manganese	Mn	25	54.94

Element	Symbol	Atomic Number	Molar mass(g mol <sup>-1</sup> )	Element	Symbol	Atomic Number	Molar mass(g mol <sup>-1</sup> )
Meitneium	Mt	109	(268)	Samarium	Sm	62	150.35
Mendelevium	Md	101	258.10	Scandium	Sc	21	44.96
Mercury	Hg	80	200.59	Seaborgium	Sg	106	(266)
Molybdenum	Mo	42	95.94	Selenium	Se	34	78.96
Neodymium	Nd	60	144.24	Silicon	Si	14	28.08
Neon	Ne	10	20.18	Silver	Ag	47	107.87
Neptunium	Np	93	(237.05)	Sodium	Na	11	22.99
Nickel	Ni	28	58.71	Strontium	Sr	38	87.62
Niobium	Nb	41	92.91	Sulphur	S	16	32.06
Nitrogen	N	7	14.0067	Tantalum	Ta	73	180.95
Nobelium	No	102	(259)	Technetium	Tc	43	(98.91)
Osmium	Os	76	190.2	Tellurium	Te	52	127.60
Oxygen	O	8	16.00	Terbium	Tb	65	158.92
Palladium	Pd	46	106.4	Thallium	Tl	81	204.37
Phosphorus	P	15	30.97	Thorium	Th	90	232.04
Platinum	Pt	78	195.09	Thulium	Tm	69	168.93
Plutonium	Pu	94	(244)	Tin	Sn	50	118.69
Polonium	Po	84	210	Titanium	Ti	22	47.88
Potassium	K	19	39.10	Tungsten	W	74	183.85
Praseodymium	Pr	59	140.91	Ununbium	Uub	112	(277)
Promethium	Pm	61	(145)	Ununnilium	Uun	110	(269)
Protactinium	Pa	91	231.04	Unununium	Uuu	111	(272)
Radium	Ra	88	(226)	Uranium	U	92	238.03
Radon	Rn	86	(222)	Vanadium	V	23	50.94
Rhenium	Re	75	186.2	Xenon	Xe	54	131.30
Rhodium	Rh	45	102.91	Ytterbium	Yb	70	173.04
Rubidium	Rb	37	85.47	Yttrium	Y	39	88.91
Ruthenium	Ru	44	101.07	Zinc	Zn	30	65.37
Rutherfordium	Rf	104	(261)	Zirconium	Zr	40	91.22

The value given in parenthesis is the molar mass of the isotope of highest known half life

## APPENDIX -2

### Electronic Configuration of Elements

Element	Atomic Number	Electronic Configuration
H	1	1s <sup>1</sup>
He	2	1s <sup>2</sup>
Li	3	[He] 2s <sup>1</sup>
Be	4	[He] 2s <sup>2</sup>
B	5	[He] 2s <sup>2</sup> 2p <sup>1</sup>
C	6	[He] 2s <sup>2</sup> 2p <sup>2</sup>
N	7	[He] 2s <sup>2</sup> 2p <sup>3</sup>
O	8	[He] 2s <sup>2</sup> 2p <sup>4</sup>
F	9	[He] 2s <sup>2</sup> 2p <sup>5</sup>
Ne	10	[He] 2s <sup>2</sup> 2p <sup>6</sup>
Na	11	[Ne] 3s <sup>1</sup>
Mg	12	[Ne] 3s <sup>2</sup>
Al	13	[Ne] 3s <sup>2</sup> 3p <sup>1</sup>
Si	14	[Ne] 3s <sup>2</sup> 3p <sup>2</sup>
P	15	[Ne] 3s <sup>2</sup> 3p <sup>3</sup>
S	16	[Ne] 3s <sup>2</sup> 3p <sup>4</sup>
Cl	17	[Ne] 3s <sup>2</sup> 3p <sup>5</sup>
Ar	18	[Ne] 3s <sup>2</sup> 3p <sup>6</sup>
K	19	[Ar] 4s <sup>1</sup>
Ca	20	[Ar] 4s <sup>2</sup>
Sc	21	[Ar] 3d <sup>1</sup> 4s <sup>2</sup>
Ti	22	[Ar] 3d <sup>2</sup> 4s <sup>2</sup>
V	23	[Ar] 3d <sup>3</sup> 4s <sup>2</sup>
*Cr	24	[Ar] 3d <sup>5</sup> 4s <sup>1</sup>
Mn	25	[Ar] 3d <sup>5</sup> 4s <sup>1</sup>
Fe	26	[Ar] 3d <sup>6</sup> 4s <sup>2</sup>

Element	Atomic Number	Electronic Configuration
Co	27	[Ar] 3d <sup>7</sup> 4s <sup>2</sup>
Ni	28	[Ar] 3d <sup>8</sup> 4s <sup>2</sup>
*Cu	29	[Ar] 3d <sup>10</sup> 4s <sup>1</sup>
Zn	30	[Ar] 3d <sup>10</sup> 4s <sup>2</sup>
Ga	31	[Ar] 3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>1</sup>
Ge	32	[Ar] 3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>2</sup>
As	33	[Ar] 3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>3</sup>
Se	34	[Ar] 3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>4</sup>
Br	35	[Ar] 3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>5</sup>
Kr	36	[Ar] 3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>6</sup>
Rb	37	[Kr] 5s <sup>1</sup>
Sr	38	[Kr] 5s <sup>2</sup>
Y	39	[Kr] 4d <sup>1</sup> 5s <sup>2</sup>
Zr	40	[Kr] 4d <sup>2</sup> 5s <sup>2</sup>
*Nb	41	[Kr] 4d <sup>4</sup> 5s <sup>1</sup>
*Mo	42	[Kr] 4d <sup>5</sup> 5s <sup>1</sup>
Tc	43	[Kr] 4d <sup>5</sup> 5s <sup>2</sup>
Ru	44	[Kr] 4d <sup>6</sup> 5s <sup>2</sup>
Rh	45	[Kr] 4d <sup>7</sup> 5s <sup>2</sup>
Pd	46	[Kr] 4d <sup>8</sup> 5s <sup>2</sup>
*Ag	47	[Kr] 4d <sup>10</sup> 5s <sup>1</sup>
Cd	48	[Kr] 4d <sup>10</sup> 5s <sup>2</sup>
In	49	[Kr] 4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>1</sup>
Sn	50	[Kr] 4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>2</sup>
Sb	51	[Kr] 4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>3</sup>
Te	52	[Kr] 4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>4</sup>

Element	Atomic Number	Electronic Configuration
I	53	[Kr] 4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>5</sup>
Xe	54	[Kr] 4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>6</sup>
Cs	55	[Xe] 6s <sup>1</sup>
Ba	56	[Xe] 6s <sup>2</sup>
*La	57	[Xe] 5d <sup>1</sup> 6s <sup>2</sup>
*Ce	58	[Xe] 4f <sup>2</sup> 6s <sup>2</sup>
Pr	59	[Xe] 4f <sup>3</sup> 6s <sup>2</sup>
Nd	60	[Xe] 4f <sup>4</sup> 6s <sup>2</sup>
Pm	61	[Xe] 4f <sup>5</sup> 6s <sup>2</sup>
Sm	62	[Xe] 4f <sup>6</sup> 6s <sup>2</sup>
Eu	63	[Xe] 4f <sup>7</sup> 6s <sup>2</sup>
*Gd	64	[Xe] 4f <sup>7</sup> 5d <sup>1</sup> 6s <sup>2</sup>
Tb	65	[Xe] 4f <sup>9</sup> 6s <sup>2</sup>
Dy	66	[Xe] 4f <sup>10</sup> 6s <sup>2</sup>
Ho	67	[Xe] 4f <sup>11</sup> 6s <sup>2</sup>
Er	68	[Xe] 4f <sup>12</sup> 6s <sup>2</sup>
Tm	69	[Xe] 4f <sup>13</sup> 6s <sup>2</sup>
Yb	70	[Xe] 4f <sup>14</sup> 6s <sup>2</sup>
Lu	71	[Xe] 4f <sup>14</sup> 5d <sup>1</sup> 6s <sup>2</sup>
Hf	72	[Xe] 4f <sup>14</sup> 5d <sup>2</sup> 6s <sup>2</sup>
Ta	73	[Xe] 4f <sup>14</sup> 5d <sup>3</sup> 6s <sup>2</sup>
W	74	[Xe] 4f <sup>14</sup> 5d <sup>4</sup> 6s <sup>2</sup>
Re	75	[Xe] 4f <sup>14</sup> 5d <sup>5</sup> 6s <sup>2</sup>
Os	76	[Xe] 4f <sup>14</sup> 5d <sup>6</sup> 6s <sup>2</sup>
Ir	77	[Xe] 4f <sup>14</sup> 5d <sup>7</sup> 6s <sup>2</sup>
*Pt	78	[Xe] 4f <sup>14</sup> 5d <sup>9</sup> 6s <sup>1</sup>
*Au	79	[Xe] 4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>1</sup>
Hg	80	[Xe] 4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup>
Tl	81	[Xe] 4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p <sup>1</sup>

Element	Atomic Number	Electronic Configuration
Pb	82	[Xe] 4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p <sup>2</sup>
Bi	83	[Xe] 4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p <sup>3</sup>
Po	84	[Xe] 4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p <sup>4</sup>
At	85	[Xe] 4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p <sup>5</sup>
Rn	86	[Xe] 4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p <sup>6</sup>
Fr	87	[Rn] 7s <sup>1</sup>
Ra	88	[Rn] 7s <sup>2</sup>
Ac	89	[Rn] 6d <sup>1</sup> 7s <sup>2</sup>
Th	90	[Rn] 6d <sup>2</sup> 7s <sup>2</sup>
Pa	91	[Rn] 5f <sup>2</sup> 6d <sup>1</sup> 7s <sup>2</sup>
U	92	[Rn] 5f <sup>3</sup> 6d <sup>1</sup> 7s <sup>2</sup>
Np	93	[Rn] 5f <sup>4</sup> 6d <sup>1</sup> 7s <sup>2</sup>
Pu	94	[Rn] 5f <sup>6</sup> 7s <sup>2</sup>
Am	95	[Rn] 5f <sup>7</sup> 7s <sup>2</sup>
Cm	96	[Rn] 5f <sup>7</sup> 6d <sup>1</sup> 7s <sup>2</sup>
Bk	97	[Rn] 5f <sup>8</sup> 6d <sup>1</sup> 7s <sup>2</sup>
Cf	98	[Rn] 5f <sup>10</sup> 7s <sup>2</sup>
Es	99	[Rn] 5f <sup>11</sup> 7s <sup>2</sup>
Fm	100	[Rn] 5f <sup>12</sup> 7s <sup>2</sup>
Md	101	[Rn] 5f <sup>13</sup> 7s <sup>2</sup>
No	102	[Rn] 5f <sup>14</sup> 7s <sup>2</sup>
Lr	103	[Rn] 5f <sup>14</sup> 6d <sup>1</sup> 7s <sup>2</sup>
Rf	104	[Rn] 5f <sup>14</sup> 6d <sup>2</sup> 7s <sup>2</sup>
Db	105	[Rn] 5f <sup>14</sup> 6d <sup>3</sup> 7s <sup>2</sup>
Sg	106	[Rn] 5f <sup>14</sup> 6d <sup>4</sup> 7s <sup>2</sup>
Bh	107	[Rn] 5f <sup>14</sup> 6d <sup>5</sup> 7s <sup>2</sup>
Hs	108	[Rn] 5f <sup>14</sup> 6d <sup>6</sup> 7s <sup>2</sup>
Mt	109	[Rn] 5f <sup>14</sup> 6d <sup>7</sup> 7s <sup>2</sup>

\* Elements having exceptional electronic configuration

### APPENDIX -3

## Physical Constants

Quantity	Symbol	Traditional Units	SI Units
Acceleration of gravity	g	980.6 cm s <sup>-1</sup>	9.806 m s <sup>-1</sup>
Atomic mass unit (1/12 <sup>th</sup> of the mass of <sup>12</sup> C atom)	amu or u	1.6606 × 10 <sup>-24</sup> g	1.6606 × 10 <sup>-27</sup> kg
Avogadro constant	N <sub>A</sub>	6.022 × 10 <sup>23</sup> particles mol <sup>-1</sup>	6.022 × 10 <sup>23</sup> particles mol <sup>-1</sup>
Bohr radius	a <sub>0</sub>	0.52918 Å <sup>0</sup>	5.2918 × 10 <sup>-11</sup> m 5.2918 × 10 <sup>-9</sup> cm
Boltzmann constant	k	1.3807 × 10 <sup>-16</sup> erg K <sup>-1</sup>	1.3807 × 10 <sup>-23</sup> J K <sup>-1</sup>
Charge-to-mass ratio of electron	e / m	1.7588 × 10 <sup>8</sup> coulomb g <sup>-1</sup>	1.7588 × 10 <sup>11</sup> C kg <sup>-1</sup>
Electronic charge	e	1.60219 × 10 <sup>-19</sup> coulomb 4.8033 × 10 <sup>-19</sup> esu	1.60219 × 10 <sup>-19</sup> C
Electron rest mass	m <sub>e</sub>	9.10952 × 10 <sup>-28</sup> g 0.00054859 u	9.10952 × 10 <sup>-31</sup> kg
Faraday constant	F	36,487 coulombs eq <sup>-1</sup> 23.06 kcalvolt <sup>-1</sup> eq <sup>-1</sup>	96,487 C (mol e <sup>-</sup> ) <sup>-1</sup> 36,487 J V <sup>-1</sup> .(mol e <sup>-</sup> ) <sup>-1</sup>
Gas constant	R	0.8206 Latmmol <sup>-1</sup> K <sup>-1</sup> 1.987 calmol <sup>-1</sup> K <sup>-1</sup>	8.3145 kPa dm <sup>3</sup> mol <sup>-1</sup> K <sup>-1</sup> 8.3145 J mol <sup>-1</sup> K <sup>-1</sup>
Molar volume (STP)	V <sub>m</sub>	22.710981 L mol <sup>-1</sup>	22.710981 × 10 <sup>-3</sup> m <sup>3</sup> mol <sup>-1</sup> 22.710981 dm <sup>3</sup> mol <sup>-1</sup>
Neutron rest mass	m <sub>n</sub>	1.67495 × 10 <sup>-24</sup> g 1.008665 u	1.67495 × 10 <sup>-27</sup> kg
Planck constant	h	6.6262 × 10 <sup>-27</sup> ergs	6.6262 × 10 <sup>-34</sup> J s
Proton rest mass	m <sub>p</sub>	1.6726 × 10 <sup>-24</sup> g 1.007277 u	1.6726 × 10 <sup>-27</sup> kg
Rydberg constant	R	3.089 × 10 <sup>15</sup> cycles s <sup>-1</sup> 2.1799 × 10 <sup>-11</sup> erg	1.0974 × 10 <sup>7</sup> m <sup>-1</sup> 2.1799 × 10 <sup>-18</sup> J
Speed of light (in vacuum)	c	2.9979 × 10 <sup>10</sup> cm s <sup>-1</sup> (186,281 miles second <sup>-1</sup> )	2.9979 × 10 <sup>8</sup> m s <sup>-1</sup>

$$\pi = 3.1416 \quad 2.303 R = 4.576 \text{ calmol}^{-1} \quad K = 19.15 \text{ J mol}^{-1} \text{ K}^{-1}$$

$$e = 2.71828 \quad 2.303 RT \text{ (at } 25^{\circ}\text{C)} - 1364 \text{ cal mol}^{-1} = 5709 \text{ J mol}^{-1}$$

$$\ln X = 2.303 \log X$$

## APPENDIX - 4

### Some Useful Conversion Factors

#### Common Units of Mass and Weight

- 1 pound = 453.59 grams**  
 1 pound = 453.59 grams = 0.45359 kilogram  
 1 kilogram = 1000 grams = 2.205 pounds  
 1 gram = 10 decigrams = 100 centigrams  
           = 1000 milligrams  
 1 gram =  $6.022 \times 10^{23}$  atomic mass units or u  
 1 atomic mass units =  $1.6606 \times 10^{-24}$  gram  
 1 metric ton = 1000 kilograms  
                   = 2205 pounds

#### Common Unit of Volume

- 1 quart = 0.9463 litre**  
**1 litre = 1.056 quarts**  
 1 litre = 1 cubic decimetre = 1000 cubic centimetres = 0.001 cubic metre  
 1 millilitre = 1 cubic centimetre = 0.001 litre  
                   =  $1.056 \times 10^{-3}$  quart  
 1 cubic foot = 28.316 litres = 29.902 quarts  
                   = 7.475 gallons

#### Common Units of Energy

- 1 Joule =  $1 \times 10^7$  ergs**  
 1 thermochemical calorie  
                                   = 4.184 joules  
                                   =  $4.184 \times 10^7$  ergs  
 =  $4.129 \times 10^{-2}$  litre-atmosphere  
 =  $2.612 \times 10^{-19}$  electron volts  
 1 ergs =  $1 \times 10^{-7}$  joule =  $2.3901 \times 10^{-8}$  calorie  
 1 electron volt =  $1.6022 \times 10^{-19}$  joule  
                   =  $1.6022 \times 10^{-12}$  erg  
                   = 96.487 kJ/mol

- 1 litre-atmosphere = 24.217 calories  
                           = 101.32 joules  
                           =  $1.0132 \times 10^9$  ergs  
 1 British thermal Unit = 1055.06 joules  
                               =  $1.05506 \times 10^{10}$  ergs  
                               = 252.2 calories

#### Common Units of Length

- 1 inch = 2.54 centimetres (exactly)**  
 1 mile = 5280 feet = 1.609 kilometres  
 1 yard = 36 inches = 0.9144 metre  
 1 metre = 100 centimetres = 39.37 inches  
                   = 3.281 feet  
                   = 1.094 yards  
 1 kilometre = 1000 metres = 1094 yards  
                   = 0.6215 mile  
 1 angstrom =  $1.0 \times 10^{-8}$  centimetre  
                   = 0.10 nanometre  
                   =  $1.0 \times 10^{-10}$  metre  
                   =  $3.937 \times 10^{-9}$  inch

#### Common Units of Force\* and Pressure

- 1 atmosphere = 760 millimetres of mercury  
                   =  $1.013 \times 10^5$  pascal  
                   = 14.70 pounds per square inch  
 1 bar =  $10^5$  pascals  
 1 toor = 1 millimetre of mercury  
 1 pascal =  $1 \text{ kg/ms}^2 = 1 \text{ N/m}^2$

#### Temperature SI Base Unit: Kelvin (K)

- K =  $-273.15^{\circ}\text{C}$   
 K =  $^{\circ}\text{C} + 273.15$   
 $^{\circ}\text{F} = 1.8(^{\circ}\text{C}) + 32$

## APPENDIX - 5

### Noble Prize Winners of 21<sup>st</sup> century (chemistry)

Year	Scientist	Birth place (Birth date)	Place of work	Research work
2001	K. Barry Sharpless	USA (28-04-1941)	USA	Study on chirality Catalyse hydroamination reactions
	Ryoji Noyori	Japan (03-09-1938)	Japan	
	William S. Knowles	USA (01-06-1917)	USA	
2002	John B. Fenn	USA (15-6-1917)	USA	Development of Nuclear Magnetic Resonance spectroscopy for determining the three-dimensional structure of biological macromolecules in solution
	Koichi Tanaka	Japan (3-8-1959)	Japan	
	Kurt Wuthrich	Switzerland (4-10-1938)	USA	
2003	Peter Agre	USA (30-1-1949)	USA	Discovery of Water channels (transport of water and ions from cell membrane)
	Roderick Mackinnon	USA (19-2-1956)		
2004	Aaron Ciechanover	Israel (1-10-1947)	Israel	Discovery of degradation of Ubiquitin Mediated protein
	Avram Hershko	Hungary (31-12-1937)	Israel	
	Irwin Rose	USA (16-7-1926)	USA	
2005	Yves Chauvin	France (10-10-1930)	France	Development of the metathesis method in organic synthesis
	Robert H. Grubbs	USA (27-2-1942)	USA	
	Richard R. Schrock	USA (4-1-1945)	USA	
2006	Roger D. Kornberg	USA (26-4-1947)	USA	Studies of mechanism and control of the eukaryotic transcription
2007	Gerhard Ertl	Germany (10-10-1936)	Germany	Studies of the chemical processes on solid surfaces
2008	Osamu Shimomura	Japan (1928)	USA	Discovery and development of the green Fluorescent Protein
	Martin Chalfie	USA (1947)	USA	
	Roger Y. Tsien	USA (1-2-1952)	USA	
2009	Venkatraman Rama krishnan	India(Tamilnadu)(1952)	UK	Studies of the Structure and Function of the Ribosome
	Thomas A. Steitz	USA (23-8-1940)	USA	
	Ada E. Yonath	Israel (22-6-1939)	Israel	

