

Ideal Gas Law

$$pV = nRT = Nk_B T$$

(molar form)

where

p = absolute pressure of gas

V = volume of gas

n = number of moles of gas

R = universal gas constant = 8.314

T = absolute temperature of gas

N = number of gas molecules = $n N_A$

N_A = Avogadro constant = 6.02×10^{23}

k_B = Boltzmann constant = 1.38×10^{-23}

$$[p] = \frac{N}{m^2} = \frac{kg}{m \cdot s^2}$$

$$[m^3]$$

$$[mol]$$

$$\left[\frac{J}{mol \cdot K} \right] = \frac{kg \cdot m^2}{mol \cdot s^2 \cdot K}$$

$$[K]$$

$$[]$$

$$\left[\frac{J}{K} \right] = \frac{kg \cdot m^2}{s^2 \cdot K}$$

$$pV = mR_s T$$

(mass form)

where

m = mass of gas

R_s = specific gas constant of gas

$$[kg]$$

$$\left[\frac{J}{kg \cdot K} \right] = \frac{m^2}{s^2 \cdot K}$$

Convert from molar form to mass form

$$pV = nRT$$

(1)

and

$$M = \text{molar (atomic) mass of gas} = \frac{m}{n}$$

$$\left[\frac{kg}{mol} \right]$$

(2)

sub (2) into (1)

$$pV = \left[\frac{m}{M} \right] RT$$

or

$$pV = mR_s T \quad \text{where } R_s = \frac{R}{M}$$

Determine Molar (atomic) Mass and Specific Gas Constant of Air

air is composed of 78% N_2 , 21% O_2 and 1% Ar
 so $\uparrow$ diatomic $\uparrow$ diatomic

$$M_{air} = \sum x_i M_i$$

$$= (0.78)[(14.0)(2)] + (0.21)[(16.0)(2)] + (0.01)(39.9)$$

$$= 28.96 \text{ g/mol}$$

$$= 0.02896 \text{ kg/mol}$$

so

$$R_{air} = \frac{R}{M_{air}} = \frac{8.314}{0.02896} = 287 \frac{J}{kg \cdot K}$$

N has $M = 14.0$ so
 N_2 will have $M = 28.0$

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H Hydrogen 1.00794	2 He Helium 4.002602																
3 Li Lithium 6.941	4 Be Beryllium 9.012182																
11 Na Sodium 22.98976928	12 Mg Magnesium 24.304																
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955912	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938045	26 Fe Iron 55.845	27 Co Cobalt 58.933195	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.64	33 As Arsenic 74.921595	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.798
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90584	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.94	43 Tc Technetium (97.9072)	44 Ru Ruthenium 96.906	45 Rh Rhodium 101.07	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.757	52 Te Tellurium 127.6	53 I Iodine 126.90547	54 Xe Xenon 131.29
55 Cs Cesium 132.90545196	56 Ba Barium 137.327																
87 Fr Francium (223)	88 Ra Radium (226)																

57-71 La Lanthanum 138.9047	Ce Cerium 140.116	Pr Praseodymium 140.90766	Nd Neodymium 144.242	Pm Promethium (145)	Sm Samarium 150.36	Eu Europium 151.964	Gd Gadolinium 157.25	Tb Terbium 158.92535	Dy Dysprosium 162.500	Ho Holmium 164.93033	Er Erbium 167.259	Tm Thulium 168.93048	Yb Ytterbium 173.054	Lu Lutetium 174.967
89 Ac Actinium (227)	Th Thorium 232.0377	Pa Protactinium 231.03688	U Uranium 238.02891	Np Neptunium (237)	Pu Plutonium (244)	Am Americium (243)	Cm Curium (247)	Bk Berkelium (247)	Cf Californium (251)	Es Einsteinium (252)	Fm Fermium (257)	Md Mendelevium (258)	No Nobelium (259)	Lr Lawrencium (262)

For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.