ideal gas and real gas

At very low Pressures and very high temperatures, the gases tend to obey the gas laws.

A gas which obeys the gas laws under all Circumstances has been named as ideal or Perfect gas, while a gas do not obey the gas laws is known as a real gas.

The gas which obeys the equation of state $PV = nRT$ strictly is Called ideal gas.

Gases which donot obey the equation of state $PV = nRT$ are Called real gases.

All gases are real and no one is ideal in true sense.

Other differences may be mentioned below

1. Equation of State i.e $PV = nRT$
   ideal gases strictly Obey
   Real gases donot obey

2. Compressibility factor Z. $(Z = \frac{PV}{RT})$
   Compressibility factor $Z = 1$ for ideal gases
   " " $Z \neq 1$ for Real gases

3. Molar Volume -
   Molar Volume is 22.4L. for ideal gases
   Molar volume is not exact 22.4L. for real gases

4. Intermolecular attraction :-
   Inter molecular attraction donot exist in ideal gases
   Inter molecular attraction exist in Real gases

5. PV Vs P Curve :-
   In ideal gas PV Vs P Curve is Horizontal st. line.
   In Real gas PV Vs P Curve is not so.

6. PV Vs Z Curve :-
   In ideal gas PV Vs Z Curve is Horizontal st. line.
   But In Real gas PV Vs Z Curve is not so.

Explain the Nature of Gas Constant 'R' in ideal gas equation $PV = nRT$ or $PV = RT$ and also express it's value in different units.

Now the actual nature of gas constant R can be cleared by considering the nature of quantities involved in the ideal gas equation $PV = nRT$, or For one mole $PV = 1 \cdot RT$, $(n = 1)$

$$PV = 1 \cdot RT \quad \text{or } 1 \cdot RT = PV$$

$$R = \frac{PV}{1 \cdot T}$$

$$R = \frac{PV}{T}$$

or, $R = PV \ mol^{-1} \ K^{-1}$

or $R = \frac{Force}{Area} \times Volume \ mol^{-1} K^{-1}$

$= \frac{Force}{(length)^2} \times (Length)^3 \ mol^{-1} K^{-1}$

or $R = Force \times Length \cdot mol^{-1} K^{-1}$

We know, $(W = F.S.\cos\theta)$ & $\cos 0° = 1$ $\therefore W = F.S$

$R = Force \times length \cdot mol^{-1} K^{-1}$

$= W \ (energy) \ mol^{-1} K^{-1}$

Therefore R may be expressed (in terms of energy) as Work per mole per degree Ke
i.e. ergs, cals, Jule

Unit of 'R' in S.I Unit is Jule per mole per Kelvin or $J \cdot mol^{-1} K^{-1}$

Expression of 'R'

(i) In C.G.S. Unit at N.T.P or S.T.P

$V = 22.4 \, L = 22.4 \times 1000 \, ml = 22400 \, ml$

$P = 76 \, cm$ of $Hg = 13.6 \times 980 \times 76 \ dynes/cm^2$

Therefore

$$R = \frac{PV}{T} = \frac{13.6 \times 980 \times 76 \times 22400}{273}$$

$= 8.3162 \times 10^7 \ ergs \ mol^{-1} K^{-1}$

$= 8.3162 \ Jules \ mol^{-1} K^{-1}$ [$\because 10^7 ergs = 1 J$]
(S.I. Unit)

(ii) Expression of 'R' in Litre atmosphere at N.T.P :-

If volume is expressed in litre & Pressure is expressed in atm.

then $R = \frac{PV}{T} = \frac{1 \times 22.4}{273} \ mol^{-1}$ litre atm $\cdot K^{-1}$

$= 0.082$ litre atm $mol^{-1} K^{-1}$

(iii) Expression of 'R' in Calorie :- We know, the value of R

$$R = 8.3162 \times 10^7 \ ergs \ mol^{-1} K^{-1}$$

4.18×10^7 ergs $= 1$ cal.

4.2×10^7 ergs $= 1$ cal.

[$\because 1 cal. = 4.2 \times 10^7$ ergs]

$$R = \frac{8.3162 \times 10^7}{4.18 \times 10^7} \ Cals \ mol^{-1} K^{-1}$$

$= 1.987 = 2 \ Cals \ mol^{-1} K^{-1}$