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 do not 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 do not 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 do not 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) i.e. ergs, cals, Jule as work per mole per degree Kel[vin]

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

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

$= 8.3162\ Jules\ mol^{-1} K^{-1}$ $[\because 10^7 ergs = 1 Jule]$
(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 = 1cal.
4.2 × 10^7 ergs = 1 cal.
[∵ 1cal. = 4.2 × 10^7 ergs]

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

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