

NATURE OF GASES: LAWS AND FORMULAS

The Gas Constant

Assuming a system of one pound of gas occupies a volume V in cubic feet we refer to this volume as the specific volume of that gas (α cu. Ft./lbs.)

Substituting into the general gas law we get:

$$\frac{P \times \alpha}{T} = \text{Constant}$$

If we have W pounds of gas then the volume would be:

$$V = \alpha \times W \quad \text{in which} \quad \alpha = \frac{V}{W}$$

By substituting $\frac{V}{W}$ into $\frac{P \times \alpha}{T}$, we arrive at $\frac{P \times V}{T \times W} = \text{Constant}$

$$\frac{P \times V}{T \times W} = R \quad \text{or} \quad P \times V = W \times R \times T$$

For all gases a relation has been found between the molecular weight of the gas and the gas constant R . The empirical value 1545 is referred to as the *universal gas constant*.

$$R = \frac{1545}{MW} \quad \text{MW is the molecular weight}$$

Molecular weight is the sum of the atomic weight of all the atoms in a molecule. The following chart shows the molecular weight for most common gases:

COMPOUND	FORMULA	MOLECULAR WEIGHT	COMPOUND	FORMULA	MOLECULAR WEIGHT	COMPOUND	FORMULA	MOLECULAR WEIGHT
AIR	N ₂ O ₂	28.964	Ethylene	H ₂	28.054	Neopentane	C ₅ H ₁₂	72.151
Acetylene	C ₂ H ₂	26.038	3-Ethylpentane	C ₇ H ₁₆	100.205	Nitrogen	N ₂	28.013
Ammonia	NH ₃	17.031	Helium	HE	4.003	n-Nonane	C ₉ H ₂₀	128.259
Benzene	C ₆ H ₆	78.031	n-Heptane	C ₇ H ₁₆	100.205	n-Octane	C ₈ H ₁₈	114.232
n-butene	C ₄ H ₁₀	58.124	n-Hexane	C ₆ H ₁₄	86.178	Oxygen	O ₂	31.999
I-Butane	C ₄ H ₈	56.108	Hydrogen	H ₂	2.016	n-Pentene	C ₅ H ₁₂	72.151
1,2-butadiene	C ₄ H ₆	54.092	Hydrogen Chloride	HCl	36.461	1-Pentene	C ₅ H ₁₀	70.135
1,3-butadiene	C ₄ H ₆	54.092	Hydrogen Sulfide	H ₂ S	34.076	Propane	C ₃ H ₈	44.097
Carbon Dioxide	CO ₂	44.01	Iso butane	C ₄ H ₁₀	58.124	Propene	C ₃ H ₆	42.081
Carbon Monoxide	CM	28.01	Iso butene	C ₄ H ₈	56.108	Styrene	C ₈ H ₈	104.152
Chlorine	Cl ₂	70.906	Iso octane	C ₈ H ₁₈	114.232	Sulfur Dioxide	SO ₂	64.059
Cis-2-Butene	C ₄ H ₈	56.108	Iso pentane	C ₅ H ₁₂	72.151	Toluene	C ₇ H ₈	92.141
Cyclohexane	C ₆ H ₁₂	84.162	Iso prene	C ₅ H ₈	68.119	Trans-2-Butene	C ₄ H ₈	56.108
Cyclopentane	C ₅ H ₁₀	70.135	Iso propylbenzene	C ₉ H ₁₂	120.195	Triptane	C ₇ H ₁₆	100.205
N-Decane	C ₁₀ H ₂₂	142.286	Methane	CH ₄	16.043	Water	H ₂ O	18.015
Diisobutyl	C ₈ H ₁₈	114.232	Methyl Alcohol	CH ₄ O	32.042	m-Xylene	C ₈ H ₁₀	106.168
2,3-Dimethylbutane	C ₆ H ₁₄	86.178	Methylcyclohexane	C ₇ H ₁₄	98.189	o-Xylene	C ₈ H ₁₀	106.168
2,2-Dimethylpentane	C ₇ H ₁₆	100.205	Methylcyclopentane	C ₆ H ₁₂	84.162	p-Xylene	C ₈ H ₁₀	106.168
2,4-Dimethylpentane	C ₇ H ₁₆	100.205	2-Methylhexane	C ₇ H ₁₆	100.205			
3,3-Dimethylpentane	C ₇ H ₁₆	100.205	3-Methylhexane	C ₇ H ₁₆	100.205			
Ethane	C ₂ H ₆	30.07	2-Methylpentane	C ₆ H ₁₄	86.178			
Ethylalcohol	C ₂ H ₆	46.069	3-Methylpentane	C ₆ H ₁₄	86.178			
Ethylbenzene	C ₈ H ₁₀	106.168	Neohexane	C ₆ H ₁₄	86.178			

**Values are rounded off into whole numbers
ie. MW Air = 29
MW Water = 28



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