The over-pressure $p = P - P_{atm} = \Delta P$ required to compress a gas of initial volume V to $V - \Delta V$ is:

$$p = P - P_{atm} = \Delta P = -B\left(\frac{\Delta V}{V}\right)$$

Change in the pressure for a fractional change in volume (adiabatic conditions)

Fractional change in volume

(Adiabatic) bulk modulus, B of fluid (here, a gas)

B is the so-called <u>adiabatic bulk modulus</u>, $B = 1/\kappa$ where κ = <u>compressibility</u> of the fluid (liquid or gas) – *n.b.* B has same *SI* units as pressure, p (from dimensional analysis of above formula)!

Thus, we see that the adiabatic bulk modulus B of a fluid (liquid or gas) is the (negative) of the change in the {over-pressure} divided by the <u>fractional</u> change in the volume of the fluid due to the change in the over-pressure:

$$B = \frac{-\Delta P}{(\Delta V/V)} \quad (Pascals)$$

Now, for so-called adiabatic (*i.e.* slow) compression of a gas due to *e.g.* propagation of sound waves in the gas:

γ = "gamma" ≡ C_V/C_P = Ratio of: $\dfrac{\text{specific heat of gas @ constant volume}}{\text{specific heat of gas @ constant pressure}}$

γ = 5/3 for <u>monatomic</u> gases (*e.g.* helium, neon, argon & xenon)

γ = 7/5 for <u>diatomic</u> gases (*e.g.* oxygen & nitrogen molecules – O_2 & N_2)

<u>The Ideal Gas Law</u>:

$$PV = NRT$$

Absolute temperature (*degrees Kelvin*)

Pressure (N/m^2) Volume (m^3) # Moles of gas

R = universal gas constant = 8.3145 (*Joules/mole/deg.K*)

e.g. Carbon atom has 12 atomic mass units (amu's), and thus 1 *mole* (*mol*) of carbon {having Avogadro's number, $N_A = 6.022 \times 10^{23}$ *atoms/mole*} weighs 12 *grams*.

Now air @ NTP (a mixture of oxygen & nitrogen molecules, traces of argon, *etc*.) is <u>NOT</u> a <u>perfect</u> ideal gas – but is <u>close</u> to an ideal gas.

For the so-called <u>adiabatic condition</u>: PV^{γ} = <u>constant</u> = K, thus: $P = KV^{-\gamma}$