S. S. College. Jehanabad (Magadh University)

Department : Physics Subject : Thermodynamics Class : B.Sc(H) Physics Part I Topic: Application of Maxwell's Thermodynamical Relation Teacher : M. K. Singh • Using Maxwell's thermodynamical relations, to prove that the ratio of the adiabatic to the isobaric coefficient of volume expansion is

$$\frac{1}{(1-\gamma)}$$

Adiabatic coefficient of volume expansion is given by

Isobaric coefficient of volume expansion is given by

$$\alpha_{P} = \frac{1}{V} \left(\frac{\partial V}{\partial T} \right)_{P} \qquad (2)$$

Dividing the above two equations

Bringing the first term in the numerator to the denominator

$$= \frac{1}{\left(\frac{\partial T}{\partial V}\right)_{s} \left(\frac{\partial V}{\partial T}\right)_{p}}$$

Using Maxwell's Relation

$$\left(\frac{\partial T}{\partial V}\right)_{S} = -\left(\frac{\partial P}{\partial S}\right)_{V}$$

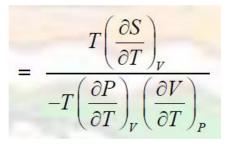
Substituting in the above equation

$$\frac{\alpha_s}{\alpha_p} = -\frac{1}{\left(\frac{\partial P}{\partial S}\right)_V \left(\frac{\partial V}{\partial T}\right)_p}$$

Splitting the first term of the denominator

$$= \frac{1}{-\left[\left(\frac{\partial P}{\partial T}\right)_{V}\left(\frac{\partial T}{\partial S}\right)_{V}\left(\frac{\partial V}{\partial T}\right)_{P}\right]}$$

Taking the second term of the denominator to the numerator and multiplying by T



We know that

$$C_P - C_V = T \left(\frac{\partial P}{\partial T} \right)_V \left(\frac{\partial V}{\partial T} \right)_P$$

and

$$C_{\mathcal{V}} = T \left(\frac{\partial S}{\partial T} \right)_{\mathcal{V}}$$

Substituting these values in the above equation we get

$$\frac{\alpha_s}{\alpha_p} = \frac{C_v}{-(C_p - C_v)}$$

$$\frac{\alpha_s}{\alpha_p} = \frac{1}{1 - \left(\frac{C_p}{C_p}\right)}$$

Dividing the numerator and denominator by $C_{\rm V}$