VISCOSITY-TRANSPORT OF MOMENTUM

Dr Mamta

Physics

Shivaji College

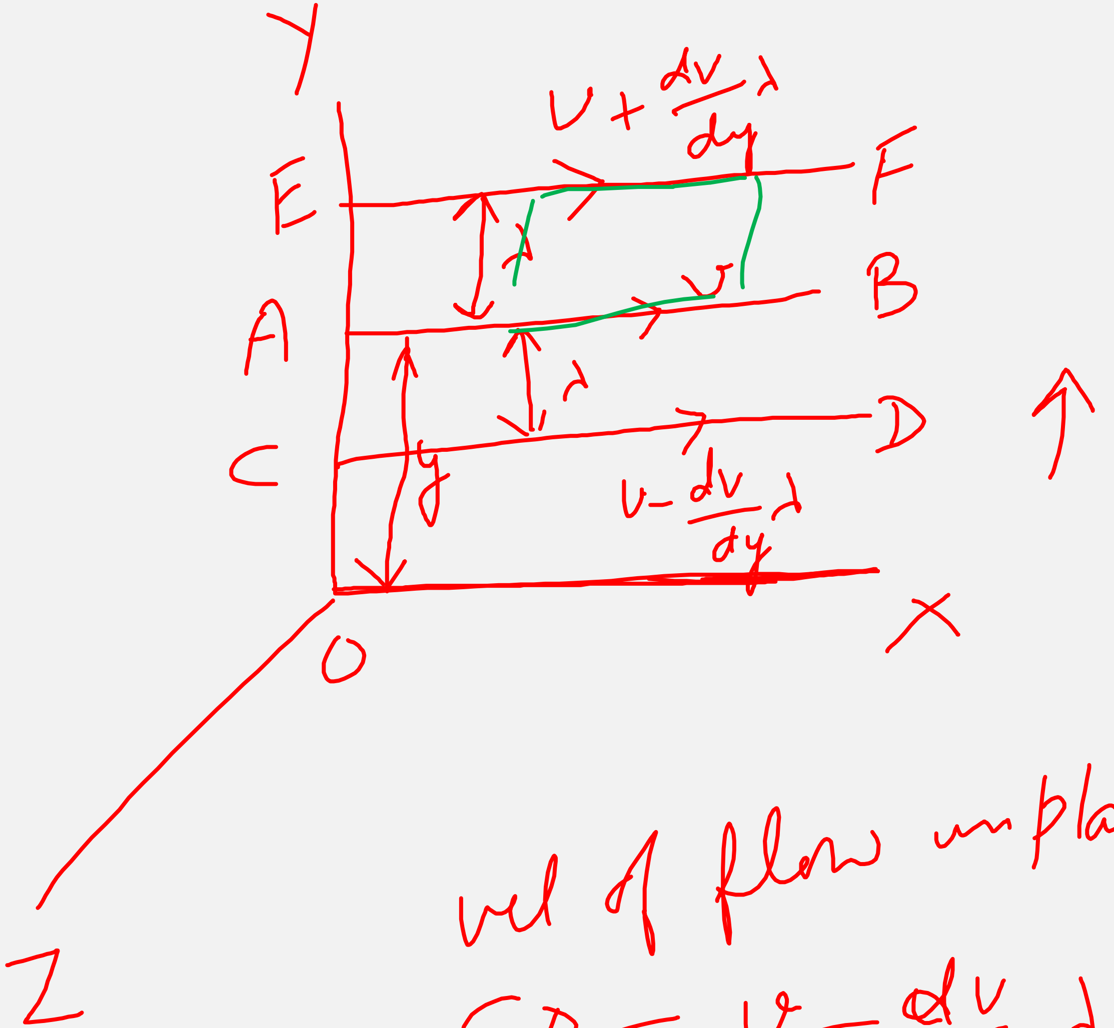
$$\frac{dv}{dy}$$

viscous force

$$F = \eta \frac{dv}{dy} \quad \text{—} (1)$$

↓

coeff of viscosity



The vel. of flow in the plane EF $= v + \frac{dv}{dy}\lambda$ — (2)

vel of flow in plane

CD $= v - \frac{dv}{dy}\lambda$ — (3)

The net transfer of momentum to the plane

$$= m\left(v + \frac{dv}{dy}\right)\lambda - m\left(v - \frac{dv}{dy}\right)\lambda$$

$$= 2m\lambda \frac{dv}{dy} \qquad \text{— (4)}$$

$$1 \times \lambda = \lambda$$

$$\frac{\frac{n\lambda}{6}}{\frac{\lambda}{c}} = \frac{1}{6} n c \quad \text{--- (5)}$$

∴ Total momentum transported per unit area per sec

$$= \frac{nc}{6} \times 2m\lambda \frac{du}{dy}$$

$$= \frac{1}{3} mnc\lambda \frac{dv}{dy} \quad \text{--- (6)}$$

$$F = \frac{1}{3} mnc\lambda \frac{dv}{dy}$$

$$\boxed{\eta = \frac{1}{3} mnc\lambda} \quad \text{--- (7)}$$

$$mn = \rho$$

$$\boxed{\eta = \frac{1}{3} \rho c \lambda} \quad \text{— (8)}$$

$$\lambda = \frac{1}{\sqrt{2}\pi n \sigma^2} \quad \Rightarrow \eta = \frac{1}{3} mnc \frac{1}{\sqrt{2}\pi n \sigma^2}$$

$$\boxed{\eta = \frac{mc}{3\sqrt{2}\pi\sigma^2}} \quad \text{— (9)}$$

(i) $\rightarrow$ $c \propto \sqrt{T}$, $\eta \propto \sqrt{T}$

(ii) $\rho\lambda \rightarrow$ const

η is <u>independent of pressure</u>

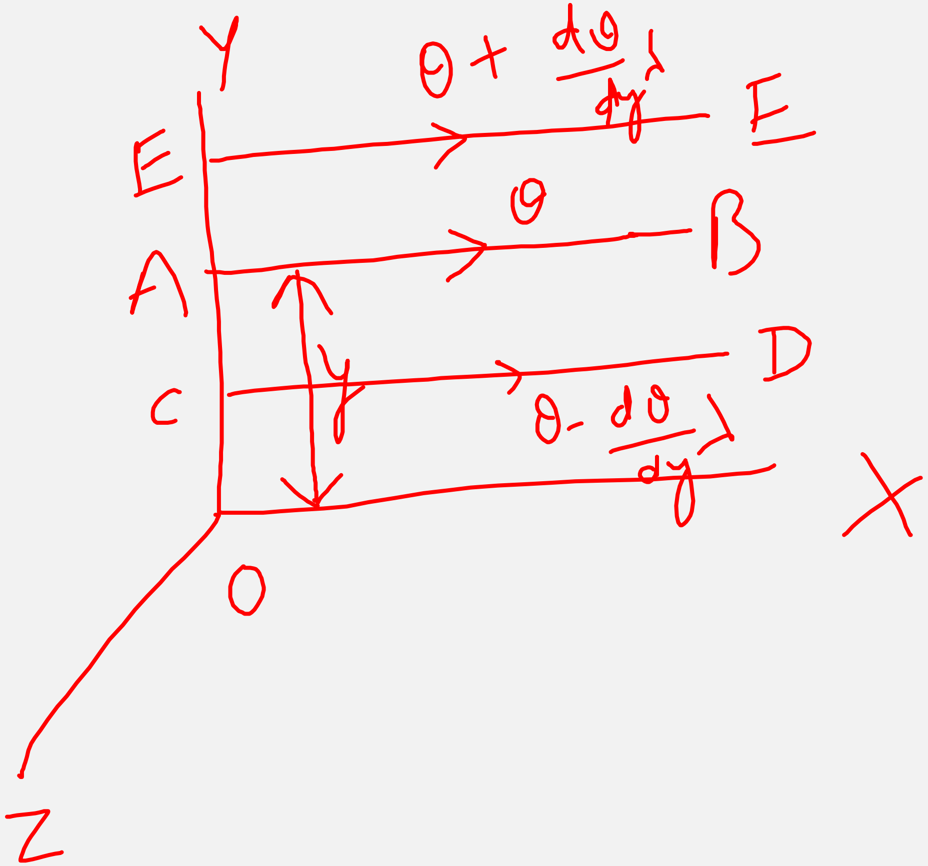
THERMAL CONDUCTION IN GASES(TRANSPORT OF ENERGY)

$y \rightarrow \theta$

$\frac{d\theta}{dy}$

temp of layer EF $\rightarrow \theta + \frac{d\theta}{dy} \lambda$

temp of layer CD $\rightarrow \theta - \frac{d\theta}{dy} \lambda$



$\boxed{\frac{n\lambda}{6}}$

Total heat energy carried by all the mol crossing the layer AB downward per unit area per sec

$$= \frac{nc}{6} m C_v \left(\theta + \frac{d\theta}{dy} \lambda \right)$$

$$= \frac{mnc C_v}{6} \left(\theta + \frac{d\theta}{dy} \lambda \right) \quad \text{—} \ (1)$$

$\frac{nc}{6}$ heat

heat energy carried by mol crossing the layer AB upward

$$= \frac{mnc C_v}{6} \left(\theta - \frac{d\theta}{dy} \lambda \right) \quad \text{—} \ (2)$$

Net transfer of heat

$$Q = \frac{mnC}{6} C_v \left[\left(\theta + \frac{d\theta}{dy}\lambda \right) - \left(\theta - \frac{d\theta}{dy}\lambda \right) \right]$$

$$= \frac{1}{3} mnC C_v \lambda \frac{d\theta}{dy} \quad — (3)$$

$$Q = K \frac{d\theta}{dy} \quad — (4)$$

$$K \frac{d\theta}{dy} = \frac{1}{3} mnC C_v \lambda \frac{d\theta}{dy}$$

$$\Rightarrow \boxed{K = \frac{1}{3} mnC C_v \lambda = \frac{1}{3} \rho C C_v \lambda} \quad — (5)$$

$$K = \eta C_v$$

① Independent of pressure

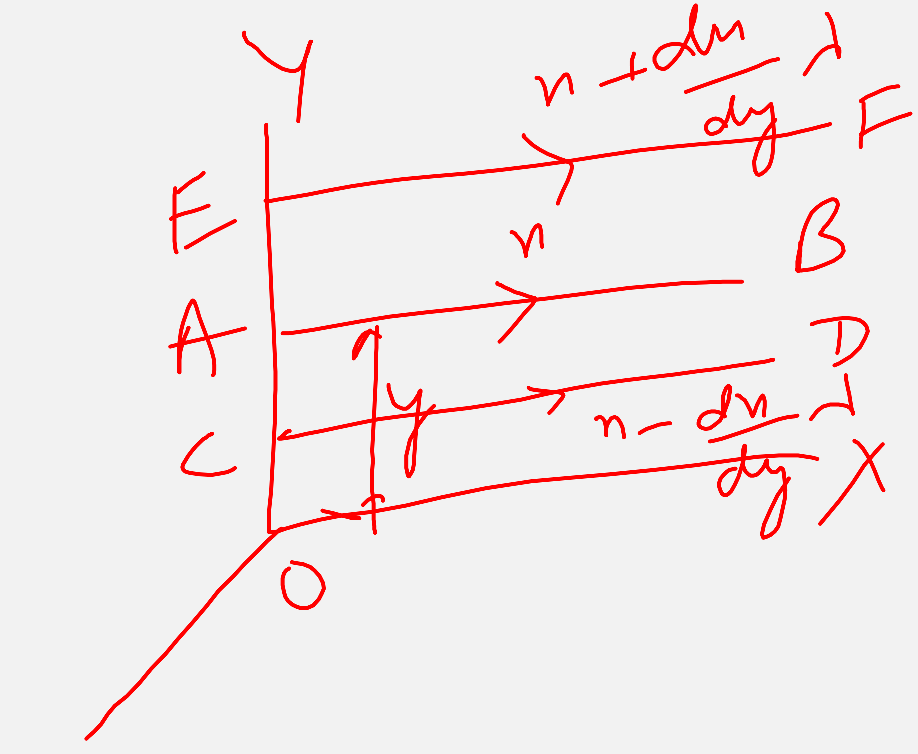
② $\propto \sqrt{T}$

DIFFUSION (TRANSPORT OF MASS)

$$\frac{nc}{6}$$

$$\frac{1}{6}c\left(n+\frac{dn}{dy}\lambda\right) \quad -(1)$$

$$\frac{1}{6}c\left(n-\frac{dn}{dy}\lambda\right) \quad -(2)$$



$$\frac{1}{3}c\lambda\frac{dn}{dy}$$

coeff of diff $= D = \dfrac{\frac{1}{3} c \lambda \frac{du}{dy}}{\frac{du}{dy}}$

$$D = \frac{1}{3} c \lambda$$

$$D = \frac{\eta}{\rho}$$

$$D \propto p^{-1} T^{3/2}$$

THANKYOU