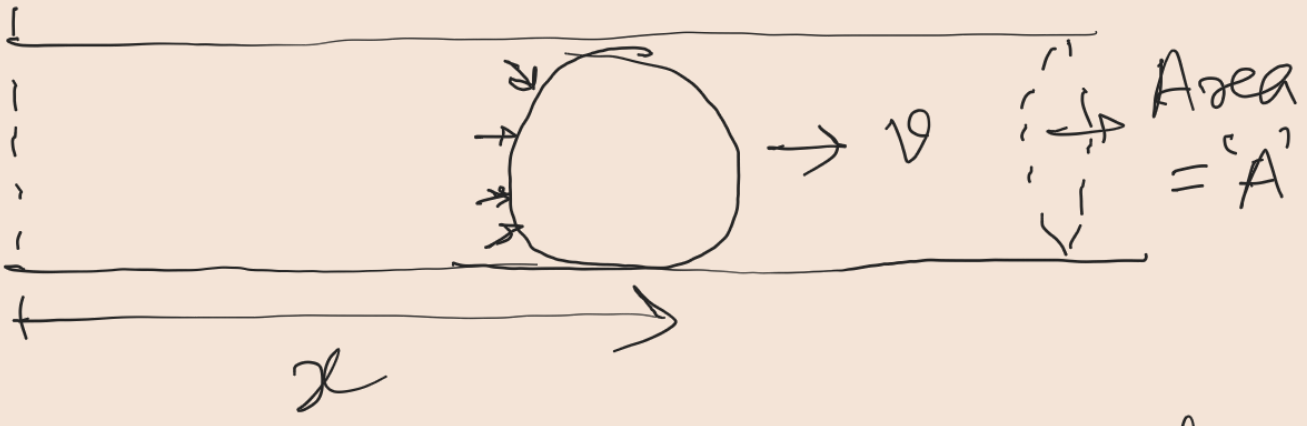


At any given instant, let gas pressure be 'P'. Then,

$$P\frac{dV}{dt} + V\frac{dP}{dt} = \left(\frac{dn}{dt}\right)RT$$

$$PA\frac{dx}{dt} + (Ax)\frac{dP}{dt} = \frac{\gamma}{M}RT.$$

$$(PA) = F = m_0\frac{dv}{dt} = m_0\frac{d^2x}{dt^2}.$$

$$A\frac{dP}{dt} = m_0\frac{d^3x}{dt^3}. \quad \text{From que}$$

information, $x = Kt^{\alpha}$

$$\frac{dx}{dt} = k\alpha t^{\alpha-1}, \quad \frac{d^2x}{dt^2} = k\alpha(\alpha-1) \times t^{\alpha-2}$$

$$\frac{d^3x}{dt^3} = k\alpha(\alpha-1)(\alpha-2)t^{\alpha-3}$$

Putting back,

$$m_0 k^2 \alpha^2 (\alpha-1) t^{\alpha-2} \times t^{\alpha-1}$$

$$+ k t^{\alpha} m_0 k \alpha (\alpha-1)(\alpha-2) t^{\alpha-3}$$

$$= \frac{m_0}{M} RT$$ time independent.

Hence,

$2\alpha - 3 = 0$ &

$$\boxed{\alpha = 3/2}$$

Also,

$$m_0 k^2 \times \frac{9}{4} \times \frac{1}{2} + m_0 k^2 \times \frac{3}{2} \times \frac{1}{2} \times \left(-\frac{1}{2}\right)$$

$$= m_0 k^2 \left(\frac{9}{8} - \frac{3}{8}\right) = \frac{3 m_0 k^2}{4}$$

$$= \frac{r}{M} RT$$

$$k = \left(\frac{4 r R T}{3 M m_0}\right)^{\frac{1}{2}}$$

$$l = (k)\, t^{3/2} \qquad t = \left(\frac{l}{k}\right)^{\frac{2}{3}}$$

$$v = (k) \times \frac{3}{2} \times \left(\frac{l}{k}\right)^{\frac{2}{3} \times \frac{1}{2}}$$

$$= \frac{3}{2}(\ell)^{\frac{1}{3}}(k)^{\frac{2}{3}}$$

$$= \frac{3}{2}(\ell)^{\frac{1}{3}}\left(\frac{4\gamma RT}{3Mm_0}\right)^{\frac{2}{3}\times\frac{1}{x}}$$

$$= \boxed{\frac{3}{2}\left(\frac{4\gamma RT\ell}{3Mm_0}\right)^{\frac{1}{3}}}\ell$$