

1 Solution

$$\begin{aligned}\frac{qR}{\hbar} - l\pi + \delta_l &= n\pi, n = 1, 2, 3, \dots \\ \delta_l &= (n + l)\pi - \frac{qR}{\hbar} \\ \frac{\partial \delta_l}{\partial \epsilon} &= \frac{\partial \delta_l}{\partial q} \frac{\partial q}{\partial \epsilon} = \frac{-R}{\hbar} \frac{\partial q}{\partial \epsilon}\end{aligned}$$

We substitute this into our formula for the Virial Coefficient

$$\begin{aligned}A_2 &= -2^{3/2} \sum_l \int d\epsilon \frac{2l+1}{\pi} \frac{d\delta_l}{d\epsilon} e^{-\epsilon/T} \\ & \qquad \qquad \qquad E = \frac{q^2}{2m} \\ A_2 &= \frac{2^{3/2} R}{\pi \hbar} \int_{-\infty}^{\infty} dq e^{-q^2/2mT} \sum_l (2l+1) \\ &= \frac{2^{3/2} R}{\pi \hbar} \sqrt{2mT\pi} = \frac{4R}{\hbar} \sqrt{\frac{mT}{\pi}} (2l+1)\end{aligned}$$