Answer on Question #48423, Physics, Molecular Physics | Thermodynamics

The temperature (T) of an ideal gas varies with it's volume (V) as T=-aV ^ 3+bV^2, where 'a' and 'b' are positive constants. The maximum pressure of gas during this process is.

Solution:

An ideal gas can be characterized by three state variables: absolute pressure (P), volume (V), and absolute temperature (T). The relationship between them may be deduced from kinetic theory and is called the *ideal gas law*:

$$PV = nRT$$

where n = number of moles,

R = universal gas constant = 8.3145 J/mol K

$$P = \frac{nRT}{V}$$

From given

$$T = -aV^3 + bV^2$$

Thus,

$$P = nR(-aV^2 + bV)$$

To find maximum we will differentiate and equal it to zero:

$$P' = nR(-2aV + b) = 0$$

Thus,

$$-2aV + b = 0$$

$$V = \frac{b}{2a}$$

and

$$T = -aV^3 + bV^2 = -a\left(\frac{b}{2a}\right)^3 + b\left(\frac{b}{2a}\right)^2 = \frac{b}{2a}\left(-\frac{b^2}{4a} + \frac{b^2}{2a}\right) = \frac{b}{2a}\frac{b^2}{4a} = \frac{b^3}{8a^2}$$

Answer: The maximum pressure of gas during this process is where $V = \frac{b}{2a}$ and $T = \frac{b^3}{8a^2}$.