1. If the potential energy between two molecules is given by $U = -\frac{A}{r^6} + \frac{B}{r^{12}}$, then at equilibrium, separation between molecules, and the potential energy are: **[Sep. 06, 2020 (I)]**

(a) $\left(\frac{B}{2A}\right)^{\frac{1}{6}}, -\frac{A^2}{2B}$

(b) $\left(\frac{B}{A}\right)^{\frac{1}{6}}, 0$

(c) $\left(\frac{2B}{A}\right)^{\frac{1}{6}}, -\frac{A^2}{4B}$

(d) $\left(\frac{2B}{A}\right)^{\frac{1}{6}}, -\frac{A^2}{2B}$

1. **(c)** Given : $U = \frac{-A}{r^6} + \frac{B}{r^{12}}$

For equilibrium,

$$F = \frac{dU}{dr} = -(A(-6r^{-7})) + B(-12r^{-13}) = 0$$

$$\Rightarrow 0 = \frac{6A}{r^7} - \frac{12B}{r^{13}} \Rightarrow \frac{6A}{12B} = \frac{1}{r^6}$$

$\therefore$ Separation between molecules, $r = \left(\frac{2B}{A}\right)^{1/6}$

Potential energy,

$$U\left(r = \left(\frac{2B}{A}\right)^{1/6}\right) = -\frac{A}{2B/A} + \frac{B}{4B^2/A^2}$$

$$= \frac{-A^2}{2B} + \frac{A^2}{4B} = \frac{-A^2}{4B}$$