PYQ [GATE]

(Chapter 3 Crystal Binding)

Q1. The binding energy per molecule of $NaCl$ (lattice parameter is $0.563\,nm$) is $7.956\ eV$. The repulsive term of the potential is of the form $\frac{K}{r^9}$, where K is a constant. The value of the Modelung constant is ___________ (upto three decimal places)

(Electron charge $e = -1.6\times10^{-19}\,C$; $\varepsilon_0 = 8.854\times10^{-12}\,C^2N^{-1}m^{-2}$)

GATE-2015

Q2. The total energy of an inert-gas crystal is given by $E(R) = \frac{0.5}{R^{12}} - \frac{1}{R^6}$ (in eV), where R is the inter-atomic spacing in Angstroms. The equilibrium separation between the atoms is Angstroms. (up to two decimal places)

GATE-2017

Q3. The total energy of an ionic solid is given by an expression $E = -\frac{\alpha e^2}{4\pi\varepsilon_0 r} + \frac{B}{r^9}$ where α is Madelung constant, *r* is the distance between the nearest neighbours in the crystal and *B* is a constant. If r_0 is the equilibrium separation between the nearest neighbours then the value of *B* is

(a) $\frac{\alpha e^2 r_0^8}{36\pi\varepsilon_0}$ (b) $\frac{\alpha e^2 r_0^8}{4\pi\varepsilon_0}$ (c) $\frac{2\alpha e^2 r_0^{10}}{9\pi\varepsilon_0}$ (d) $\frac{\alpha e^2 r_0^{10}}{36\pi\varepsilon_0}$

GATE-2013

Q4. Consider a three-dimensional crystal of N inert gas atoms. The total energy is given by $U(R) = 2N\in\left[p\left(\frac{\sigma}{R}\right)^{12} - q\left(\frac{\sigma}{R}\right)^6\right]$, where $p = 12.13$, $q = 14.45$ and R is the nearest neighbour distance between two atoms. The two constants, $\in$ and R, have the dimensions of energy and length, respectively. The equilibrium separation between two nearest neighbour atoms in units of σ (rounded off to two decimal places) is____________

GATE-2019

PYQ [NET]

Q1. The potential of a diatomic molecule as a function of the distance *r* between the atoms is given by $V(r) = -\frac{a}{r^6} + \frac{b}{r^{12}}$. The value of the potential at equilibrium separation between the atoms is:

(a) $-4a^2/b$ (b) $-2a^2/b$ (c) $-a^2/2b$ (d) $-a^2/4b$

NET/JRF (DEC-2011)

Worksheet

Q1. The potential energy of a diatomic molecule in terms of inter atomic distance R is given by

$$U(R) = -\frac{A}{R^m} + \frac{B}{R^n},$$

where A, B, m and n are constants characteristics for the MX -molecules. Attractive and repulsive exponents are related through:

(a) $n << m$ (b) $n < m$ (c) $n > m$ (d) $n >> m$

Q2. The potential energy of a diatomic molecule in terms inter atomic distance R is given by

$$U(R) = -\frac{A}{R^m} + \frac{B}{R^n},$$

where A, B, m and n are constant characteristics for the MX - molecules. The equilibrium separation R_e, is obtained as:

(a) $\left(\frac{nA}{mB}\right)^{\frac{1}{n-m}}$ (b) $\left(\frac{nA}{mB}\right)^{\frac{1}{m-n}}$ (c) $\left(\frac{nB}{mA}\right)^{\frac{1}{m-n}}$ (d) $\left(\frac{nB}{mA}\right)^{\frac{1}{n-m}}$

Q3. The potential energy of a diatomic molecule in terms of inter atomic separation R is given by

$$U(R) = -\frac{\alpha}{R^4} + \frac{\beta}{R^{12}}$$

The equilibrium separation is obtained as:

(a) $(3\beta/\alpha)^{1/8}$ (b) $(3\beta/\alpha)^{1/6}$ (c) $(3\beta/\alpha)^{1/4}$ (d) $(3\beta/\alpha)^{1/2}$

Q4. The potential energy of a system of two atoms is given by

$$U = -\frac{A}{R^6} + \frac{B}{R^{12}}$$

If the atoms form a stable bond with bond length $3\overset{0}{\text{A}}$ and the bond energy $1.8eV$ the value of the constant A is:

(a) $1.9 \times 10^{-76} Jm^6$ (b) $2.9 \times 10^{-76} Jm^6$ (c) $3.9 \times 10^{-76} Jm^6$ (d) $4.9 \times 10^{-76} Jm^6$

Q5. The potential energy of a system of two atoms is given by

$$U(R) = -\frac{A}{R^6} + \frac{B}{R^{12}}$$

If the atoms form a stable bond with bond length $3\overset{0}{\text{A}}$ and the bond energy $1.8eV$ the critical separation R_c is obtained as:

(a) $1.33\overset{0}{\text{A}}$ (b) $2.33\overset{0}{\text{A}}$ (c) $3.33\overset{0}{\text{A}}$ (d) $4.33\overset{0}{\text{A}}$

Q6. If the equilibrium separation between cesium and chlorine atoms is $3.56\overset{0}{\mathrm{A}}$, $A = 1.76$ and $n = 11.5$, the potential energy of $CsCl$ at equilibrium is:

(a) $-2.5eV$ (b) $-4.5eV$ (c) $-6.5eV$ (d) $-8.5eV$

Q7. A pair of Li^{+} and Cl^{-} ion with their radii $0.60\overset{0}{\mathrm{A}}$ and $1.81\overset{0}{\mathrm{A}}$ touch each other, the attractive force between them is:

(a) $1.96\times10^{-9}N$ (b) $2.96\times10^{-9}N$ (c) $3.96\times10^{-9}N$ (d) $4.96\times10^{-9}N$

Q8. Show that the Madelung constant A for an infinite linear chain of ions of alternating charge at an equilibrium separation R_e is:

(a) 0.3863 (b) 1.3863 (c) 2.3863 (d) 3.3863

Q9. Show that the potential energy of two particles in stable configuration (at equilibrium) with $m = 2$ and $n = 10$ is equal to:

(a) $-\frac{1}{5}\left(\frac{A}{R_e^2}\right)$ (b) $-\frac{2}{5}\left(\frac{A}{R_e^2}\right)$ (c) $-\frac{3}{5}\left(\frac{A}{R_e^2}\right)$ (d) $-\frac{4}{5}\left(\frac{A}{R_e^2}\right)$

Q10. Assume a repulsive potential of the form B/R^9 acts between the neighboring ions of $NaCl$. If the nearest neighbor distance is $2.81\overset{0}{\mathrm{A}}$ and the Madelung constant is 1.7476, the compressibility $NaCl$ is

(a) $2.48\times10^{-11}m^2N$ (b) $3.48\times10^{-11}m^2N$ (c) $4.48\times10^{-11}m^2N$ (d) $5.48\times10^{-11}m^2N$