Assessment 5

The due date for submitting this assignment has passed. **Due on 2016-03-18, 23:59 IST.**

Submitted assignment

Assume speed of light to be $3 \times 10^8 \text{ m.s}^{-1}$; Planck's constant $h = 6.626 \times 10^{-34} \text{ J.s}$. Boltzmann constant $k_B = 1.38 \times 10^{-23} \text{ J.K}^{-1}$

1) The force constants of HI, HBr, HCl and HF are given as 314, 412, 516 and 966 $N\text{m}^{-1}$ respectively. The fundamental (or harmonic) vibrational frequencies are in the order $\nu_{\text{HF}} > \nu_{\text{HCl}} > \nu_{\text{HBr}} > \nu_{\text{HI}}$ 1 point

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\nu_{\text{HF}} > \nu_{\text{HCl}} > \nu_{\text{HBr}} > \nu_{\text{HI}}$

2) The fundamental vibrational frequencies of HCl and DCI have the relation $\nu_{\text{HCl}} = \nu_{\text{DCI}}$ 1 point

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\nu_{\text{HCl}} = 1.395 \nu_{\text{DCI}}$

3) The reduced mass of CO is $1.138 \times 10^{-26} \text{ kg}$ and the force constant is 1902 $N\text{m}^{-1}$. Light required to induce a transition from $n = 2$ to $n = 3$ has a wavenumber of $6507 \text{ cm}^{-1}$ 1 point
4338 cm⁻¹
2169 cm⁻¹
1085 cm⁻¹

No, the answer is incorrect.
Score: 0
Accepted Answers:
2169 cm⁻¹

4) The energy required to excite a molecule from its ground state to the first excited state corresponds to a wavenumber of 1000 cm⁻¹. In thermal equilibrium, at a temperature of 100 K, the ratio of the number of molecules in the excited vibrational state to those in the ground vibrational state is

5.55 × 10⁻³
5.55 × 10⁻⁵
5.55 × 10⁻⁷
5.55 × 10⁻⁹

No, the answer is incorrect.
Score: 0
Accepted Answers:
5.55 × 10⁻⁷

5) The Morse potential energy function for a diatomic molecule is given by the formula \( D[1 - e^{-\alpha x}]^2 \) where \( x \) is the vibrational amplitude. The interpretation of \( D \) is

- It is the force constant
- It is the frequency of fundamental vibration
- It is the energy required to excite the molecule from the ground state to the first excited state
- It is the dissociation energy of molecule

No, the answer is incorrect.
Score: 0
Accepted Answers:
It is the dissociation energy of molecule

6) The energy level expression for the Morse oscillator is (\( x_e \) is the anharmonicity constant and 1 point is \( << 1 \))

\[ E = \hbar \nu_e (n + 1/2) \]
\[ E = \hbar \nu_e (n + 1/2)^2 \]
\[ E = \hbar \nu_e (1 - x_e)(n + 1/2) \]
\[ E = \hbar \nu_e (n + 1/2) - \hbar \nu_e x_e(n + 1/2)^2 \]

No, the answer is incorrect.
Score: 0
Accepted Answers:
\[ E = \hbar \nu_e (n + 1/2) - \hbar \nu_e x_e(n + 1/2)^2 \]

7) The energy required to raise a Morse oscillator from an energy state with vibrational quantum number \( n = 3 \) to another state with \( n = 5 \) is given as

\[ 2\hbar \nu_e - 18\hbar \nu_e x_e \]
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Chemistry - II - Unit 4 - Week 3

https://onlinecourses.nptel.ac.in/noc16_cy01/unit?unit=28&assessment=31

1) \(2h\nu_e\)

2) \(2h\nu_e - 9h\nu_e x_e\)

3) \(2h\nu_e - 2h\nu_e x_e\)

No, the answer is incorrect.
Score: 0
Accepted Answers:
\(2h\nu_e - 18h\nu_e x_e\)

8) The approximate formula for the anharmonicity coefficient \(x_e\) is (D is the dissociation energy):

\[x_e \approx \sqrt{\frac{1}{D}}\]

\[x_e \approx \sqrt{\frac{2}{D}}\]

\[x_e \approx \sqrt{\frac{h\nu_e}{4D}}\]

\[x_e \approx \sqrt{\frac{p}{4\hbar\nu_e}}\]

No, the answer is incorrect.
Score: 0
Accepted Answers:
\(x_e \approx \sqrt{\frac{h\nu_e}{4D}}\)

9) The selection rule for transitions in a Morse oscillator is

\[\Delta n = \pm 1\]

\[\Delta n = \pm 1 \text{ or } \pm 2\]

\[\Delta n = \pm 2\text{ only}\]

\[\Delta n\] can be of any integer

No, the answer is incorrect.
Score: 0
Accepted Answers:
\(\Delta n\) can be of any integer

10) The parameter \(\alpha\) in Morse oscillator is related to the harmonic oscillator frequency. The possible expression is

\[\alpha \approx \nu_e\]

\[\alpha \approx \nu_e / c\]

\[\alpha \approx 1 / \nu_e\]

\[\alpha \approx \nu_e x_e\]

No, the answer is incorrect.
Score: 0
Accepted Answers:
\[ \alpha \approx \nu / c \]