APEX CARE ACADEMY, RASIPURAM

(A REAL INSTITUTE FOR PHYSICS)

PG & POLY. TRB – PHYSICS

Name of the Candidate :	No. of Questions Answered :
Date of Examination :	No. of Questions False answered :
Sign. of the candidate :	No. of Questions Right answered :
Time: 10.00 A.M – 1.00 P.M	Negative Mark (i.e: No. of False questions will carry 2 marks for Negative) :
	Net Marks For Better Improvement (3)-(4) :

SPECTROSCOPY

Mark : 150 Time : 3 Hr

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1) A thin uniform ring carrying charge Q and mass M rotates about its axis. what is the gyromagnetic ratio (defined as ratio of magnetic dipole moment to the angular momentum) of this ring ?

a) $Q/2\pi M$ b) Q/M c) $Q/(2M)$ d) $Q/(\pi M)$

2) Obtain the magnitude of spin magnetic dipole moment of an electron interms of Bohr magneton :

a) $\mu_s = \sqrt{2}\,\mu_B$ b) $\mu_s = \sqrt{3}\,\mu_B$

c) $\mu_s = \sqrt{3}/4\,\mu_B$ d) none of these.

3) A beam of electrons enters a uniform magnetic field of flux density 1.2 tesla. calculate the energy difference between electrons whose spins are parallel and anti parallel to the field.

a) 1.39×10^{-3} eV b) 1.29×10^{-4} eV

c) 1.39×10^{-4} eV d) 1.93×10^{-4} eV

4) For an electron orbit with quantum number $l=2$ state the possible values of the components of angular momentum along a specified direction.

a) $\pm 5/2\,(h/2\pi)$, $\pm 3/2\,(h/2\pi)$

b) $\pm 5/2\,(h/2\pi)$, $\pm 3/2\,(h/2\pi)$, $\pm 1/2\,(h/2\pi)$

c) $\pm 5/2\,(\hbar/2\pi)$, $\pm 3/2\,(\hbar/2\pi)$, $\pm 1/2\,(\hbar/2\pi)$

d) none of these.

5) Find the magnetic moment (in terms of Bohr magneton) of $^2P_{3/2}$ state

a) $\frac{3}{5}\sqrt{6}$ b) $\frac{1}{6}\sqrt{15}$ c) $\frac{2}{3}\sqrt{15}$ d) $\frac{1}{8}\sqrt{6}$

6) The angle between $\vec{L}$ and $\vec{S}$ vectors for the term $^2D_{5/2}$.

a) 62° b) 54° c) 48° d) 70°

7) The maximum possible angle which the total angular momentum vector $\vec{J}$ corresponding $j=3$ make with the z-component of total angular momentum.

a) 30° b) 45° c) 60° d) 90°

8) The Lande g-factor for the $^3D_2$ level of an atom is

a) $1/2$ b) $7/6$ c) $5/2$ d) $7/2$

9). A beam of neutral atoms passes through a Stern Gerlach apparatus. Five equally spaced lines are observed. The total angular momentum of atom is

a) $\sqrt{6}\,\hbar$ b) $2\hbar$ c) $\sqrt{2}\,\hbar$ d) $6\hbar$.

10). The degeneracy of an excited state of Neon having electronic configuration $1s^2\,2s^2\,2p^5\,5s^1$.

a) 2 b) 6 c) 10 d) 15

11). The pure rotational spectrum of $H^1 Br^{79}$ consists of a series of lines spaced $17\ cm^{-1}$ apart. Find the inter nuclear distance of $H^1 Br^{79}$. (Here reduced mass of HBr $= 1.64 \times 10^{-27}$ kg)

a) 1.86 Å b) 1.36 Å c) 1.42 Å d) 2.45 Å

12). The frequency of the $J=4$ to $J=3$ transition in the pure rotational spectra of $^{14}N\,^{16}O$. (Here equilibrium bond length is 115 pm and reduced mass of nitrogen and oxygen is 1.240×10^{-26} kg)

a) 4.1×10^{11} Hz b) 2.2×10^{11} Hz

c) 1.1×10^{11} Hz d) 8.2×10^{11} Hz

13). The bond length of $^{12}C\,^{16}O$ using $\bar{B} = 1.9302\ cm^{-1}$ and the reduced mass of $^{12}C\,^{16}O$ is $(\mu) = 1.14 \times 10^{-26}$ kg is

a) 0.5 Å b) 1.8 Å c) 1.1 Å d) 3.6 Å

14) The molecule that will exhibit a pure rotational absorption spectrum out of this

a) CH_4 b) CO_2 c) O_2 d) NF_3

15). In a rigid rotator the energy of fourth excited state is 10 meV, then the energy of second excited state is

a) 1.5 meV b) 2 meV c) 2.5 meV d) 3 meV.

16) In case of pure rotational if the temperature (T) will doubled then the rotational quantum number corresponding to maximum population density will be (assume the case 'T' is high)

a) will remained unchanged.

b) become halfed.

c) will become $\sqrt{2}$ times

d) will become doubled.

17). The H_2 molecule has a reduced mass $M = 8.35 \times 10^{-28}$ kg and an equilibrium internuclear distance $R = 0.742 \times 10^{-10}$ m. The rotational energy interms of the rotational quantum number J is.

a) $E_{rot}(J) = 7J(J-1)$ meV b) $E_{rot}(J) = \frac{5}{2} J(J+1)$ meV

c) $E_{rot}(J) = 7J(J+1)$ meV d) $E_{rot}(J) = 5/2\, J(J-1)$ meV

18) The strongest three lines in the emission spectrum of an interstellar gas cloud are found to have wavelengths λ_0, $2\lambda_0$ and $6\lambda_0$ respectively. where λ_0 is a known wavelength. From this we can deduce that the radiating particles in the cloud behave like.

a) free particles b) particles in a box.
c) harmonic oscillators d) rigid rotators.

19) The separation between neighbouring absorption lines in a pure rotational spectrum of the hydrogen bromide (HBr) molecule is 2.23 MeV. If this molecule is considered as a rigid rotor and the atomic mass number of Br is 80. the corresponding absorption line separation in deuterium bromide (DBr) molecule, in units of MeV. would be

a) 2.234 b) 1.115 c) 1.128 d) 4.461.

20) Hydrogen atoms in the atmosphere of a star are in thermal equilibrium with an average kinetic energy of 1 eV. The ratio of the number of hydrogen atoms in the 2nd excited state (n=3) to the number in the ground state. (n=1) is

a) 3.16×10^{-11} b) 1.33×10^{-8} c) 3.16×10^{-8} d) 5.67×10^{-6}

21) Two homonuclear diatomic molecules produce different rotational spectra even though the atoms are known to have identical chemical properties. This leads to the conclusion that the atoms must be

a) Isotope : (ie) with the same atomic number.

b) isobar : (ie) with the same atomic weight

c) Isotones : (ie) with the same neutron number.

d) isomers : (ie) with the same atomic number and weight.

22) The equilibrium vibration frequency for an oscillator observed at 2990 cm^{-1}. The ratio of the frequencies corresponding to the first and the fundamental spectral lines is 1.96. Considering the oscillators be anharmonic the anharmonic

a) 0.005 b) 0.02

c) 0.05 d) 0.1

23) The spacing between vibrational energy levels in CO molecule is found to be 8.44×10^{-1} eV. Given that the reduced mass of CO is 1.14×10^{-26} kg, planck's constant is 6.626×10^{-34} J.s and 1 eV = 1.6×10^{-19} Joule. The force constant of the bond in CO molecule is

a) 1.87 N/m b) 18.7 N/m

c) 187 N/m d) 1870 N/m

24) If H_2 molecule behaves like a harmonic oscillator with a force constant K = 573 N/m. The vibrational quantum number corresponding to its 4.5 eV dissociation energy.

a) 6 b) 5 c) 8 d) 7

25) The force constant of the bond in CO molecule is 1870 Nm^{-1}. Find the energy of the lowest vibrational level. The reduced mass of CO molecule is 1.14×10^{-26} kg.

a) 0.134 eV b) 0.228 eV

c) 0.268 eV d) 0.456 eV.

26) In an harmonic vibrational spectra the fundamental spectra, the fundamental band for CO molecule is centered at 2143.3 cm^{-1} and the first overtone is at 4259.7 cm^{-1}. The anharmonic constant is (in terms of $\times 10^{-3}$)

a) 6.2 b) 1.3 c) 7.3 d) 8.3

27) The anharmonicity constant of CO molecule (x_e) is 6.2×10^{-3} then the vibrational quantum numbers corresponding to dissociation energy is

a) 108 b) 80 c) 97 d) 135.

28) The force constant of a vibrating HCl molecule is 480 N/m. The energy difference between the lowest and the first vibrational level of the HCl (reduced mass of hydrogen and chlorine = 1.61×10^{-27} kg)

a) 0.36 eV b) 0.72 eV c) 1.4 eV

29) The value of $\bar{\omega}_e$ for H_2 is 4395 cm^{-1} and wave number corresponding to zero point energy = 2168 cm^{-1} Then the anharmonicity constant (x_e) is.

a) 1.3×10^{-3} b) 2.1×10^{-1}

c) 2.6×10^{-2} d) 2.8×10^{-3}

30) The reduced mass of a molecule 'A' is four times the reduced mass of a molecule 'B' is also force constant of molecule 'A' is twice the force constant of molecule 'B' Then the ratio of the ground state energy of pure vibrational motion $\left(\frac{E_A}{E_B}\right)$ is

a) $1/\sqrt{2}$ b) $\sqrt{2}$ c) $2\sqrt{2}$ d) $3\sqrt{2}$

D. Answer : (c)

Solution :

The magnetic dipole moment :

$\mu = i \times A$

$\mu = \frac{q}{T} \times A$

$= \frac{Q}{(2\pi r / v)} \times \pi r^2$

$= \frac{Q \cdot V}{2\pi r} \times \pi r^2$

$= \frac{Q \cdot V}{2} \times \frac{m}{m}$

$\mu = \frac{Q}{2m} \times L$

$\frac{\mu}{L} = \frac{Q}{2m}$

$\gamma = \frac{\mu}{L} = \frac{\text{magnetic momentum}}{\text{Angular momentum}}$

$\gamma = \frac{Q}{2m}$

$T = \frac{2\pi m}{Bq}$

$\omega = 2\pi \gamma$

$\gamma = \frac{\omega}{2\pi}$

$T = \frac{2\pi}{\omega}$

$\omega = \frac{V}{r}$

$T = \frac{2\pi r}{V}$

2). Answer : (b)

Solution :

spin magnetic momentum of electron

$$\vec{\mu_s} = -g_s\left(\frac{e}{2m}\right)\vec{s}$$

∴ magnitude of spin angular momentum

$$\mu_s = g_s\left(\frac{e}{2m}\right)s$$

Now, electron $g_s = 2$, $s = 1/2$

$$s' = \sqrt{s(s+1)}\,\hbar$$

$$s' = \sqrt{1/2\,(1/2+1)}\,\hbar = \sqrt{3/4}\,\hbar = \frac{\sqrt{3}}{2}\hbar$$

$$\mu_s = 2 \times \frac{e}{2m} \times \frac{\sqrt{3}}{2}\hbar$$

$$= 2 \times \frac{e}{2m} \times \frac{\sqrt{3}}{2} \times \frac{h}{2\pi}$$

$$= \frac{eh}{4\pi m}\cdot\sqrt{3}$$

$$\mu_s = \sqrt{3}\cdot\mu_B$$ [where $\mu_B = \frac{eh}{4\pi m}$ (Bohr magnetron)]

3).

Answer : (c)

Solution :

calculate the energy difference between electron: $U_m = -\mu_s . B$

The different in energy having spin parallel and antiparallel to the field is

$$\Delta U_m = \frac{ehB}{4\pi m} - \left(\frac{-ehB}{4\pi m}\right)$$

$$= \frac{ehB}{2\pi m}$$

$$= \frac{1.6 \times 10^{-19} \times 6.626 \times 10^{-34} \times 1.2}{2 \times 3.14 \times 9.11 \times 10^{-31}}$$

$$\Delta U_m = 2.23 \times 10^{-23} \text{ Joule}$$

$$\Delta U_m = 1.39 \times 10^{-4} \text{ eV}$$

4).

Answer : (b)

Solution :

$$J_z = m_j \hbar$$

$$= m_j \cdot \frac{h}{2\pi}$$

For $l = 2$, $s = 1/2$

The possible values of j are

$j = l \pm s = 2 \pm 1/2 = 5/2$ and $3/2$

$\Rightarrow$ $j = 5/2$ the possible value of m_j

$-5/2, -3/2, -1/2, 1/2, 3/2, 5/2$

$\Rightarrow$ $J = 3/2$ the possible values of m_j

$3/2, 1/2, -1/2, -3/2$

$\therefore$ possible value of the z-component of total angular momentum

$\pm 5/2 \hbar, \pm 3/2 \hbar, \pm 1/2 \hbar$

(ie) $\pm 5/2 \cdot (h/2\pi)$, $\pm 3/2 (h/2\pi)$, $\pm 1/2 (h/2\pi)$

5).

Answer = (c)

Solution:

$$\mu = g \cdot \left(\frac{e}{2m}\right) \sqrt{J(J+1)} \cdot \hbar$$

$$\mu = g \cdot \mu_B \sqrt{J(J+1)}$$

$$\left(\mu_B = \frac{eh}{4\pi m}\right)$$

Lande g- factor :

$$g = 1 + \frac{J(J+1) - L(L+1) + S(S+1)}{2J(J+1)}$$

$${}^2P_{3/2} \rightarrow {}^{2S+1}P_J \; ; \; 2S+1 = 2$$

$$2S = 1$$

$$\boxed{g = 4/3}$$

$$S = 1/2$$

$$J = 3/2$$

$$\therefore \mu = 4/3 \cdot \mu_B \cdot \sqrt{3/2\,(3/2+1)}$$

$$\mu = 2/3 \cdot \sqrt{15} \cdot \mu_B$$

6).

Answer = (a)

Solution :

$$^2D_{5/2} \longrightarrow {}^{2S+1}D_J \qquad \begin{matrix} & s & p & d \\ L= & 0 & 1 & 2 \end{matrix}$$

$L=2$, $J=5/2 \Rightarrow 2S+1=2 \Rightarrow 2S=1 \Rightarrow S=1/2$

$$\cos(\vec{L},\vec{S}) = \frac{j(j+1)+l(l+1)-s(s+1)}{2\sqrt{l(l+1)}\cdot\sqrt{s(s+1)}}$$

$$\cos(\vec{L},\vec{S}) = \frac{35/4 - 6 - 3/4}{2\sqrt{6 \times 3/4}}$$

$$= 0.4714$$

The angle between L and S

$$\cos^{-1}(0.4714) = 62^\circ$$

7).

Answer = (d).

Solution :

$j = 3, \quad m_j = 3, 2, 1, 0, -1, -2, -3$

The possible value of θ is

$$\cos\theta = \frac{|J_z|}{|J|} = \frac{m_j \hbar}{\sqrt{j(j+1)}\,\hbar}$$

$$= \frac{m_j}{\sqrt{12}}$$

So the value of $\cos\theta$ are

$3/\sqrt{12}, \; 2/\sqrt{12}, \; 1/\sqrt{12}, \; 0/\sqrt{12}, \; -1/\sqrt{12}, \; -2/\sqrt{12}, \; -3/\sqrt{12}$

$\therefore \theta = 90^\circ$

$\cos 90^\circ = 0$.

8). Answer : (b)

Solution:

The Lande g factor $^3D_2$

$$^3D_2 \Rightarrow {}^{2S+1}D_j$$

$J = 2$

$2S+1 = 3$

$2S = 2$

s, p, d, e, f

$L = 0, 1, 2, 3, 4$

$\boxed{S=1}$, $\boxed{L=2}$, $\boxed{J=2}$

$$g = 1 + \left[\frac{j(j+1) - l(l+1) + s(s+1)}{2j(j+1)}\right]$$

$$g = 1 + \left[\frac{6 - 6 + 2}{2 \times 6}\right]$$

$$= 1 + \left(\frac{2}{12}\right) = \frac{12+2}{12}$$

$$= \frac{14}{12} = \frac{7}{6}$$

$$g = \frac{7}{6}$$

9) Answer = (a)

Solution :

The total angular momentum of atom is

$$|\vec{J}| = \sqrt{j(j+1)}\,\hbar$$

we observed five equally lines,

$$2J+1 = 5$$

$$\boxed{J = 2}$$

$$|\vec{J}| = \sqrt{2(2+1)}\,\hbar$$

$$\vec{J} = \sqrt{6}\,\hbar$$

10). Answer : (a)

Solution:

The degeneracy of excited state of Neon:

$1s^2, 2s^2, 2p^5, 5s^1$

For last state is $5s^1$

s state $l = 0$, spin of electron = 1.

$J = |l+s|$ to $|l-s|$

$= |0+1/2|$ to $|0-1/2|$

$= 1/2$

Degeneracy of excited state of Neon atom is $\Sigma(2J+1) = \Sigma(2 \times 1/2 + 1)$

$= 2$

11). Answer = (c)

Solution :

The spacing between two spectrum line : $2B = 17\,cm^{-1}$

$$B = \frac{17}{2} = 8.5\ cm^{-1} = 850\,m^{-1}$$

$$B = \frac{h}{8\pi^2 I c}$$

$$I = \frac{h}{8\pi^2 B c}$$

$$= \frac{6.626 \times 10^{-34}}{8 \times 3.14 \times 3.14 \times 850 \times 3 \times 10^{8}}$$

$$= \frac{6.626 \times 10^{-34}}{8 \times 3.14 \times 3.14 \times 3 \times 10^{8}} \times \frac{1}{850}$$

$$= 28 \cdot 10^{-45} \times \frac{1}{850} = 0.0329 \times 10^{-45}$$

$$\boxed{I = 3.29 \times 10^{-47}\ kg.m^2}$$

$$I = \mu . r^2 \ ; \ r = \sqrt{I/\mu}$$

$$r = \sqrt{\frac{3.29 \times 10^{-47}}{1.64 \times 10^{-27}}} = \sqrt{\frac{3.29}{1.64}} \times 10^{-10}$$

$r = 1.42\ \text{Å}$

12). Answer : (a)

Solution :

NO : $J=4 \rightarrow J=3$

$E = BJ(J+1)$

$\Delta E = B\,4(4+1) - B\,3(3+1)$

$= 20B - 12B$

$\Delta E = 8B$

$B = \frac{h}{8\pi^2 I c}$, $I = \mu r^2$

$\Delta E = 8 \times B = 8 \times \frac{h}{8\pi^2 I c}$

$\overline{\Delta E} = 1365.6\ m^{-1}$

$E = h\nu = h \cdot \frac{c}{\lambda}$

$E = hc\bar{\nu}$

$\therefore \nu = 4.096 \times 10^{11}\ Hz$

13) .

Answer = ([illegible])

Solution :

$$B = \frac{h}{8\pi^2 I c} = \frac{h}{8\pi^2 M R^2 c}$$

$$R^2 = \frac{h}{8\pi^2 m c}$$

$$R = \sqrt{h/8\pi^2 \mu c}$$

$\therefore R = 1.1\ \text{Å}$

14) . Answer = (d)

NF_3 has dipole moment.

15) . Answer = (d)

Solution :

$$10\ meV = \frac{\hbar^2}{2I} J(J+1)$$

$$10\ meV = \frac{\hbar^2}{2I} 4(4+1)$$

$$10\ meV = \frac{\hbar^2}{2I} \times 20 \Rightarrow \boxed{\frac{\hbar^2}{2I} = \frac{10\ meV}{20}}$$

energy of 2^{nd} excited state is

$$E_2 = \frac{\hbar^2}{2I} 2(2+1)$$

$$= \frac{\hbar^2}{2I} \times 6 \Rightarrow \frac{10\ meV}{20} \times 6$$

$$E_2 = 3\ meV$$

16). Answer = (c)

Solution :

$$J_{max} \simeq \sqrt{\frac{KT}{2Bhc}} - \frac{1}{2}$$

$$J_i = \sqrt{\frac{K \cdot T_i}{2Bhc}} \quad \text{------ (1)}$$

$$J_f = \sqrt{\frac{K\, T_f}{2Bhc}} \quad , T_f = 2T_i$$

$$J_f = \sqrt{\frac{2K\, T_i}{2Bhc}} \quad \text{------ (2)}$$

$$\frac{J_f}{J_i} = \sqrt{\frac{2KT_i}{2Bhc}} \times \sqrt{\frac{2Bhc}{K \cdot T_i}}$$

$$\frac{J_f}{J_i} = \sqrt{\frac{2\, T_i}{T_i}}$$

$$J_f = \sqrt{2} \cdot J_i$$

17). Answer = (c)

$$E_{rot}(J) = 7\,J\,(J+1)\ \text{meV}.$$

18). Answer = (d)

Rigid rotators

19).

Answer = (c)

Solution :

HBr reduced mass .

$$\mu = \frac{1 \times 80}{1+80} \times \frac{1}{6.023 \times 10^{23}}$$

$$\mu' = \frac{2 \times 80}{2+80} \times \frac{1}{6.023 \times 10^{23}}$$

$$E = \frac{\hbar^2}{2I} J(J+1) , \quad E = \frac{\hbar^2}{2\mu R^2} J(J+1)$$

$$\Delta E \propto \frac{1}{\mu}$$

$$\frac{\Delta E_{DBr}}{\Delta E_{HBr}} = \frac{\mu_{HBr}}{\mu_{DBr}}$$

$$\Delta E_{DBr} = \left(\frac{80 \times 82}{81 \times 2 \times 80} \right) \times 2.23 \text{ MeV}$$

$$\Delta E_{DBr} = 1.128 \text{ MeV}.$$

20). Answer = (b) :

Solution :

$$E_n = \frac{-13.6}{n^2}$$

K.E = 1 eV

$\frac{3}{2} \cdot KT = 1$ eV

$KT = \frac{2}{3}$ eV

$n=1$, $E_1 = -13.6$ eV

$n=3$, $E_3 = -1.51$ eV

The no of particle in a state proportional to $e^{-E_i/KT}$

$$\frac{N_3}{N_1} = \frac{e^{-E_3/KT}}{e^{-E_1/KT}} = e^{(E_1-E_3)/KT}$$

$$\frac{N_3}{N_1} = e^{(-13.6+1.51)\,eV/KT} \quad \left[eV/_{KT} = 3/2\right]$$

$$\frac{N_3}{N_1} = e^{-12.09/0.667} = e^{-18.13}$$

$$\frac{N_3}{N_1} = 1.33 \times 10^{-8}$$

21).

Answer : (a)

Solution :

Isotope with same atomic number. Homonuclear diatomic molecules have identical chemical properties. The molecules have different rotational spectra.

22).

Answer = (b) :

Solution :

The equilibrium vibration frequency for an oscillator observed at 2990 cm^{-1}.

fundamental $\bar{\nu}_{0\to1} = \bar{\omega}_e (1 - 2x_e)\ cm^{-1}$

first over $\bar{\nu}_{1\to2} = 2\bar{\omega}_e (1 - 3x_e)\ cm^{-1}$

$$\frac{2\bar{\omega}_e (1-3x_e)}{\bar{\omega}_e (1-2x_e)} = 1.96$$

$$2 - 6x_e = 1.96 - 3.92x_e$$

$$2.08x_e = 1.96 - 2$$

$$x_e = 0.02$$

Anharmonic constant is 0.02.

23). Answer : (c)

Solution :

$$\nu = \frac{1}{2\pi}\sqrt{\frac{K}{\mu}}$$

The difference in two energy level.

$$= h\nu = h \times \frac{1}{2\pi}\sqrt{\frac{K}{\mu}}$$

$$13.472 \times 10^{-21} = \frac{6.626 \times 10^{-34}}{2 \times 3.14} \times \sqrt{\frac{6}{1.14 \times 10^{-26}}}$$

$$K = 187 \text{ N/m}$$

21).

Answer : (c)

Solution :

$K = 573\ N/m$

$\mu_H = 0.835 \times 10^{-27}\ kg.$

$\nu = 1.32 \times 10^{14}\ s^{-1}$

$E_v = (v + 1/2) h\nu$

$= \frac{6.626 \times 10^{-34}}{1.6 \times 10^{-19}} \times (v + 1/2) \times 1.32 \times 10^{14}\ s^{-1}$

$= 0.547\ (v + 1/2)\ eV$

Dissociation energy = 4.50 eV

$4.50 = 0.547\ (v + 1/2)$

$v = 7.7$

$\boxed{v = 8}$

25).

Answer : (a)

Solution :

$K = 1870\ N/m$

$\mu_{CO} = 1.14 \times 10^{-26}\ kg$

$\nu = \frac{1}{2\pi}\sqrt{K/\mu}$

$= \frac{1}{2 \times 3.14}\sqrt{\frac{1870}{1.14 \times 10^{-26}}}$

$\nu = 6.45 \times 10^{13}\ s^{-1}$

$E_v = (v + 1/2) h\nu$

$E_0 = 1/2\ h\nu$

$= 1/2 \times \frac{6.626 \times 10^{-34} \times 6.45 \times 10^{13}}{1.6 \times 10^{-19}}$

$E_0 = 0.134\ eV.$

26).

Answer = (a).

Solution :

$$\bar{\nu}_{0\to1} = \bar{\omega}_e(1-2x_e)$$

$$= 2143.3\ cm^{-1}$$

$$\bar{\nu}_{1\to2} = 2\bar{\omega}_e(1-3x_e)$$

$$= 4259.7\ cm^{-1}$$

$$\frac{2\bar{\omega}_e(1-3x_e)}{\bar{\omega}_e(1-2x_e)} = \frac{4259.7}{2143.3}$$

$$2\times 2143.3(1-3x_e) = 4259.7(1-2x_e)$$

$$4340.4\ x_e = 26.9$$

$$x_e = 0.006198$$

$$x_e = 0.006198$$

$$\therefore x_e = 6.198\times10^{-3}$$

$$x_e = 6.2\times10^{-3}$$

27). Answer = (b)

Solution: $x_e = 6.2 \times 10^{-3}$

$$\bar{E}_v = (v+1/2)\,\bar{\omega}_e - (v+1/2)^2\,\bar{\omega}_e x_e$$

At dissociation energy the vibrational energy is maximum.

$$v_{max} = \frac{1}{2x_e} - \frac{1}{2}$$

$$= \frac{1}{2}\left(\frac{1}{x_e} - 1\right)$$

$$= 1/2\left[\frac{1}{6.2 \times 10^{-3}} - 1\right]$$

$$v_{max} = 80.145 \simeq 80$$

$$v_{max} = 80$$

28) .

Answer = (a)

Solution :

$K = 480 \ N/m$

$\mu_{HCl} = 1.61 \times 10^{-27} \ kg$

$\nu = 0.87 \times 10^{14} \ s^{-1}$

$E_v = (v + 1/2) h\nu$

$\Delta E = E_{v=1} - E_{v=0}$

$= 3/2 \ h\nu - 1/2 \ h\nu$

$\Delta E = h\nu$

$$= \frac{6.626 \times 10^{-34} \times 0.87 \times 10^{14}}{1.6 \times 10^{-19}}$$

$\Delta E = 0.36 \ eV$

29).

Answer: (c)

Solution :

The anharmonic constant :

$$E_v = (v+1/2)\,\bar{\omega}_e - (v+1/2)^2\,\bar{\omega}_e \cdot x_e$$

for zero point energy $v=0$

$$2168 = 1/2\,\bar{\omega}_e - 1/4\,\bar{\omega}_e \cdot x_e$$

$$2168 = 1/2\,\bar{\omega}_e\,(1 - 1/2\,x_e)$$

$$2168 = \frac{4395}{2}(1 - 1/2\,\omega_e)$$

$$\frac{2 \times 2168}{4395} = 1 - 1/2\,\omega_e$$

$$x_e = 0.026.$$

30) : Answer: (a)

Solution :

$$\mu_A = 4 \cdot \mu_B$$

$$K_A = 2 \cdot K_B$$

$$E = (v + 1/2) h\nu$$

$$E = (v+1/2) h \cdot \frac{1}{2\pi} \cdot \sqrt{\frac{K}{\mu}}$$

$$E = (v+1/2) \hbar \sqrt{K/\mu}$$

For A :

$$E_A = \frac{\hbar}{2}\sqrt{\frac{K_A}{\mu_A}}$$

$$E_B = \frac{\hbar}{2}\sqrt{\frac{K_B}{\mu_B}}$$

$$E_B = \frac{\hbar}{2}\sqrt{\frac{K_A \times 4}{2 \times \mu_A}} = \frac{\hbar}{2}\sqrt{\frac{K_A \cdot 2}{\mu_A}}$$

$$E_B = \sqrt{2} \cdot E_A$$

$$\frac{E_A}{E_B} = \frac{1}{\sqrt{2}}$$

APEX CARE ACADEMY, RASIPURAM

COACHING CENTRE FOR PHYSICS

HIGHLIGHTS:

- APEX CARE Academy is the leading coaching centre for CSIR-NET, TNSET, **TRB-PG & POLYTECHNIC**, IIT, NIT- Entrance exam.
- A ***person*** takes classes who achieved CSIR-NET, TNSET (2016, 17, 18), PG-TRB, ISRO, DRDO.
- Highly qualified materials and question papers for excellent preparations. (10 - Set of Unit test question papers for each unit will be trained).
- APEX CARE Academy has produced wonderful results in past several years. 2017- PGTRB achievers (all over Tamilnadu) more than 70% were guided by us through under the guidance and counseling.
- In PGTRB – 2017 : 4 Districts First Rank were our students.
  And also around 120 students were achieved so for.
- Needless to say, this all could be possible only due to blessings of the almighty, proper planning at the institute, sharp implementation of the planning, taking timely feedback from the students regarding their level of satisfaction at the institute & follow up action to plug the short coming pointed out by the students from time to time.
- We promise a better future for you,
  We make your life better and brighter
  We educate students at confident level to score marks.
  We educate students in only low fees.

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COACHING CENTRE FOR PHYSICS

PATH TO SUCCESS

NEW BATCH SCHEDULE:

- EFFECTIVENESS OF COURSE WITNESSED ONLY ATTENDING THE DEMO CLASS : *DEMO CLASS - 29.09.18,* | *Morning - 10.00 a.m to 12.00 p.m*
- CLASS STARTS AT 10.00 AM AND ENDS AT 5.00 P.M
- STUDENTS ARE EXPECTED TO ATTEND THE CLASSES UNTIL THE SUCCESS.
- EVENING TIME COACHING CLASSES TO BE CONDUCTED.
- HOSTEL FACILITY IS ALSO AVAILABLE.
- ADMISSIONS BASED ON ENTRANCE AND ALSO STUDENT'S PERFORMANCE.

Schedule

DATE	UNIT	TEST 150 Mark
29.09.18 - 30.09.18	Solid State Physics	
06.10.18 – 07.10.18	Statistical Mechanics	Unit Test - 1 SSP
13.10.18 – 14.10.18	Nuclear Physics	Unit Test - 2 SM

20.10.18 – 21.10.18	Mathematical Physics	Unit Test - 3 NP
27.10.18 – 28.10.18	Classical Mechanics	Unit Test - 4 MP
03.11.18 – 04.11.18	Quantum Mechanics	Unit Test - 5 CM
10.11.18 – 11.11.18	Electromagnetic Theory	Unit Test - 6 QM
17.11.18 – 18.11.18	Group Theory & Probability	Unit Test - 7 EMT
24.11.18 – 25.11.18	Spectroscopy	Unit Test - 8 GT & P
01.12.18 – 02.12.18	Electronics	Unit Test - 9 Spectroscopy
08.12.18 – 09.12.18	Education	Unit Test - 10 Electronics
15.12.18 – 16.12.18	Psychology	
22.12.18 – 23.12.18	GK Discussion	
1.Full Test – Unit : P,GT,MP - 150Mark		
2.Full Test – Unit : SSP,SM - 150Mark		
3.Full Test – Unit : CM,QM - 150Mark		
4.Full Test – Unit : N,S - 150Mark		
5.Full Test – Unit : EMT,E - 150Mark		
Model Examination – 5 Full Test		

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Spectroscopy

Q.NO	Answer	Q.NO	Answer
1	C	16	C
2	B	17	C
3	C	18	D
4	B	19	C
5	C	20	B
6	A	21	A
7	D	22	B
8	B	23	C
9	A	24	C
10	A	25	A
11	C	26	A
12	A	27	B
13	C	28	A
14	D	29	C
15	D	30	A