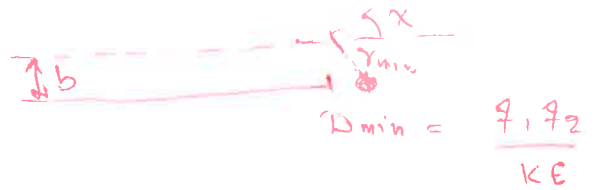


1]

$$D_{min}^{47} = \frac{1}{4\pi\epsilon_0} \frac{47 \times 2 \times 1.6 \times 10^{-19}}{10 \times 10^6}$$

$$D_{min}^{79} = \frac{1}{4\pi\epsilon_0} \frac{79 \times 2 \times 1.6 \times 10^{-19}}{5 \times 10^6}$$

$$D_{min}^{79} > D_{min}^{47}$$



$$\chi = 2 \tan^{-1} \left( \frac{D_{min}}{2b} \right)$$

$$\chi^{79} > \chi^{47}$$

For Gold deflection will be larger.

$$r_{min} = \frac{b \cos \chi/2}{1 - \sin \chi/2}$$

$$\text{So } r_{min}^{79} > r_{min}^{47}$$

This implies that size of nucleus with  $z = 47$  will be smaller than nucleus with  $z = 79$ .

2.

Silver Atom is L-S state

$$m_l = +1, 0, -1$$

There should be three spots on the screen.

Their observation is not consistent with their assumption.

electronic configuration of silver atom  $[Kr] 4d^{10} 5s^1$

Closed shell with one free electron. Idea about  $e^-$  spin which can take only two values.

y) Binding energy

$$E = -\frac{1}{2} \frac{z^2}{n_1^2} - \frac{1}{2} \frac{(z-e)^2}{n_2^2}$$

From  $1s^2$  configuration  $E = 0.656$

$$1s^2s = -\frac{1}{2} \frac{z^2}{n_1^2} - \frac{1}{2} \frac{(z-0.656)^2}{n_2^2} = -2 - \frac{1}{8} (z-0.656)^2 = -9.2294$$

5) 1s2p state

$l_1 = 0$        $l_2 = 1$   
 $m_{s1} = 1/2$        $m_{s2} = 1/2, -1/2$

L-S Coupling       ~~$L=1$~~        $S = 0, 1$        $L = 1$   
 $J = 0, 1, 2$

(1) for  $s = 0$        $L = 1$   
 $J = 1$

singlet state       $1P_1$

(3)  $L = 1$        $S = 1$   
 $J = 0, 1, 2$

≡ Triplet state       $3P_{0,1,2}$

6) J-J Coupling

$J_1 = 1/2$        $J_2 = 3/2, 1/2$

for  $J_1 = 1/2$        $J_2 = 3/2$

for  $J_1 = 1/2$        $J_2 = 1/2$

$J = \underline{J_1 + J_2}$        $\underline{J_1 - J_2}$   
 $= \underline{1, 2}$

$J = 0, 1$

$l_1 + l_2 = 1$

$1P_0, 3P_0$

$S_1 + S_2 = 0, 1$

$1P_1$        $1P_2$        $3P_1$        $3P_2$

Total state

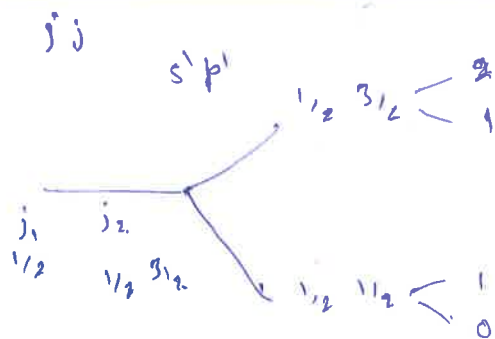
$1P_0$

$3P_{0,1,2}$

3) Nuclear spin 1

$f = \underline{3/2}$        $\underline{1/2}$

$S_{nsc} = \frac{\hbar^2}{2} [f(f+1) - S_n(S_n+1) - S_c(S_c+1)]$



for High  $Z$   
atoms

$F = 1, 0$

$= \frac{\hbar^2}{2} [f(f+1) - 2 - 3/4]$

$= \frac{\hbar^2}{2} [f(f+1) - 11/4]$

# [Solution Quiz - 2]

1] Term Symbol for  $B_2 : (1\sigma_g)^2 (1\sigma_u)^2 (2\sigma_g)^2 (2\sigma_u)^2 (1\pi_u)^2$   
 $C_2 : (1\sigma_g)^2 (1\sigma_u)^2 (2\sigma_g)^2 (2\sigma_u)^2 (1\pi_u)^4$

For  $B_2$  : ~~Outer~~ Outershell  $(1\pi_u)^2$  [2 electrons both are in  $\pi$  state]  
 $L=1$

According to Pauli's exclusion principle.

$m_{l1}$	<del><math>m_{l2}</math></del> $m_{s1}$	$m_{l2}$	$m_{s2}$	$M_L$	$M_S$
+1	+1/2	+1	-1/2	2	0
+1	+1/2	-1	+1/2	0	1
+1	+1/2	-1	-1/2	0	0
+1	-1/2	-1	+1/2	0	0
+1	-1/2	-1	-1/2	0	-1
-1	+1/2	-1	-1/2	-2	0

$M_L = 2, M_S = 0 \quad 1\Delta$

$M_L = 0, M_S = 1 \quad 3\Sigma$

$M_L = 0, M_S = 0 \quad 1\Sigma$

For  $C_2$  : All the shell are fully filled. Term symbol  $1\Sigma$

2] Transition from  $(v, J)$  to  $(v', J')$

$$\Delta E = E_{v'J'} - E_{vJ}$$

$$= h\nu_0 (v' - v) + B'hcJ'(J'+1) - BhcJ(J+1)$$

rigid rotor  $B' = B$

$\Delta E = h\nu_0 + 2Bhc(J+1)$  for R branch  $\Delta J = +1$

$\Delta E = h\nu_0 - 2BJ$  for P branch  $\Delta J = -1$

For this line spacing is equal to  $2B$  (constant)

10

10

10

10

10

10

10

10

10

10

10

10

10

10

But when we consider ro-vibrational coupling,

$$\underbrace{B'} = B_0 - \alpha_e \left( J + \frac{1}{2} \right)$$

rotational constant.

$$\Delta E = h\nu_0 (v' - v) + hc B' J' (J' + 1) - B hc J (J + 1)$$

Line spacing, (for R branch)

$$\delta = \left[ \left( B_0 - \frac{3\alpha_e}{2} \right) (J+2)(J+3) - \left( B_0 - \frac{3\alpha_e}{2} \right) (J+1)(J+2) \right] \\ - \left[ \left( B_0 - \frac{3\alpha_e}{2} \right) (J+1)(J+2) - B_0 (J)(J+1) \right]$$

$$= \left[ -\frac{3\alpha_e}{2} [J^2 + 5J + 6] + B_0 (J^2 + 8J + 6) - B_0 (J^2 + 3J + 2) \right] \\ - \left[ B_0 (J^2 + 3J + 2) - \frac{3\alpha_e}{2} (J^2 + 3J + 2) - B_0 (J^2 + J) \right]$$

$$= \left( \frac{3\alpha_e}{2} \right) J \left[ J^2 + [ \quad ] J + \text{constant} \right]$$

~~is~~ Quadratic in J.

3) Population distribution for any energy level J is given by Boltzmann distribution.

$$N_J = N_0 (2J+1) e^{\left( \frac{-\Delta E}{k_B T} \right)}$$

$$E = B hc (J)(J+1)$$

Most populated level is determined as  $\frac{dN_J}{N_J} = 0$  (zero at maxima of  $N_J$  distribution)

100

$$\frac{dN_J}{dJ} = N_0 \left[ 2 e^{-\frac{Bhc J(J+1)}{k_B T}} + (2J+1) e^{-\frac{Bhc J(J+1)}{k_B T}} \left( -\frac{Bhc (2J+1)}{k_B T} \right) \right] = 0$$

$$= N_0 e^{-\frac{Bhc J(J+1)}{k_B T}} \left[ 2 + (2J+1) \left( -\frac{Bhc (2J+1)}{k_B T} \right) \right] = 0$$

$$\Rightarrow 2 + (2J+1)^2 \left( -\frac{Bhc}{k_B T} \right) = 0$$

$$\Rightarrow (2J+1)^2 = \frac{2k_B T}{Bhc}$$

$$\Rightarrow (2J+1) = \sqrt{\frac{2k_B T}{Bhc}}$$

$$\Rightarrow J_{\max} = \sqrt{\frac{k_B T}{2Bhc}} - 1/2$$

(i) Room Temp.  $T = 300 \text{ K}$

$$k_B = 1.38 \times 10^{-23} \text{ J/K}$$

$$B = 10.6 \text{ cm}^{-2} \\ = \underline{1060 \text{ m}^{-2}}$$

$$J_{\max} = \underline{2.6}$$

(ii) At  $100^\circ \text{C}$ .  $T = 373 \text{ K}$

$$J_{\max} = \underline{2.95}$$

As it is clearly seen for the temp difference of ~~73°C~~ 73°C change in  $J_{\max}$  is very not much. ~~Eff.~~

$J_{\max}$  can not be used for accurate measurement of temperature of sample because — — — — —

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry should be supported by a valid receipt or invoice. This not only helps in tracking expenses but also ensures compliance with tax regulations.

In the second section, the author outlines the various methods used for data collection and analysis. These include surveys, interviews, and focus groups. Each method has its own strengths and weaknesses, and the choice depends on the specific research objectives.

The third section provides a detailed overview of the statistical tools used in the study. It covers both descriptive and inferential statistics, explaining how they are applied to interpret the data. The use of software like SPSS is also mentioned.

Finally, the document concludes with a summary of the findings and their implications. It suggests that the results could be useful for future research and for improving business operations.

The following table shows the distribution of responses for the different categories. As can be seen, the majority of respondents chose the first option, which is consistent with the hypothesis.

Category	Response 1	Response 2	Response 3
Age Group 1	75%	15%	10%
Age Group 2	60%	25%	15%
Age Group 3	50%	30%	20%

The data indicates a clear trend where younger respondents are more likely to select the first option. This could be due to their higher familiarity with the product or service being studied.

In addition, the analysis shows that there is a significant difference between the groups. This suggests that age is a key factor in determining the response.

Overall, the study provides valuable insights into consumer behavior and preferences. These findings can be used to tailor marketing strategies and improve customer satisfaction.



## Que: 4 Centrifugal Distortion.

A real molecule is not rigid. When it rotates, the centrifugal force act on the atom and internuclear distance widens. This force is compensated by restoring force  $\vec{F}_s$  which depends on the slope of potential energy.

In the vicinity of equilibrium  $R_e$ .

$$F_r = -k (R - R_e) R^3$$

$$\text{So } \frac{J(J+1) \hbar^2}{MR^3} = k (R - R_e)$$

$$R = R_e + \frac{J(J+1) \hbar^2}{MkR^3}$$

$$R = R_e \left( 1 + \frac{J(J+1) \hbar^2}{MkR_e^3} \right)$$

$$\frac{1}{R^3} = \frac{1}{R_e^3} \left[ 1 - \frac{3 J(J+1) \hbar^2}{MkR_e^3} + \frac{3 J^2 (J+1)^2 \hbar^4}{M^2 k^2 R_e^6} - \dots \right]$$

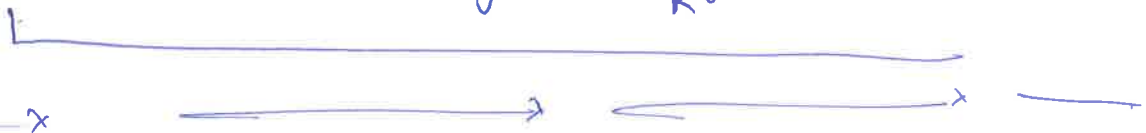
$$E_{rot} = \frac{J(J+1) \hbar^2}{2MR^2} = \frac{J(J+1) \hbar^2}{2MR_e^2} - \frac{J^2 (J+1)^2 \hbar^4}{2M^2 k R_e^6}$$

$$B_e \propto \frac{1}{R_e^2}$$

$$D_e \propto \frac{1}{R_e^6}$$

Centrifugal distortion term.

$$D_v \propto \int \psi_{vib}^* \frac{1}{R^6} \psi_{vib} dR$$



1. Introduction

2. Methodology

3. Results

4. Discussion

5. Conclusion

6. References

7. Appendix

8. Acknowledgements

9. Contact Information

10. Author Biographies

11. Declaration of Interest

12. Supplementary Materials

Que#6

$$G(n) = W_e \left( n + \frac{1}{2} \right) - \alpha_e W_e \left( n + \frac{1}{2} \right)^2$$

$$G(n+1) - G(n) = W_e \left( n+1 + \frac{1}{2} \right) - \left\{ W_e \left( n + \frac{1}{2} \right) - \alpha_e W_e \left( n + \frac{1}{2} \right)^2 \right\} + \alpha_e W_e \left( n + \frac{1}{2} \right)^2$$

$$\Rightarrow W_e - \alpha_e W_e \left[ n^2 + \frac{9}{4} + 3n \right] + \alpha_e W_e \left( n^2 + \frac{1}{4} + n \right)$$

$$\Rightarrow W_e - \cancel{\alpha_e W_e n^2} - \alpha_e W_e \frac{9}{4} - 3n \alpha_e W_e + \cancel{\alpha_e W_e n^2} + \frac{\alpha_e W_e}{4} + n \alpha_e W_e$$

$$\Rightarrow \underline{W_e} - 2\alpha_e W_e - 2n \alpha_e W_e$$

$$G(n+2) - G(n+1) = W_e \left( n+2 + \frac{1}{2} \right) - \left\{ W_e \left( n+1 + \frac{1}{2} \right) - \alpha_e W_e \left( n+1 + \frac{1}{2} \right)^2 \right\} + \alpha_e W_e \left( n+1 + \frac{1}{2} \right)^2$$

$$\Rightarrow W_e - \alpha_e W_e \left( n^2 + \frac{25}{4} + 5n \right) + \alpha_e W_e \left( n^2 + \frac{9}{4} + 3n \right)$$

$$\Rightarrow W_e - \cancel{\alpha_e W_e n^2} - \frac{25}{4} \alpha_e W_e - 5n \alpha_e W_e + \cancel{\alpha_e W_e n^2} + \frac{9}{4} \alpha_e W_e + 3n \alpha_e W_e$$

$$\Rightarrow W_e - 4\alpha_e W_e - 2n \alpha_e W_e$$

Spacing  $\Rightarrow W_e - 4\alpha_e W_e - 2n \alpha_e W_e - W_e + 2\alpha_e W_e + 2n \alpha_e W_e$   
 $= -2\alpha_e W_e$

Given Spectrum Energy level

2886	5668	8347	10923
------	------	------	-------

$\Delta E$  spacing  $\Rightarrow$  2782, 2679, 2576

Spacing

(-103), (-103), (-103)

$$-2\alpha_e W_e = -103$$

$$\alpha_e W_e = 51.5 \text{ cm}^{-1}$$

$$G(v) = W_e ($$

$$G(v) = W_e - 2x_e W_e - \frac{1}{2} x_e^2 W_e$$

Harmonic Oscillator

Transitions between any two level has same energy

$$\hbar \omega (n + \frac{1}{2})$$

But Morse potential gives that with increase in line energy difference b/w two level keep on decreasing (which is direct proportional to  $n$ )

$$\hbar \omega (n + \frac{1}{2})$$

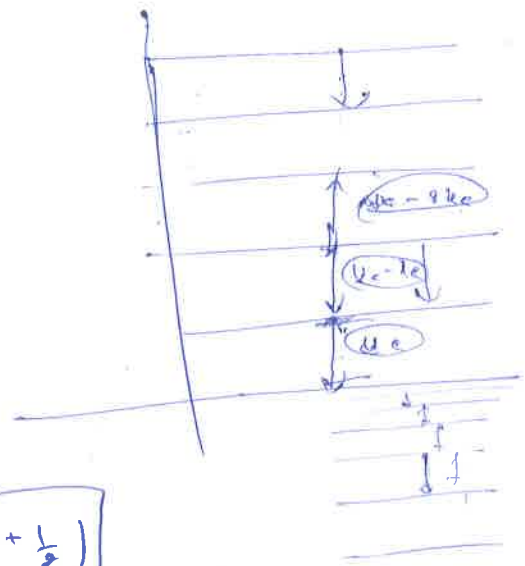
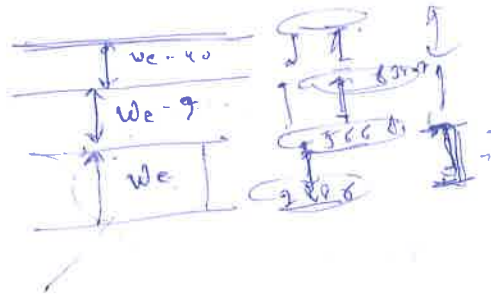
$$\hbar \omega$$

$$G(v)$$

$$W_e - n \times 2$$



(2)



$W_e$

