

Name Ananya . B

Roll no 240101012

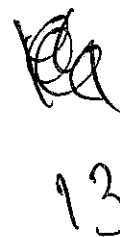
Tutorial Group 4



Signature of the Student



Signature of Invigilator


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Department of Chemistry

IIT Guwahati

CH 101 Mid Semester Exam

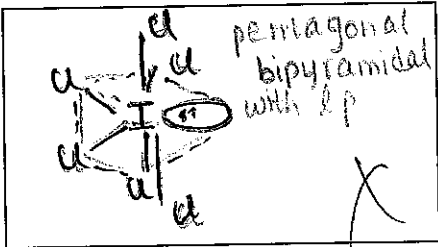
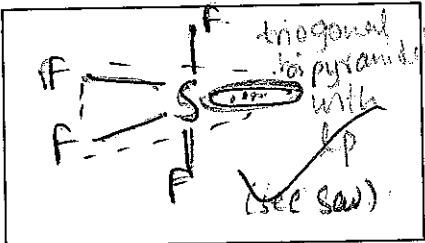
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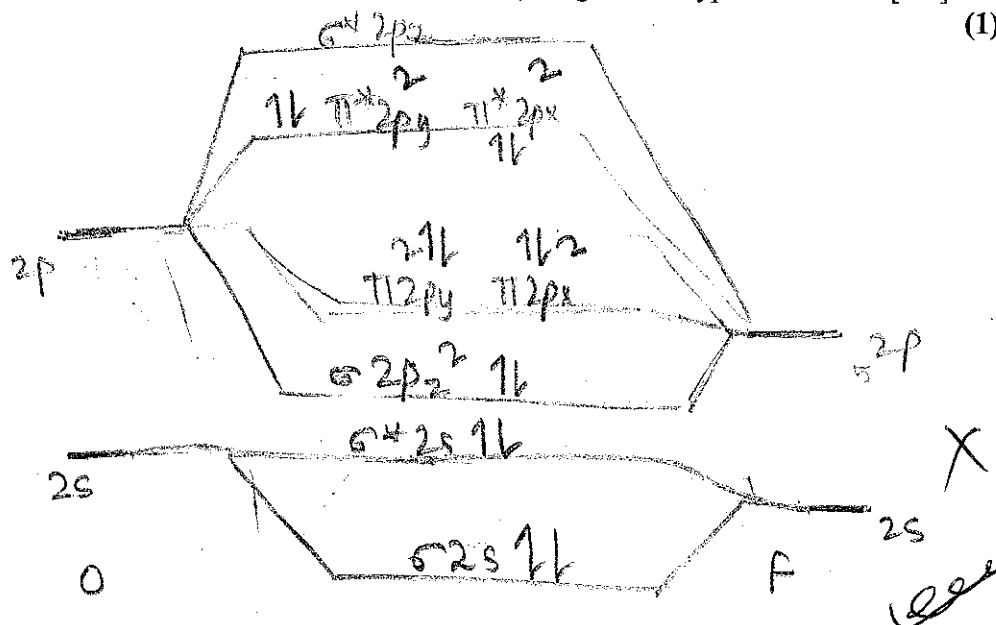
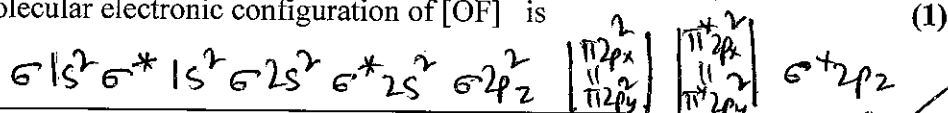
Total Marks: 30

Important Notice for the Students

1. The value in parenthesis (inside bracket) below the question no indicates the maximum marks for the question
2. There is no negative marking
3. The answers should be within the box provided
4. Any writeup outside the box will not be evaluated
5. At the end of the exam submit your question paper cum answer booklet along with the rough pages used
6. No partial marks will be awarded

Sl no	Question	Ans
1	Which of the following species does not obey the 18-electron rule? (1) [Given: the atomic number of Fe = 26, Rh = 45, Re = 75] (A) $[\text{Fe}(\text{CO})_4]^{2-}$, (B) $[\text{Rh}(\text{CO})_2(\text{Me})(\text{PPh}_3)]$, (C) $[\text{Fe}(\text{CN})_6]^{4-}$, (D) $(\eta^5\text{-C}_5\text{H}_5)\text{Re}(\text{=O})_3$	C
2	Which of the following order is correct for the IR vibrational frequency of CO? $[\text{V}(\text{CO})_6]^-$, $\text{Cr}(\text{CO})_6$, $[\text{Ag}(\text{CO})]^+$, $[\text{Mn}(\text{CO})_6]^+$ (1) [Given: the atomic number of V = 23, Cr = 24, Ag = 47, Mn = 25] (A) $\text{Cr}(\text{CO})_6 > [\text{V}(\text{CO})_6]^- > [\text{Ag}(\text{CO})]^+ > [\text{Mn}(\text{CO})_6]^+$ (B) $[\text{V}(\text{CO})_6]^- > \text{Cr}(\text{CO})_6 > [\text{Mn}(\text{CO})_6]^+ > [\text{Ag}(\text{CO})]^+$ (C) $[\text{Ag}(\text{CO})]^+ > [\text{Mn}(\text{CO})_6]^+ > \text{Cr}(\text{CO})_6 > [\text{V}(\text{CO})_6]^-$ (D) $[\text{Mn}(\text{CO})_6]^+ > [\text{Ag}(\text{CO})]^+ > \text{Cr}(\text{CO})_6 > [\text{V}(\text{CO})_6]^-$	C
3	Calculate the bond order in metal-metal bonding species for (1+1) [Given: the atomic number of Os = 76, Re = 75] (A) $[\text{Os}_2\text{Cl}_8]^{2-}$ (staggered): 4 (B) $[\text{Re}_2\text{Cl}_4(\text{PMe}_2\text{Ph})_4]^+$: 5	
4	What shapes would you expect for the species of (1/2+1/2) (A) ICl_6^-  (B) SF_4  In which of the species among A & B, the bond angle is closest to that predicted by the VSEPR model? (1) B	

5

(A) Write down the molecular orbital (MO) diagram of hypofluorite ion $[\text{OF}]^-$. (1)Molecular electronic configuration of $[\text{OF}]^-$ is(B) What is the bond order, and how many unpaired electrons are in this $[\text{OF}]^-$ ion? (1/2 + 1/2)Bond order is 1.Number of unpaired electrons is 0.(C) The site (atom) interacting most strongly with the H^+ ion in $[\text{OF}]^-$ is? (1)

F

6

If the right-hand side of the Schrödinger wave equation, corresponding to the motion of electron relative to nucleus and interaction between them, is = 0 then the left-hand side of the equation would be, (2)

(A) $-\frac{\hbar^2}{2\mu} \nabla^2 \psi - \frac{Ze^2}{4\pi\epsilon_0 r} \psi + E\psi$

(B) $-\frac{\hbar^2}{2\mu} \nabla^2 \psi + \frac{Ze^2}{4\pi\epsilon_0 r} \psi - E\psi$

(C) $-\frac{\hbar^2}{2\mu} \nabla^2 \psi - \frac{Ze^2}{4\pi\epsilon_0 r} \psi - E\psi$

(D) $\frac{\hbar^2}{2\mu} \nabla^2 \psi - \frac{Ze^2}{4\pi\epsilon_0 r} \psi - E\psi$

7

For the vibration of chemical bond, considering quantum harmonic oscillator model, the average potential energy is equal to average kinetic energy. The uncertainty in the displacement of the bond in the ground state i.e., $\Delta x = \sqrt{\hbar/2\mu\omega}$. Then the average (kinetic + potential) energy of the bond would be (2)

(A) $(1/4)\hbar\omega$

(B) $(1/2)\hbar\omega$

(C) $(3/4)\hbar\omega$

(D) $\hbar\omega$

8	<p>An electron having total kinetic energy E of 4.50 eV approaches a rectangular energy barrier with $V = 5.00$ eV and $L = 950$ pm. Assume $m_e = 9.11 \times 10^{-31}$ kg, $1 \text{ eV} = 1.6 \times 10^{-19}$ J, $h = 6.62 \times 10^{-34}$ Js. The probability of tunnelling of the electron through the barrier (using the expression $T = 16\varepsilon(1 - \varepsilon)e^{-2\kappa L}$) would approximately be, (2)</p> <p>(A) 0.15% (B) 1.5% (C) 0.05% (D) 0.5%</p>	A
9	<p>For a particle-in-a-box of length L, the wavefunction is written as $\Psi(x) = \sqrt{\frac{2}{L}} \sin \frac{n\pi x}{L}$. Use $h = 6.630 \times 10^{-34}$ Js and $m = 9.11 \times 10^{-31}$ kg. If for the first excited state ($n=2$), the value of energy is 5.5×10^{-19} J, then the de Broglie wavelength of the particle (in Å) would be about, (2)</p> <p>(A) 3.315 (B) 4.42 (C) 8.84 (D) 6.63</p>	D
10	<p>Butadiene molecule is a conjugated molecule and can be considered (for particle-in-a-box model) to be linear with length of 578 pm. With the mass of electron, 9.109×10^{-31} kg and Planck's constant being 6.626×10^{-34} Js, the absorbance band energy (in J unit) due to transition between quantum states 2 and 3 would be: (2)</p> <p>(A) 2.09×10^{-19}; (B) 9.02×10^{-19}; (C) 9.02×10^{-10} (D) 2.09×10^{-10}</p>	B
11	<p>What is the conformation of the energy maximum in the energy profile diagram for the ring inversion of cyclohexane. (1)</p> <p>(A) Twist boat (B) Boat (C) Chair (D) Half chair</p>	D

2

2

2

2

1

12

Draw the most stable conformation of *cis*-1,4-di-*tert*-butylcyclohexane. (1)

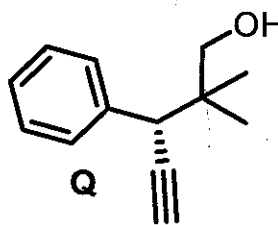
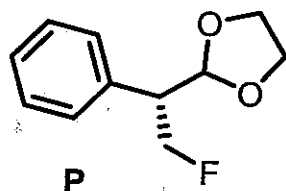


X

O

13

Predict the absolute configuration (R & S) of the following compounds P & Q. (1/2 + 1/2)



Absolute Configuration of

P is R

✓

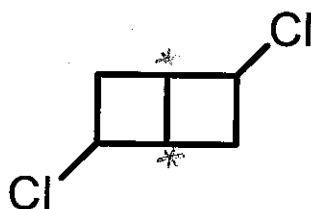
Q is S

X

5/2

14

How many stereoisomers (including enantiomers) are possible for the following compound. (2)



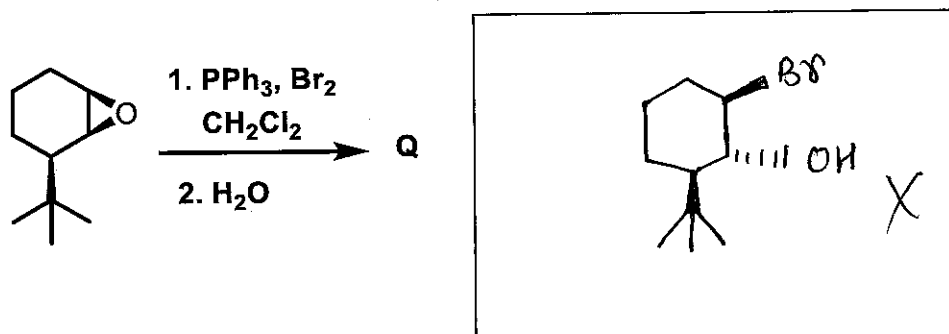
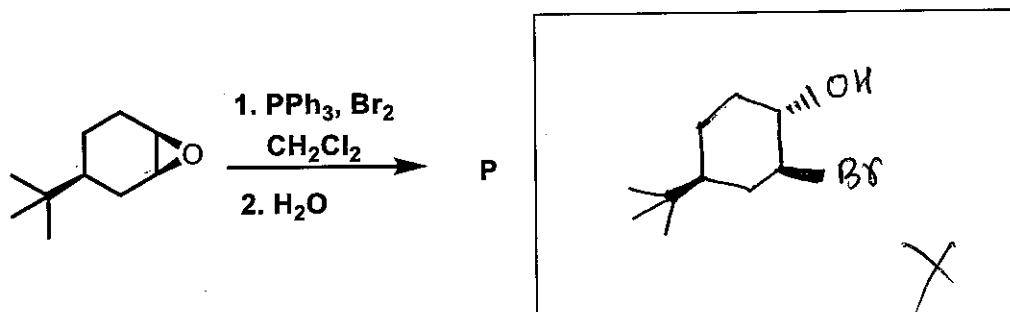
X

4

O

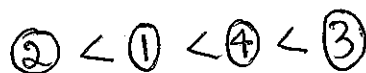
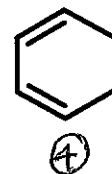
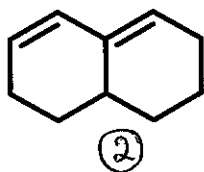
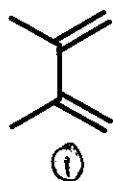
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Draw the major products (P & Q) in the following transformations. (1+1)



16

Arrange the following dienes in order of increasing reactivity in a Diels-Alder reaction. (1)



17

Use Frontier Molecular Orbitals (FMOs) and explain why $[2 + 2]$ cycloaddition between two alkenes under thermal conditions is forbidden. (2)

