Test Paper Code : CY

Time : 3 Hours   Maximum Marks : 100

INSTRUCTIONS

1. This question-cum-answer booklet has **32** pages and has **30** questions. Please ensure that the copy of the question-cum-answer booklet you have received contains all the questions.

2. Write your **Registration Number, Name and the name of the Test Centre** in the appropriate space provided on the right side.

3. Write the answers to the objective questions only in the **Answer Table for Objective Questions,** provided on Page No. **3.** Do not write anything else on this page.

4. Each objective question has **4 choices** for its answer: (A), (B), (C) and (D). Only **ONE** of them is the correct answer. There will be **negative marking** for wrong answers to objective questions. The following marking scheme for objective questions shall be used :
   (a) For each correct answer, you will be awarded **2 (Two)** marks.
   (b) For each wrong answer, you will be awarded **–0.5 (Negative half)** mark.
   (c) Multiple answers to a question will be treated as a wrong answer.
   (d) For each un-attempted question, you will be awarded **0 (Zero)** mark.
   (e) Negative marks for objective part will be carried over to the total marks.

5. Answer the fill in the blank type and descriptive type questions only in the space provided after each question. There will be no negative marks for fill in the blank and descriptive type questions.

6. Do not write more than one answer for the same question. In case you attempt a fill in the blank or a descriptive question more than once, please cancel the answer(s) you consider wrong. Otherwise, only the answer appearing last will be evaluated.

7. All answers must be written in blue/black/ blue-black ink only. Sketch pen, pencil or ink of any other colour should not be used.

8. All rough work should be done in the space provided and scored out finally.

9. No supplementary sheets will be provided to the candidates.

10. **Clip board, log tables, slide rule, cellular phone and electronic gadgets in any form are NOT allowed. Non Programmable calculator is allowed.**

11. The question-cum-answer booklet must be returned in its entirety to the Invigilator before leaving the examination hall. Do not remove any page from this booklet.

REGISTRATION NUMBER						

Name :

Test Centre :

Do not write your Registration Number or Name anywhere else in this question-cum-answer booklet.

I have read all the instructions and shall abide by them.

Signature of the Candidate

I have verified the information filled by the Candidate above.

Signature of the Invigilator

A

Objective Questions

Q.1 The most polar compound among the following is

(A) SF_4 (B) BF_3 (C) XeF_4 (D) SO_3

Q.2 Which one of the following order of the carbonates is **CORRECT** for their decomposition temperature?

(A) $BaCO_3 > CaCO_3 > SrCO_3 > MgCO_3$ (B) $BaCO_3 > SrCO_3 > CaCO_3 > MgCO_3$

(C) $MgCO_3 > CaCO_3 > SrCO_3 > BaCO_3$ (D) $MgCO_3 > CaCO_3 > BaCO_3 > SrCO_3$

Q.3 The **CORRECT** order of CO vibrational stretching frequency in the following complexes is

I: $(PF_3)_3Mo(CO)_3$ II: $(PCl_3)_3Mo(CO)_3$ III: $\{P(OMe)_3\}_3Mo(CO)_3$

(A) $I < II < III$ (B) $III < II < I$ (C) $II < I < III$ (D) $III < I < II$

Q.4 Among the following, the ligand that **BEST** stabilizes low oxidation state of tungsten (W) is

(A) H_2O (B) NH_3 (C) CO   (D) F^-

Q.5 The function $y = x \exp(-x^2)$ has a minimum at $x = -\dfrac{1}{\sqrt{2}}$. The second derivative of the function at the minimum is

(A) $2\sqrt{2} \exp\left(-\dfrac{1}{2}\right)$ (B) $-2\sqrt{2} \exp\left(-\dfrac{1}{2}\right)$

(C) 0   (D) $-\sqrt{2} \exp\left(-\dfrac{1}{2}\right)$

Q.6 For a particular reaction at constant temperature, a plot of inverse of reactant concentration $\left(\dfrac{1}{[A]}\right)$ versus time is a straight line with a slope of 4.0×10^{-2} L mol^{-1} s^{-1}. The time required (in seconds) for 1.0 M of reactant to decrease to 0.25 M is

(A) 18.8   (B) 34.7   (C) 75.0   (D) 187.5

Q.7 For a physisorption process, which one of the following statements is **NOT** correct?
(A) There are van der Waals interactions between the adsorbate and the adsorbent.
(B) The process predominates at low temperature.
(C) The process cannot proceed beyond a monolayer.
(D) The process is reversible.

Q.8 The product of the following reaction is
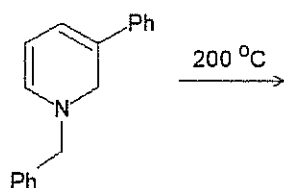
(A)   (B)

(C)   (D)

Q.9 The **CORRECT** order of stability of the following carbonium ions is
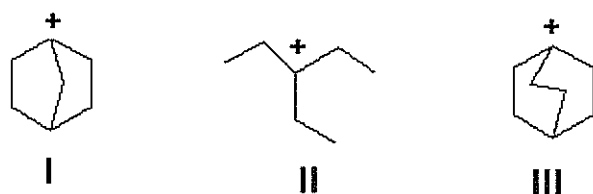
(A) II > I > III   (B) III > II > I   (C) I > III > II   (D) II > III > I

Q.10 Which one of the following statements is **CORRECT**?
(A) Naturally occurring DNA has B-configuration.
(B) Nucleic acids are derived from proteins.
(C) Proteins store genetic information.
(D) Vitamins generally act as enzymes.

Answer Table for Objective Questions

Write the Code of your chosen answer only in the 'Answer' column against each Question Number. Do not write anything else on this page.

Question Number	Answer	Do not write in this column
01		
02		
03		
04		
05		
06		
07		
08		
09		
10		

FOR EVALUATION ONLY

Number of Correct Answers		Marks	(+)
Number of Incorrect Answers		Marks	(–)
Total Marks in Questions 1-10			( )

Fill in the blank questions

Q.11 The reaction of anhydrous $FeCl_2$ with sodium-pentadienyl in ether gives an air-stable diamagnetic orange solid, which on oxidation gives an air-sensitive paramagnetic blue-green compound in solution. The blue-green compound is _____

Ans:

Q.12 CaO, VO and MnO have octahedral coordination of the metal ions in a rock-salt structure. The correct increasing order of their lattice enthalpies is _____

Ans:

Q.13 The shape of the interhalide IF_8^- is _____

Ans:

Q.14 The vapour pressures of solid and liquid chlorine are given by

$$\log_e P^{solid} = 24 - \frac{3900}{T} \text{ and}$$

$$\log_e P^{liq} = 18 - \frac{2600}{T},$$

where P^{solid} and P^{liq} are the vapour pressures (in Torr) of solid and liquid chlorine near the triple point, respectively and T is the absolute temperature. The ratio of the slope of the solid-gas curve to the slope of the liquid-gas curve at the triple point in the P-T diagram is

_____

Ans:

Q.15 For unnormalized wave-function, $\psi(r,\theta,\phi) = \sin\theta\cos\phi\left(\frac{2r}{a_0} - \left(\frac{r}{a_0}\right)^2\right)\exp\left(-\frac{r}{a_0}\right)$, the number of radial node(s) is _____

Ans:

Q.16 A hypothetical element (atomic weight = 300) crystallizes in a simple cubic lattice. For this crystal, the first order X-ray diffraction with wavelength of 5 Å appears at an angle of 30°. The density of the crystal is _____ g cm^{-3}. [Avogadro number, $N_A = 6.02 \times 10^{23}$]

Ans:

Q.17 MnO_4^- (aq) + Zn (s) + H_3O^+ (aq) $\longrightarrow$ Mn^{2+} (aq) + Zn^{2+} (aq) + H_2O (l)

For the above reaction if the equilibrium constant at 298 K is represented by 10^X, then the value of X is _____

[Given: The standard cell potential $E^0 = 2.4$ V and $\dfrac{2.303\,RT}{F} = 0.06$ V at 298 K]

Ans:

Q.18 The rotational energy barrier between the most stable and the least stable conformations of 2,3-dimethylbutane along C2−C3 bond is _____ kcal mol^{-1}.

[Given: The energies (kcal mol^{-1}) for H/CH_3 eclipsing = 1.8, CH_3/CH_3 eclipsing = 2.9 and CH_3/CH_3 gauche = 0.9]

Ans:

Q.19 The number of peaks or signals in ^1H NMR of N,N-dimethylformamide (DMF) at 25 °C is _____

Ans:

Q.20

calixene

Calixene is a polar hydrocarbon with a high dipole moment. The most stable dipolar canonical structure is _____

Ans:

Descriptive questions

Q.21 A mixture of C_3H_8 and oxygen in 1L closed vessel has an internal pressure of 4 atm at 100 °C. When the mixture is ignited, the reaction produces $CO_2(g)$ and $H_2O(g)$ until all the oxygen is consumed. After the reaction, pressure of the vessel is 4.2 atm at the same temperature. Calculate the weight of oxygen present before the reaction. [Gas constant, R= 0.082 L atm mol^{-1} K^{-1}]
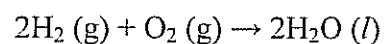
Space for the answer

Space for the answer

A

Q.22   The following reaction is carried out at 1 atm and 300 K.

$$2H_2 (g) + O_2 (g) \rightarrow 2H_2O (l)$$

ΔU for the above reaction is 550 kJ. Assuming ideal gas behavior for H_2 and O_2, calculate the value of ΔH. The value of gas constant, $R = 0.082$ L atm mol^{-1} K^{-1} = 8.314 J mol^{-1} K^{-1}.

[Given: The volume of 1 mol of liquid water is 18 mL under the above reaction condition]

Space for the answer
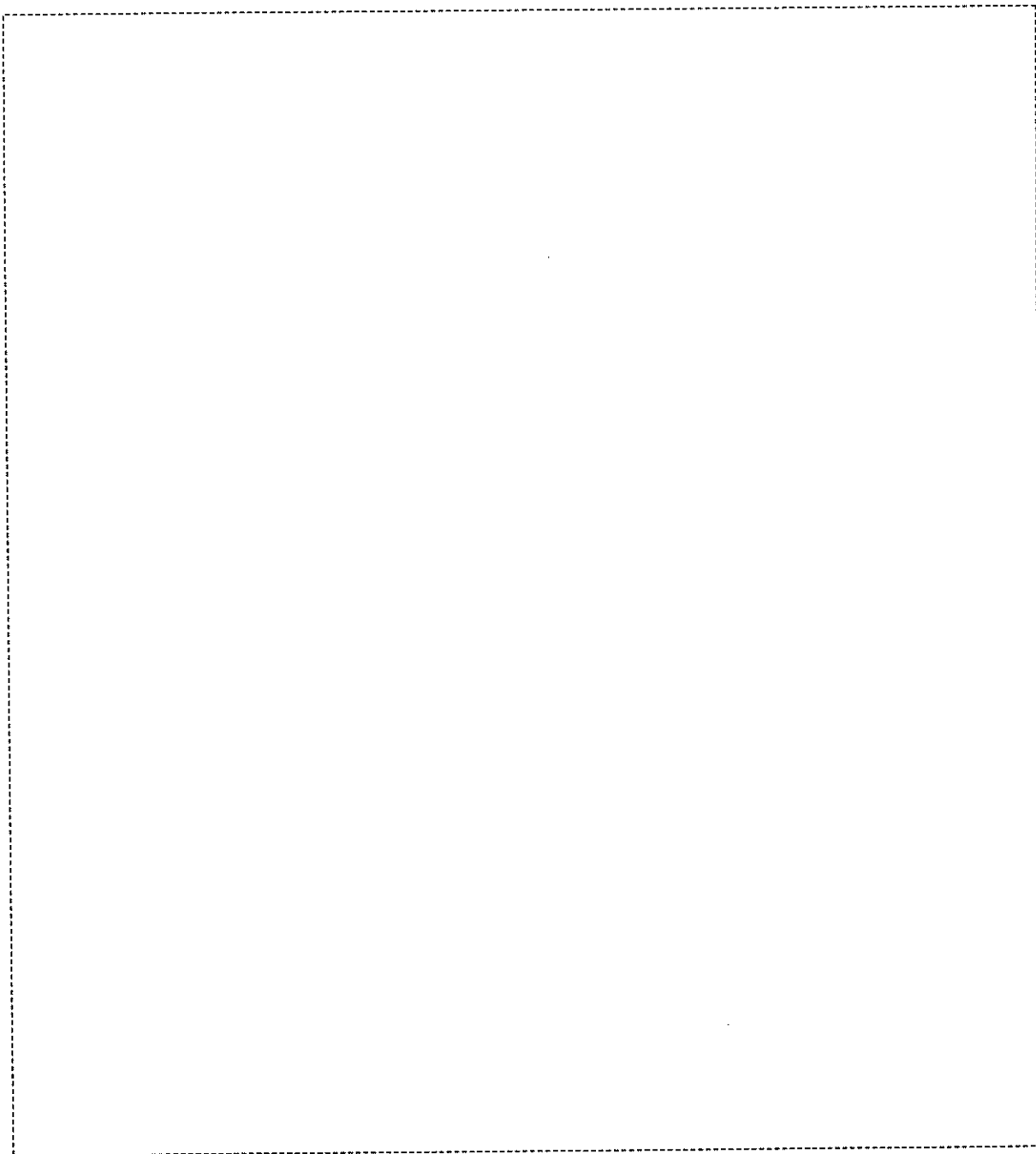
Space for the answer

Q.23 At 298 K, calculate the solubility of metal sulfide, MS(s), in a saturated solution of H_2S where the concentration of H_2S and pH are maintained at 0.1 M and 3.0, respectively.

Given at 298 K,
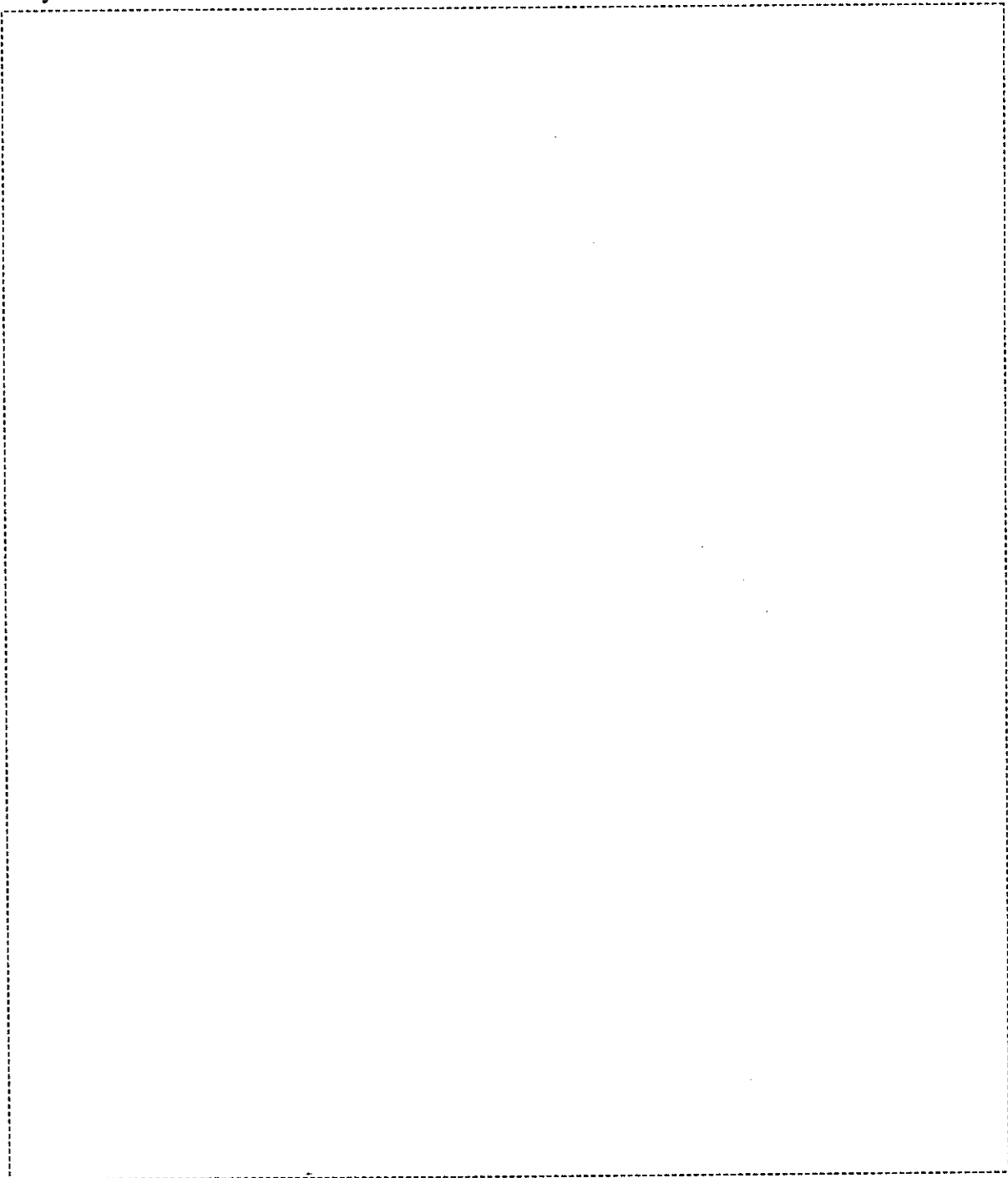
H_2S (aq) + H_2O (l) $\rightleftharpoons$ H_3O^+ (aq) + HS^- (aq) $K = 10^{-7}$

MS (s) + H_2O (l) $\rightleftharpoons$ M^{2+} (aq) + HS^- (aq) + ^-OH (aq) $K = 5 \times 10^{-19}$

Space for the answer

Space for the answer

Q.24 For each of the following metallo-proteins identify the metal-ion at the active-site and the function of the proteins:

deoxy-hemoglobin, deoxy-myoglobin, oxy-hemocyanin, cytochrome-c and carbonic anhydrase.

Space for the answer

Q.25 A solution containing 250 ppm of $CuSO_4 \cdot 5H_2O$ (formula weight = 250) has an absorbance of 0.1 measured in 1 cm cell at 600 nm. Calculate the molar absorptivity (ε) of $CuSO_4 \cdot 5H_2O$ in L $M^{-1}cm^{-1}$. When 25 mL of the above solution is titrated against Na_2EDTA (aq) solution, it consumes 50 mL of Na_2EDTA (aq) solution. Calculate the concentration of Na_2EDTA (aq) solution in moles L^{-1}.

Space for the answer
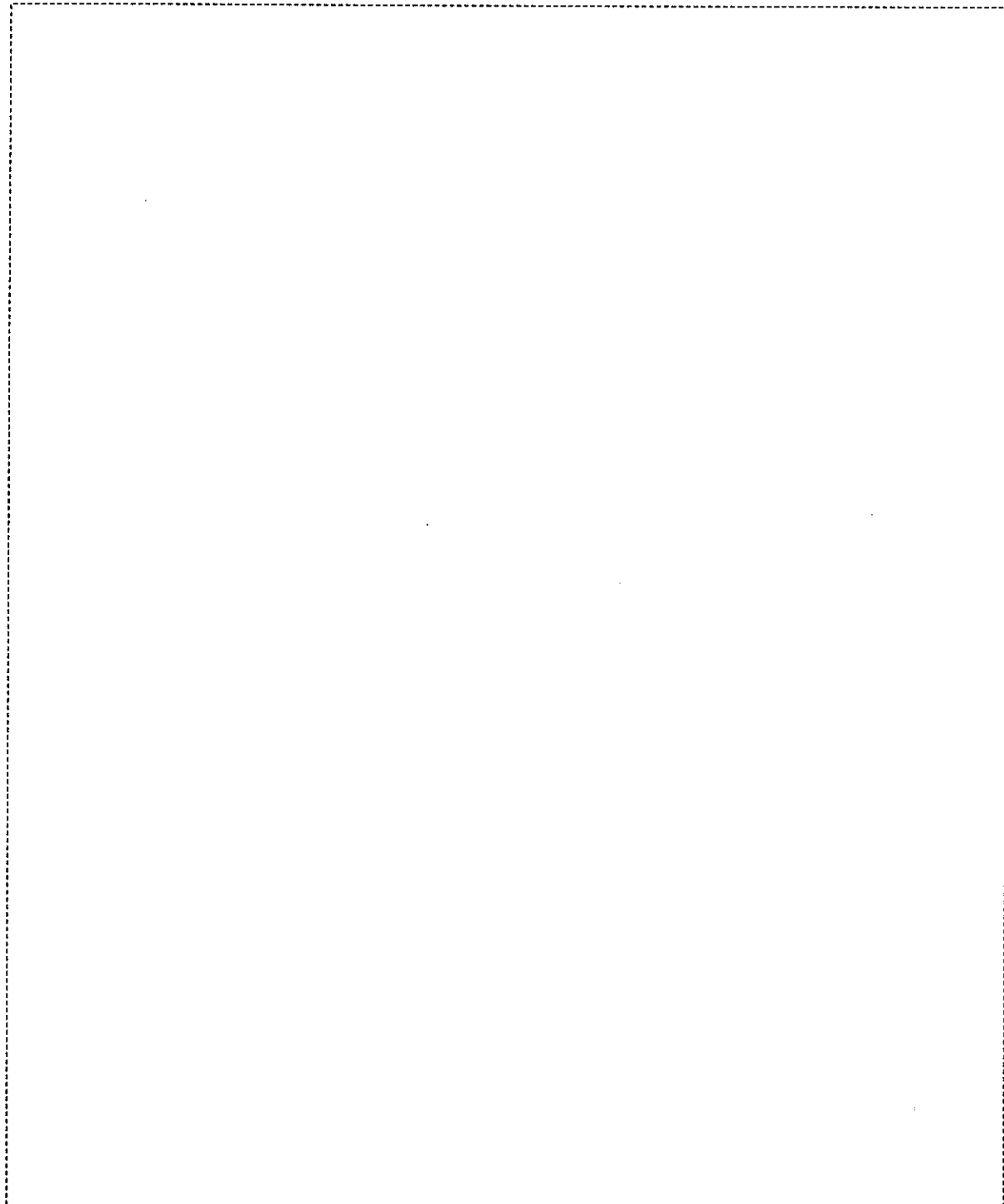
Space for the answer

Q.26 Assume the complex $[Ni(PPh_3)_2(SCN)_2]$ is paramagnetic. The analogous complex of Pd(II) is diamagnetic. Draw all the probable isomers for both the complexes considering SCN^- is an ambidentate ligand.
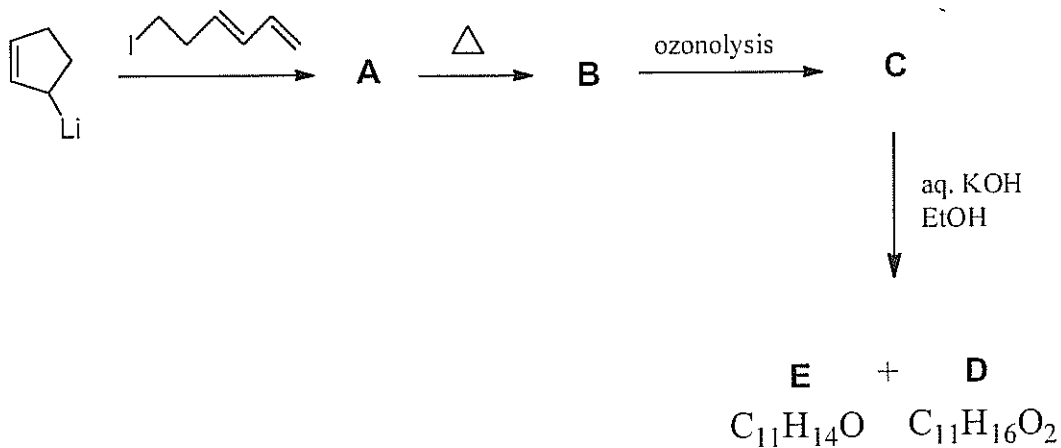
Space for the answer

A

Space for the answer

Q.27   Write the structures of **A** to **E** in the following reaction sequence:

$$\text{E} \quad + \quad \text{D}$$
$$C_{11}H_{14}O \qquad C_{11}H_{16}O_2$$

Space for the answer

CY-18/32

Space for the answer

Q.28   Write the structures of **F** to **J** in the following reaction scheme:
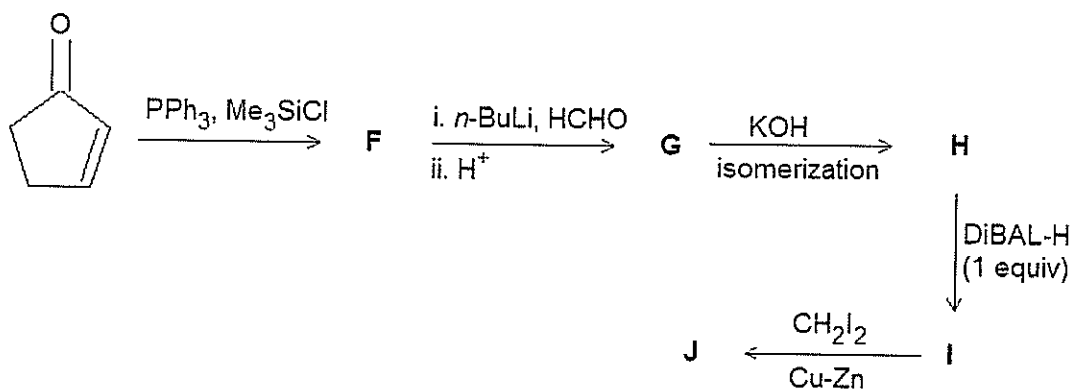
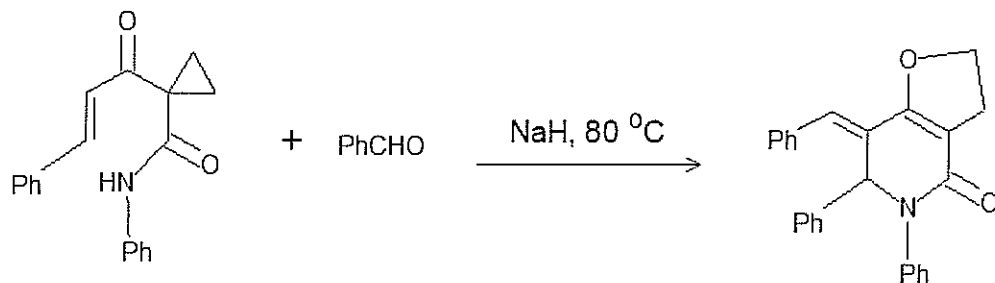[DiBAL-H = diisobutylaluminium hydride]

Space for the answer

Space for the answer

A

Q.29 Propose a mechanism for the following reaction. Show stepwise correct reactive intermediates.

Space for the answer

Space for the answer
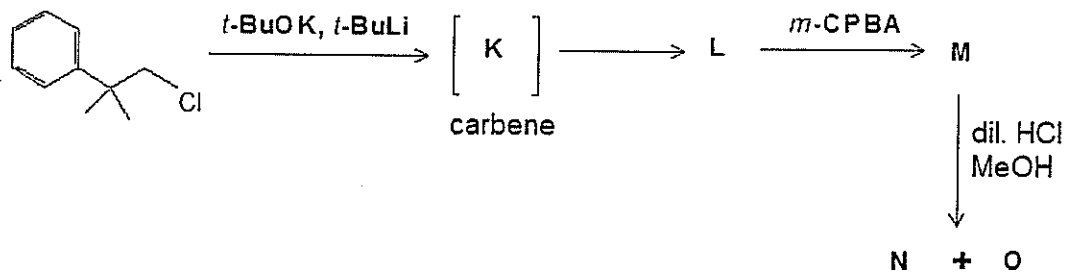
A

Q.30 Complete the following reaction sequence and write structures of **K** to **O**.

$$\text{(2-chloro-1,1-dimethylethyl)benzene} \xrightarrow{t\text{-BuOK, }t\text{-BuLi}} \left[\text{K} \right]_{\text{carbene}} \longrightarrow \text{L} \xrightarrow{m\text{-CPBA}} \text{M}$$

M $\xrightarrow{\text{dil. HCl} \atop \text{MeOH}}$ N + O

Space for the answer

Space for the answer

Space for rough work

Space for rough work

Space for rough work

Space for rough work

Space for rough work

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