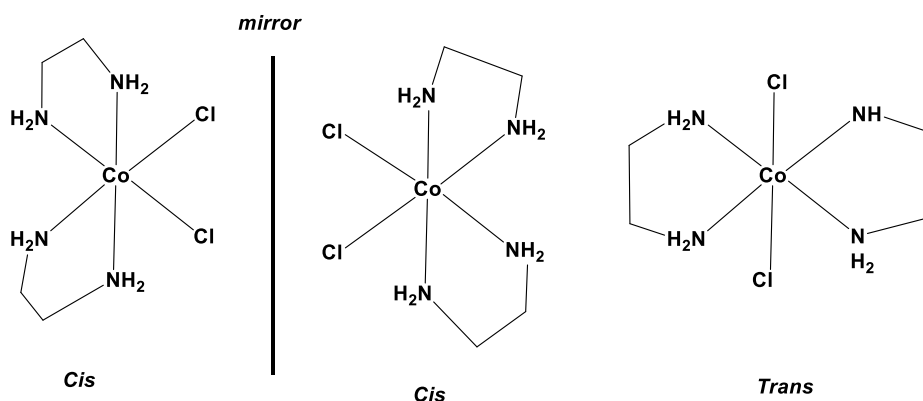# Answer keys to CHM 113M: End-Sem Examination

1.

(a) **Answer:** *Cis* **and** *trans*; 2 GI are possible   (1 mark)
Cis isomer shows optical isomerism   (1 mark)
Structure drawing   (2 mark)

(B).
Answer: For calculation   **(3 Marks)**
The CFSE for Fe^{+2} (d^6 electronic configuration, $e^3t_2^3$) in the tetrahedral field is:
$[3 \times (-0.6) + 3 \times (0.4)]\Delta t = -0.6\Delta t =$ **$-0.27\Delta o$** ($\Delta t = 4/9\Delta o$)
CFSE for Fe^{2+} in octahedral field ($t_{2g}^4e_g^2$) = $[4 \times (-0.4) + 2 (0.6)]\Delta o =$ **$-0.4\Delta o$**
CFSE for Fe^{3+} (d^5) is = 0 in both tetrahedral or octahedral holes.
Thus, Fe^{2+} would occupy octahedral holes, and Fe^{3+} would go to tetrahedral sites.

This results in **inverse spinel structure**, $Fe^{III}[Fe^{II}Fe^{III}]O_4$ **(1 Marks)**

(C)   **(1 + 1 Marks)**

3 Ru(0) = 3 × 8 = 24 e⁻   No. of metal-metal bond is $= \dfrac{54-48}{2} =$ **3**

$\underline{12 \ CO = 12 \times 2 = 24 \ e^-}$
                          Total = 48 e⁻

2. Answer: (2+2 Marks)

The tetrahedral complex shows an electronic configuration of Ni(II), $e^4 t_2^4$ with two unpaired electrons, thus paramagnetic in nature. All the electrons are paired in the square planar Ni(II) complex which is diamagnetic.
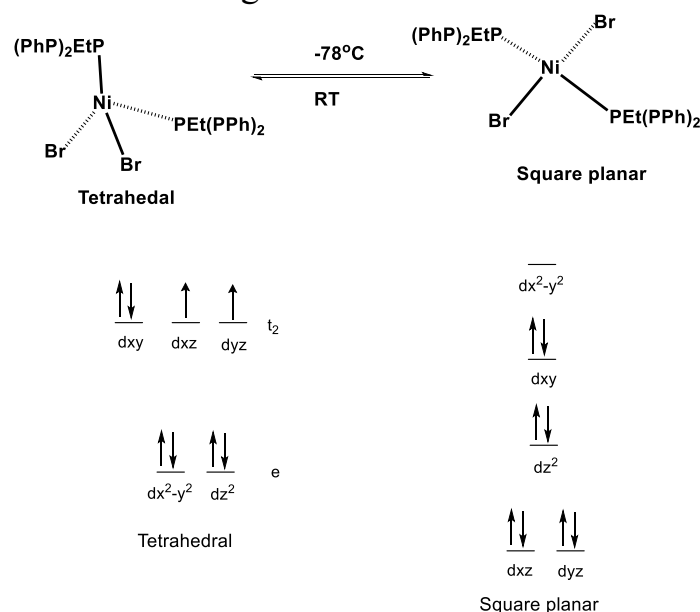
(B) (1 Marks)

Answer: | **(ii) < (i) < (iv) < (iii)** |

(C) (1 + 1+ 1 + 1 Marks)

(i)

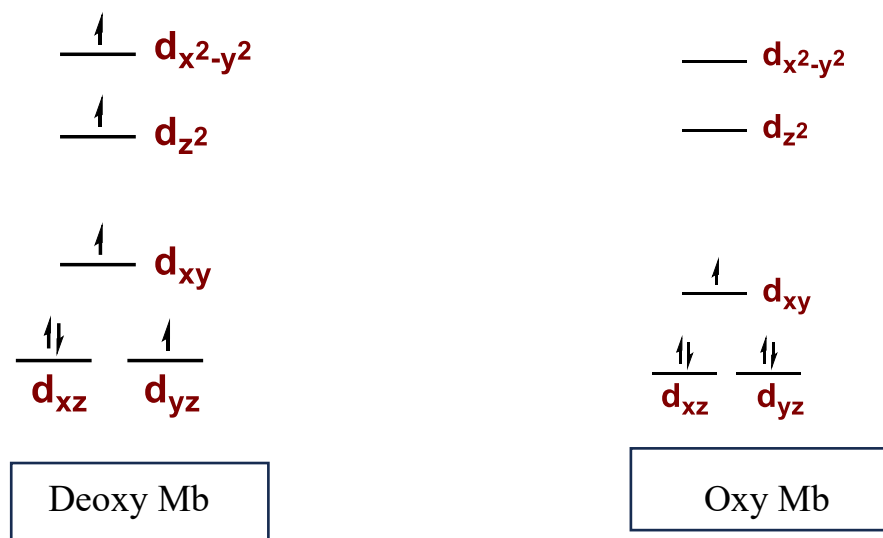| Compounds	Specify the origin of the color
I. $[Mn(H_2O)_6]^{2+}$	Mn^{2+} high-spin d^5, spin, and Laporte-forbidden d-d transition
II. $[CoCl_4]^{2-}$	Tetrahedral structure, non-centrosymmetric molecule, Laporte selection rule not applicable, d-d transition
III. $[Ti(H_2O)_6]^{3+}$	Centrosymmetric compound, Laporte forbidden, spin-allowed allowed d-d transition
IV. $[Cr_2O_7]^{2-}$	Cr^{6+} (d^0) system, ligand (oxygen) to metal (Cr^{6+}) charge-transfer transition (LMCT), Laporte and spin-allowed

(1 Marks)

(ii) Answer: | **(i) < (iii) < (ii) < (iv)** |

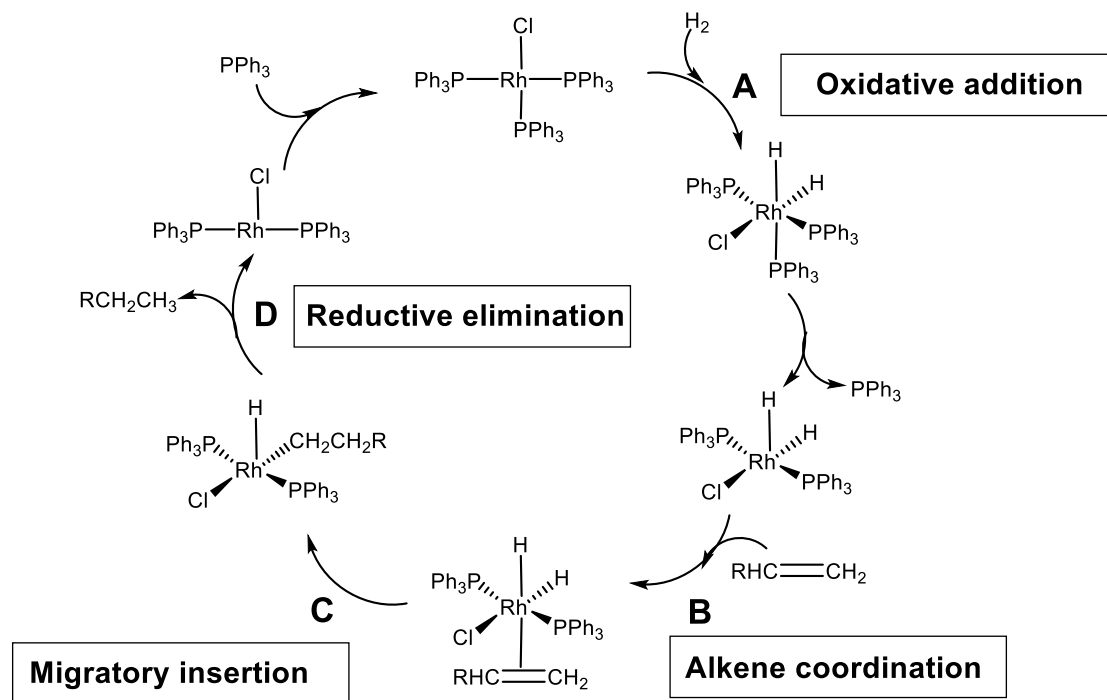## 3. (A). (3+1 Marks)

Answer: In deoxy Hb, Fe^{2+} is HS (four no. unpaired electrons). In oxy-Mb, Fe^{3+} is in LS, and due to antiferromagnetic coupling with O_2^-, it is diamagnetic.

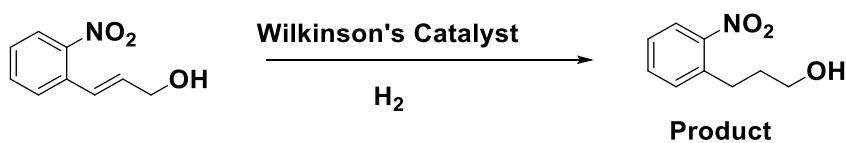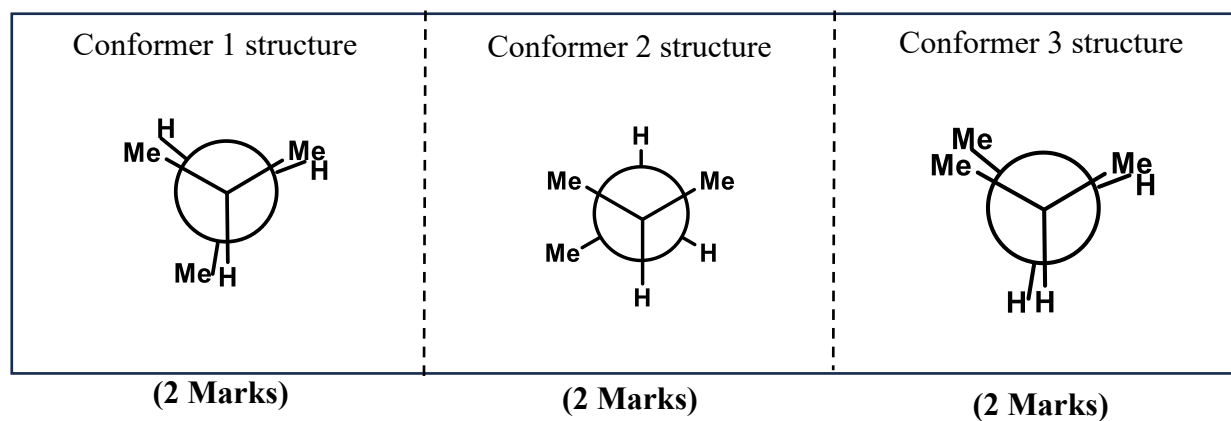**(B)** Answer: (1 + 1+ 1 + 1 Marks)

(C) (2 Mark)

4. (A) Answer:

Conformer 1 structure	Conformer 2 structure	Conformer 3 structure
(2 Marks)	**(2 Marks)**	**(2 Marks)**

(B) Answer: (2 Marks)

$$\boxed{\textbf{21}} \quad \text{kJ/mol}$$
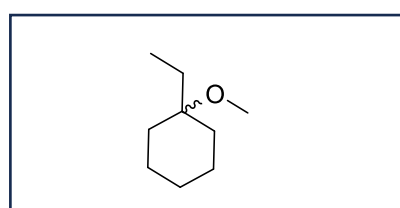
The energy of the molecule 3

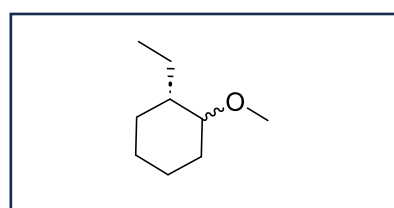=11 kJ/mol (CH$_3$-CH$_3$ eclipsed) + 6 kJ/mol (CH$_3$-H eclipsed) + 4 kJ/mol (H-H eclipsed)

=21 kJ/mol

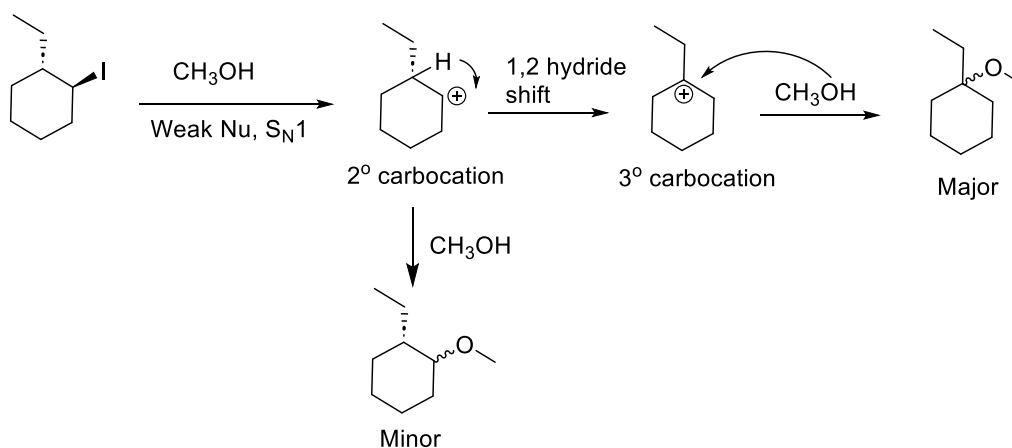## (C) Answer: (2 Marks)

Major product	Minor product
(1 mark)	(1 mark)

5. (A) Answer: (6 Marks)
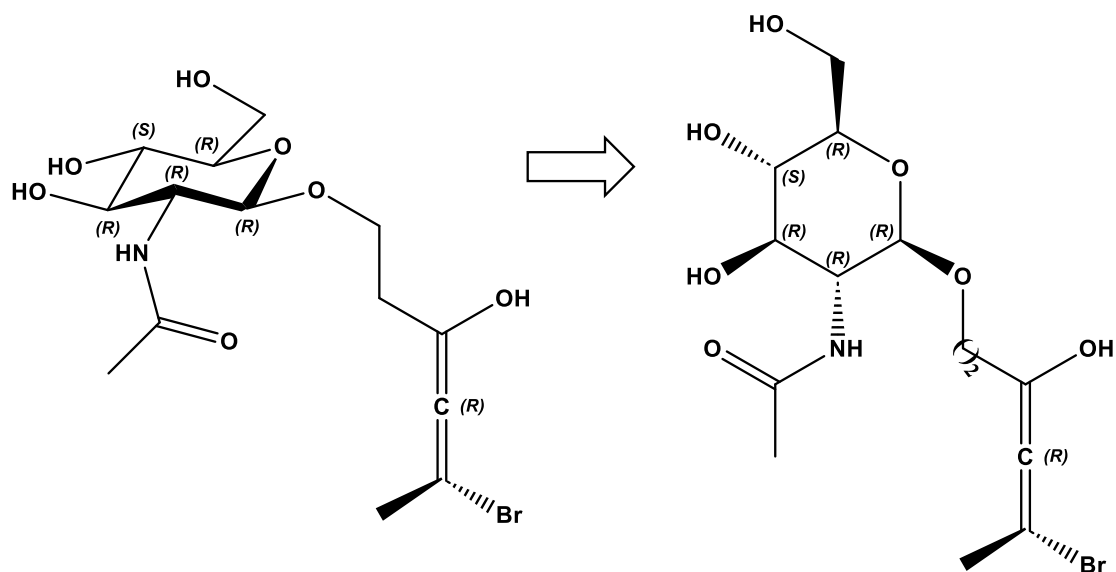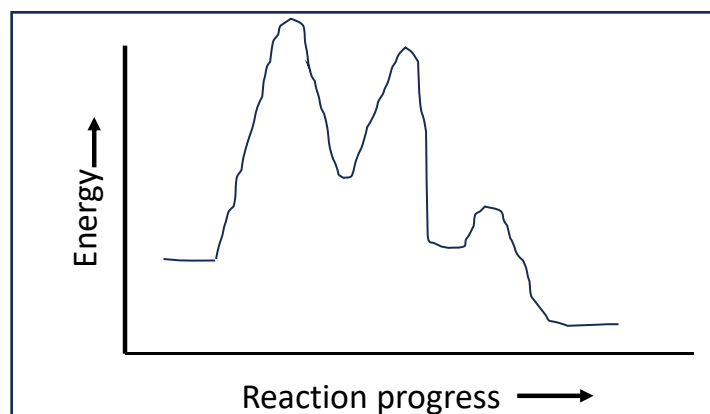

(B) Answer: (2 Marks)

(C). Answer: (2 Marks)
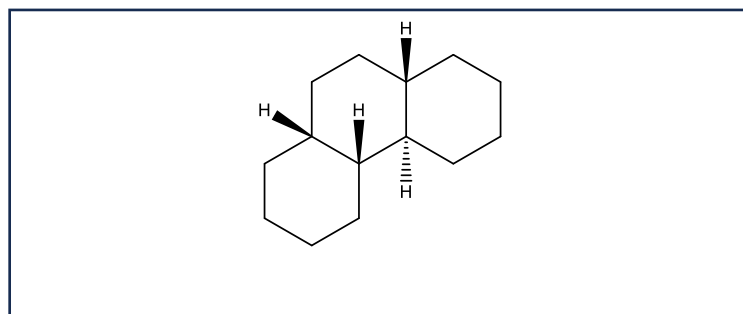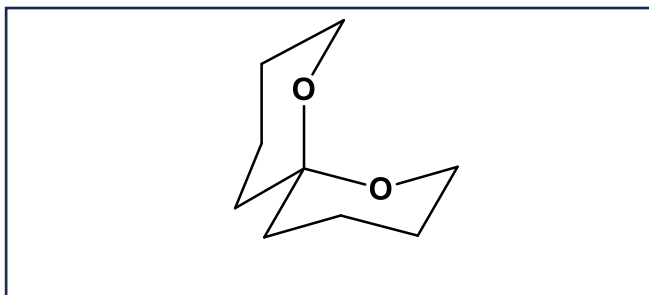
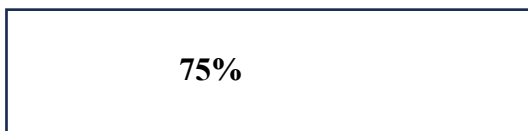**6. (A)Answer:**   **(4 Marks)**

Both the oxygen is in axial position w.r.t. the neighbor ring, the structure is stabilized due to the anomeric effect.

(B) Answer: **(4 Marks)**

75%

Enantiomeric excess= (20/40)x100% = 50 %. i.e. one of the isomers is present in 50% excess.

Here observed specific rotation is -20°, and the S isomer is present in excess.

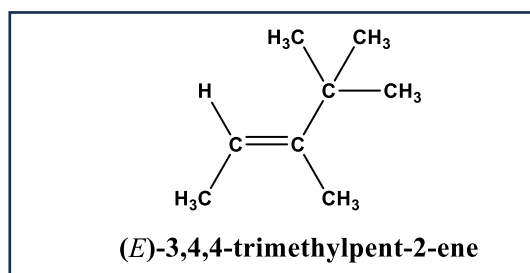The remaining 50 % is an equal mixture of R and S (i.e., 25% R and 25% S)

So total content of R in the mixture is 25 %

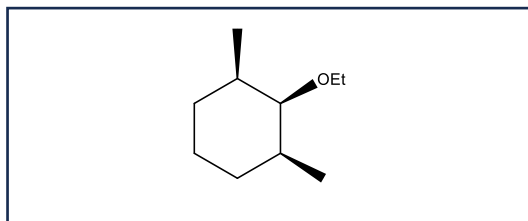The total content of S in the mixture is 50+25 %=75%

(C)   **(2 Marks)**

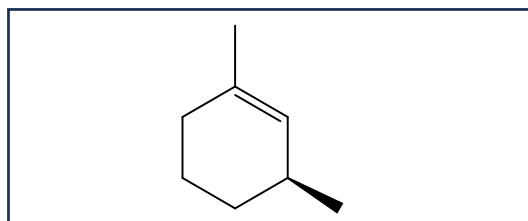(*E*)-3,4,4-trimethylpent-2-ene
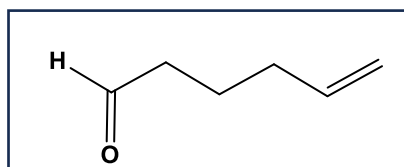
Alkane stability *E>Z*

7. (A) (4 Marks)

(2 marks)

No, β hydrogen in the *trans (anti-periplanar)* position w.r.t. leaving group, Br. Thus, only S_N2.

(2 marks)

Only one, β hydrogen in the *trans (anit-periplanar)* position w.r.t. leaving group, Br. The elimination (E2) leads to the formation of the major product.

(B) Answer: (2 Marks)

(C) Answer: (4 Marks)

Axial content is | **2.787** | %

'A' value indicates the preference of equatorial conformer over axial, the change in Gibbs free energy (ΔG) between the two conformers.

$$\Delta G = -RT \ln K_{eq}$$

ΔG is the change in Gibbs free energy, R is the universal gas constant, T is the absolute temperature (in Kelvin), Here, T=298K, R= 8.314 $JK^{-1}mol^{-1}$, ΔG= 8.8 $kJ.mol^{-1}$

$$\Delta G = -RT \ln K_{eq}$$

8.8 $kJmol^{-1} = -(8.314\ JK^{-1}mol^{-1}) \times (298\ K) \times \ln(K_{eq})$

$\ln(K_{eq})$ = -3.552

K_{eq} = 0.02867

K_{eq} = [axial]/[equatorial]

% axial= {axial/ (axial +equatorial)}×100

= axial/ {axial $(1+1/K_{eq})$}×100

= 1/(1+34.8797)×100

=2.787