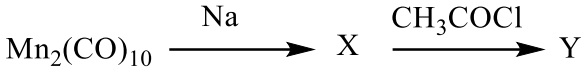
CML101 Major exam

Total Marks: 40

Exam time: 1 hr 45 mins
Uploading time: 12 mins
Extra time: 3 mins

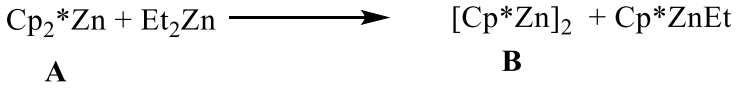
Q1. Write the products (**X** and **Y**) in the following reactions. [**1+1 Marks**]



Q2. Explain why hexaaquairon(III) is nearly colourless and on addition of potassium thiocyanate an intense blood red colour develops? [**1+1 Marks**]

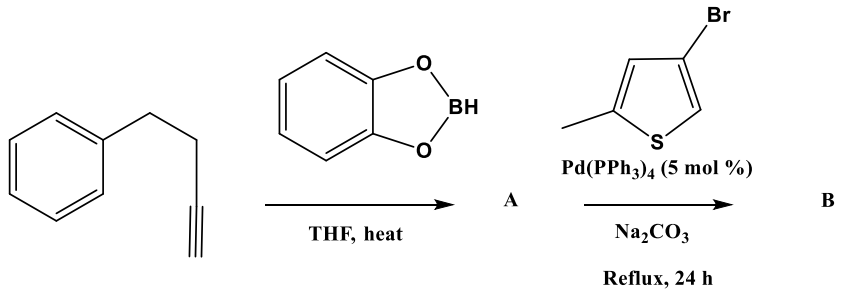
Q3. Heating $[(\eta^5\text{-}C_5H_5)Fe(CO)_3]^+$ with NaH in solution gives **A**, which has the empirical formula $C_7H_6O_2Fe$. **A** reacts rapidly at room temperature to eliminate a colourless gas **B**, forming a purple-brown solid **C** having the empirical formula $C_7H_5O_2Fe$. Treatment of **C** with iodine generates a brown solid **D** with the empirical formula $C_7H_5O_2FeI$. Compounds **A** to **D** follow 18 electrons rule. Write the correct structures of **A** to **D**? [**2 Marks**]

Q4. Compounds **A** and **B** in the given equation obey the 18 electron rule (Cp* = Pentamethylcyclopentadiene)

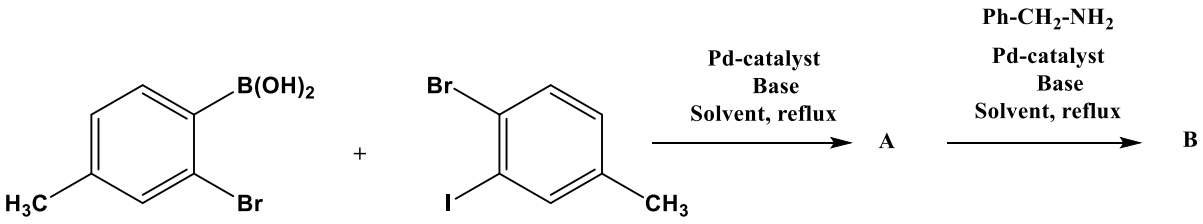


Draw the structure of compounds **A** and **B** clearly indicating the hapticity of Cp*. Also mark oxidation state of Zn in both **A** and **B**. (The η^3-hapticity can be ruled out as it is extremely rare for Cp*). [**1+1+0.5+0.5 Marks**]

Q5. Draw the correct structures of **A** and **B** in the following reactions. [**1+1 Marks**]



Q6. Draw the correct structures of **A** and **B** in the following reactions. [**1+1 Marks**]



Q7. (a) When (**A**) $[(\eta^5\text{-}C_5H_5)Mo(CO)_3]_2$ is heated carbon monoxide is released and the product (**B**) $[(\eta^5\text{-}C_5H_5)Mo(CO)_2]_2$ reacts readily with CO to reverse this reaction as given below. (Atomic number of Mo: 42)

$$\underset{\substack{\text{(A)}\\ \text{IR: 1960, 1915 cm}^{-1}}}{[(\eta^5\text{-}C_5H_5)Mo(CO)_3]_2} \underset{\text{CO}}{\overset{\triangle}{\rightleftharpoons}} \underset{\substack{\text{(B)}\\ \text{IR: 1889, 1859 cm}^{-1}}}{[(\eta^5\text{-}C_5H_5)Mo(CO)_2]_2} + 2\ CO$$

Draw the structures of **A** and **B** clearly indicating the Mo-Mo bond order and nature of CO bonding. [**1+1 Marks**]

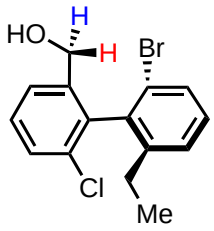
(b) Fill in the blanks [**0.5+0.5 Marks**]

(i) The exact name of the following reaction is ……

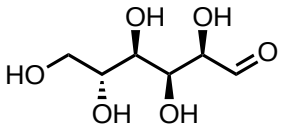
$Co(CH_2{=}CH\text{-}CH_3)(CO)_3(H) \rightarrow Co(CH_2CH_2CH_3)(CO)_3$

(ii) *β*-H elimination can be considered as the exact reverse of ……

Q8. Assign the absolute configuration for the following molecule and explain the stereochemical relationship between **H** and **H** using D labelling? [**1+1 Marks**]

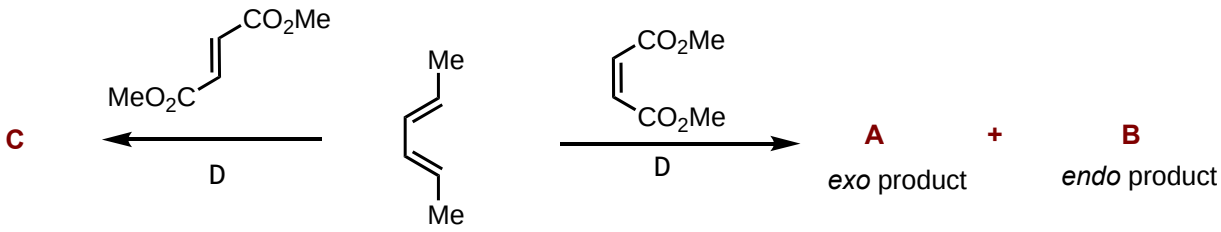


Q9. For the following molecule,



a) Draw the correct Fischer projection. [**1 Mark**]
b) Indicate the absolute configuration for all the chiral centers. [**0.5 Mark**]
c) Identify weather this molecule is D- isomer or L-isomer. [**0.5 Mark**]
(Note: Marks will be given only if all the chiral centers are correct in the structure)

Q10. For the following transformation,

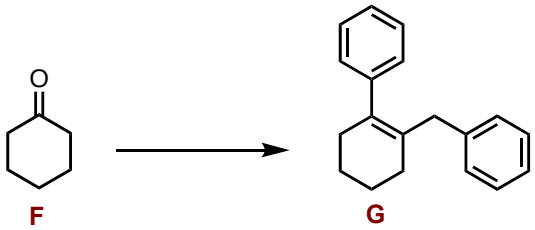


a) Draw the correct structure of products **A, B** and **C**. [**0.5+0.5+1 Marks**]
b) Identify the kinetic and thermodynamic products between **A** and **B**? [**1 Mark**]

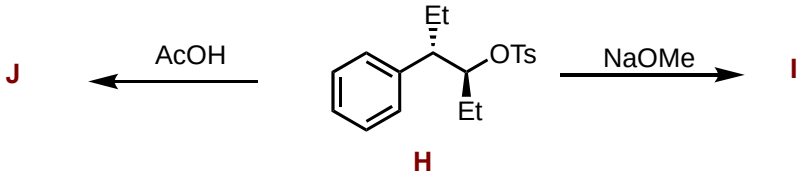
Q11. For the following transformation,

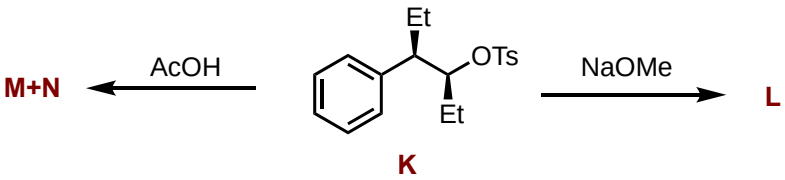
a) Draw the structures of the kinetic and thermodynamic products. [**0.5+0.5 Marks**]
b) Draw the energy profile diagram for the above reaction. Clearly mention reactants, transition states, intermediates, and products. [**2 Mark**]

Q12. Explain how to convert cyclohexanone **F** to compound **G** in least number of steps?
[**3 Marks**]

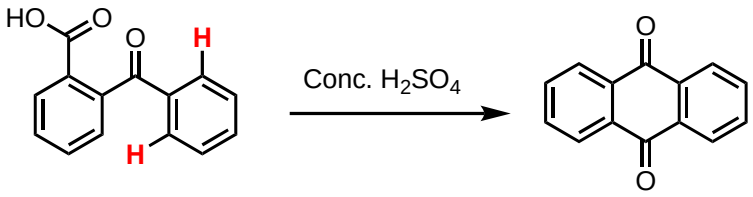


Q13. Explain the following transformations with the suitable mechanisms. [**4 Marks**]



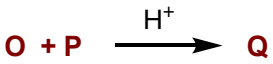


Q14. The rate constant for the following reaction was found to be 1.56 x 10^{-4} s^{-1}. When the **H** atoms (marked in red color) are replaced by the deuterium, the rate constant for this reaction was found to be 1.34 x 10^{-4} s^{-1}.



a) Calculate the kinetic isotope effect (KIE) for the above reaction. [**1 Mark**]
b) For the above reaction, propose a reasonable mechanism and clearly label the rate determining step. [**1.5+0.5 Marks**]

Q15. For the following transformation,



a) Identify the compounds **O**, **P** and **Q** using spectroscopic data given below. [**1+1+1 Marks**]

Compound **O** ($C_2H_4O_2$) - **^{1}H NMR:** 11.42 (s, 1H), 2.09 (s) *ppm.* **IR**: 3021 (broad), 1718 cm^{-1}

Compound **P** (C_2H_6O) - **^{1}H NMR:** 3.69 (q, 2H), 2.61 (s, 1H), 1.27 (t, 3H) *ppm.* **IR:** 3391 (broad) cm^{-1}

Compound **Q** ($C_4H_8O_2$) - **^{1}H NMR:** 4.12 (q, 2H), 2.04 (s, 1H), 1.26 (t, 3H) *ppm.* **IR:** 1752 cm^{-1}

(Note: s = singlet, t = triplet, q = quartet)

b) Give the mechanism for the above transformation and explain how to determine the reaction mechanism using labelled oxygen. [**0.5+0.5 Marks**]