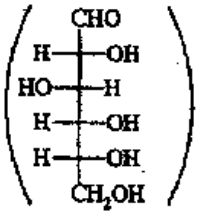
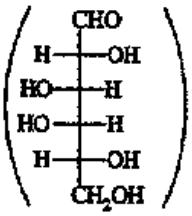
1. (15 pts)

Write the structural formula of the principal ionic species present in aqueous solution at pH 2, 7, and 12 of isoleucine (2-amino-3-methylpentanoic acid).

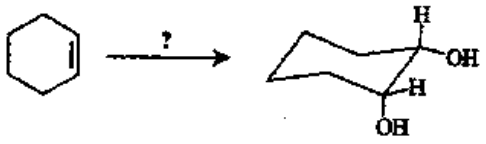
2. (10 pts)

Outline chemical tests that would allow you to distinguish between:

(a) Glucose  and galactose 

3. (5 pts)

Which reaction sequence converts cyclohexene to *cis*-1,2-cyclohexanediol? That is,



(a) Cold, dilute, aqueous $KMnO_4$, $OH^-$ (b) (1) $O_3$ (2) Zn/HOAc

(c) (1) $OsO_4$ (2) $NaHSO_3$ (d) (1) $RC(=O)-OOH$ (2) $H_3O^+/H_2O$

(e) More than one of these

4. (5 pts)

Which of the following sequences leads to the best synthesis of the compound $CH_3CH_2C{\equiv}CH$ ? (Assume that the quantities of reagents are sufficient to carry out the desired reaction.)

(a) $CH_3CH_2CH=CH_2$ $\xrightarrow{Br_2}$ $\xrightarrow[H_2O]{NaOH}$

(b) $CH_3CH_2CH=CH_2$ $\xrightarrow{Br_2}$ $\xrightarrow{NaNH_2}$

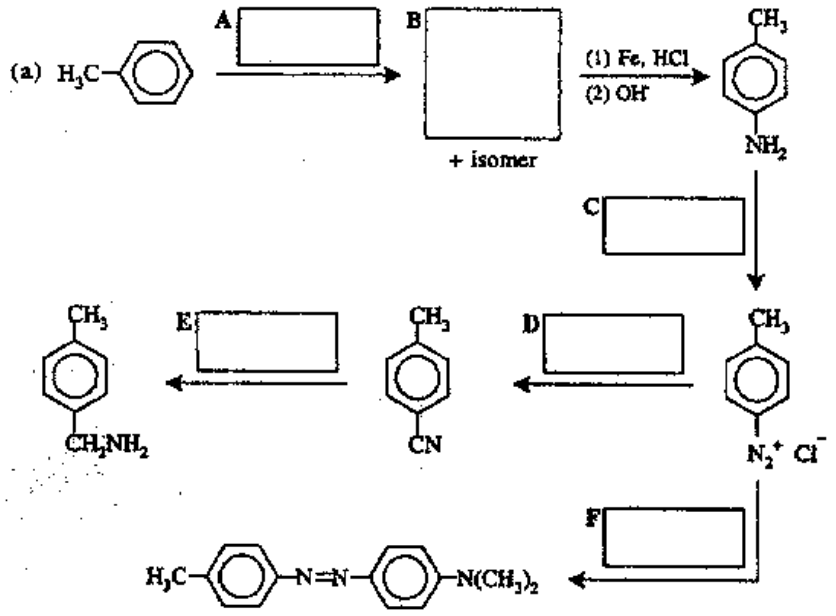
(c) $CH_3CH_2CH_2CHBr_2$ $\xrightarrow{H_2SO_4}$

(d) $CH_3CH_2CH_2CH_3$ $\xrightarrow[light]{Br_2}$ $\xrightarrow{NaNH_2}$

(e) $CH_3CH_2CH=CH_2$ $\xrightarrow{O_3}$ $\xrightarrow{Zn,HOAc}$

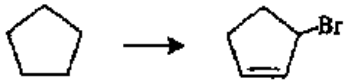
5. (24 pts)

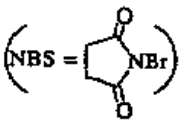
Complete the following syntheses:



6. (5 pts)

Which reagent(s) could be used to carry out the following reaction?



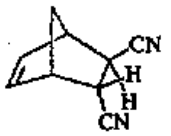

(a) NBS/$CCl_4$ (NBS =  ) (b) NBS/$CCl_4$, then $Br_2/h\nu$

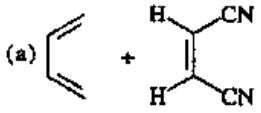
(c) $Br_2/h\nu$, then $(CH_3)_3COK/(CH_3)_3COH$, then NBS/$CCl_4$

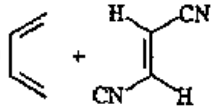
(d) $(CH_3)_3COK/(CH_3)_3COH$, then NBS/$CCl_4$

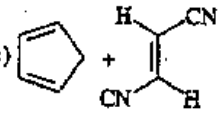
7. (5 pts)

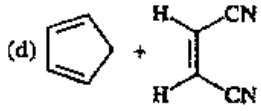
Which diene and dienophile could be used to synthesize the following compound?

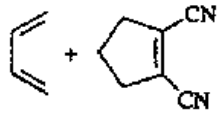



(a) 


(b) 


(c) 


(d) 


(e) 

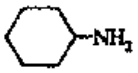

8. (15 pts)

Select the reagent from the list below that could be the basis of a simple chemical test that would distinguish between each of the following:

(a) $C_6H_5\overset{O}{\overset{\|}{C}}NH_2$ and $C_6H_5CH_2NH_2$

(b) $C_6H_5CH_2NH_2$ and $C_6H_5NHCH_3$

(c) 

and 


1. Cold dilute $NaHCO_3$
2. Cold dilute HCl
3. $NaNO_2$, HCl, 5°C, then 2-naphthol
4. $C_6H_5SO_2Cl$, $OH^-$, then HCl
5. Cold dilute NaOH

9. (16 pts)

Complete the following synthesis: