

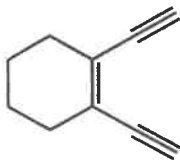


## 1. Consider the equilibrium



Which are the Brønsted-Lowry bases? (6%, more than one answer, give scores depending on the degree of correctness)

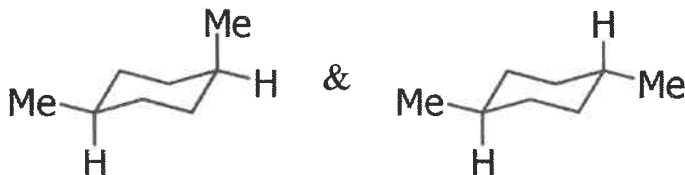
## 2. (a) Calculate the index of hydrogen deficiency (or degree of unsaturation) of the following molecule. (5%)



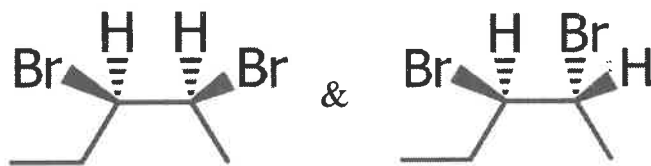
(b) Calculate the index of hydrogen deficiency (or degree of unsaturation) of a compound with the molecular formula of  $\text{C}_7\text{H}_7\text{NOS}$ . (5%)

## 3. Label the following pairs of molecules as enantiomers, diastereomers, or same molecule. (9%)

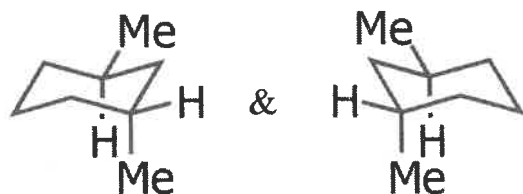
(a)



(b)

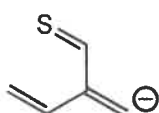
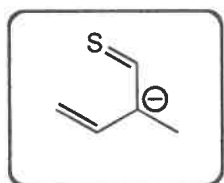


(c)

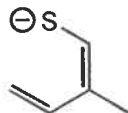




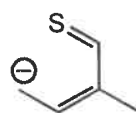
4. Which of the following species are *not* a resonance form(s) of the anionic species in the box? (6%, more than one answer, give scores depending on the degree of correctness)



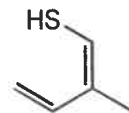
I



II



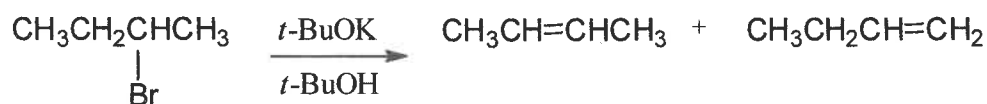
III



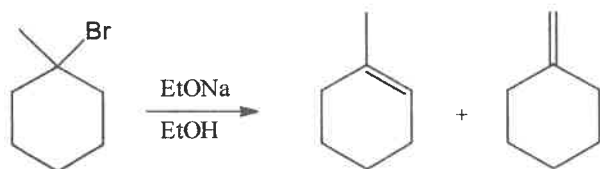
IV

5. Which will be the major products of the following reactions? (9%)

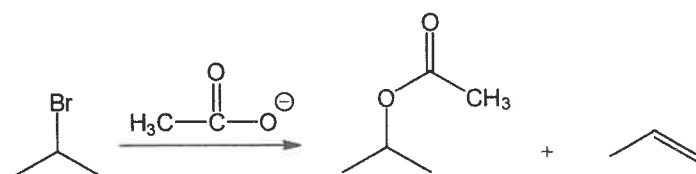
(a)



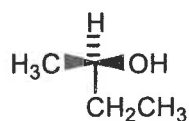
(b)



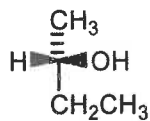
(c)



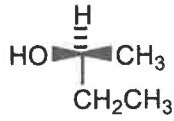
6. Which of the following represent (*R*)-2-butanol? (10%, more than one answer, give scores depending on the degree of correctness)



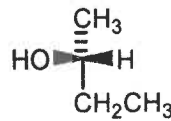
I



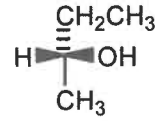
II



III



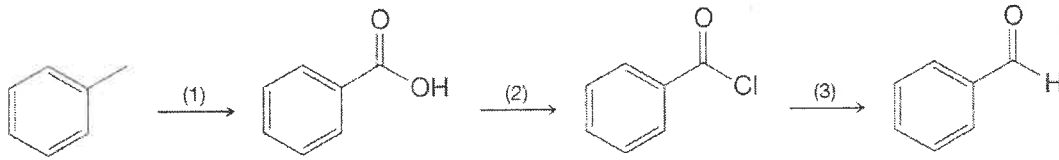
IV



V

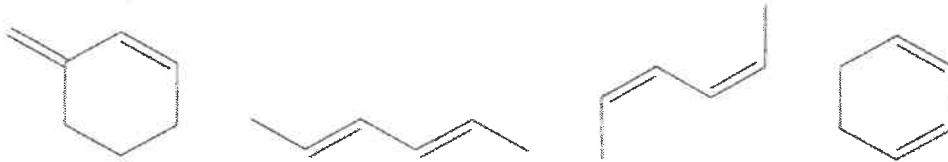


7. Provide the reagents for transformations (1), (2), and (3). (15%)

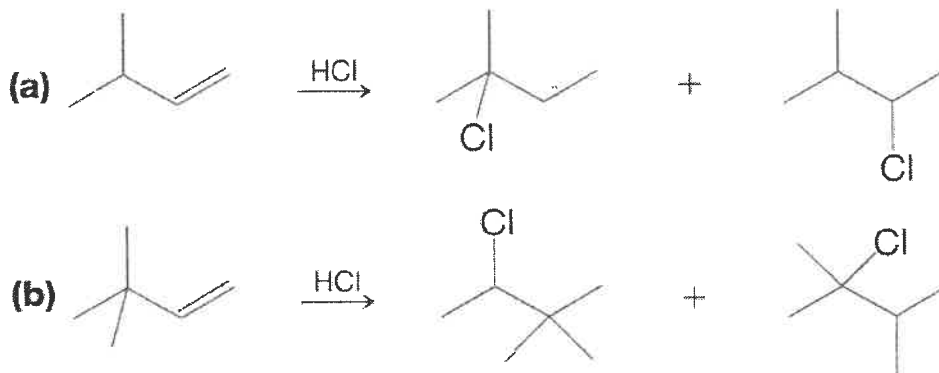


8. When benzene reacts with 1-chloro-2,2-dimethylpropane (neopentyl chloride) in the presence of aluminum chloride, the major product is 2-methyl-2-phenylbutane, not 2,2-dimethyl-1-phenylpropane (neopentylbenzene). Explain this result. (10%)

9. Rank the following dienes in order of increasing reactivity in a Diels-Alder reaction (1 = least reactive, 4 = most reactive). Briefly explain your ranking. (5%)



10. Provide mechanistic explanations for the following observations: (10%)

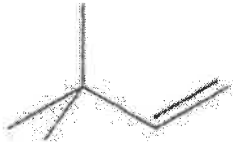




11. Starting with an appropriate alkyl halide and base, outline syntheses that would yield each of the following alkenes as the major (or only) product:

(10%)

(a)



(b)

