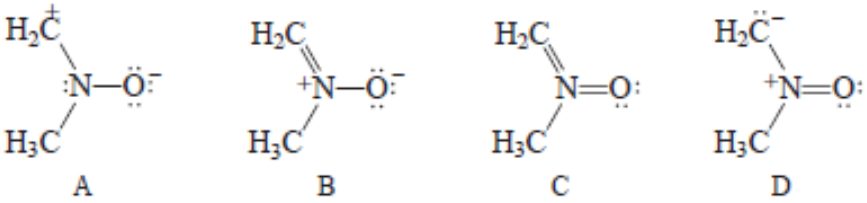
CH1101: End-Semester Examination

Autumn 2021

Total Marks = 30; Time = 90 min

There are **EIGHT** questions and you have to answer all of them.

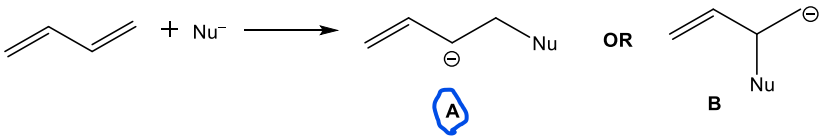
1. (a) Which one of the following is *not* a permissible contributing structure? Why?

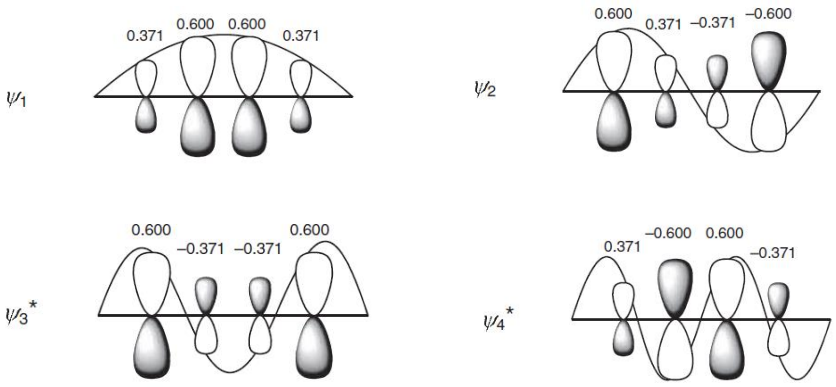


(b) Rank the three remaining structures in order of their contribution to the resonance hybrid. Explain your reasoning. Show the formal charges on each of the atoms in the resonance structures.

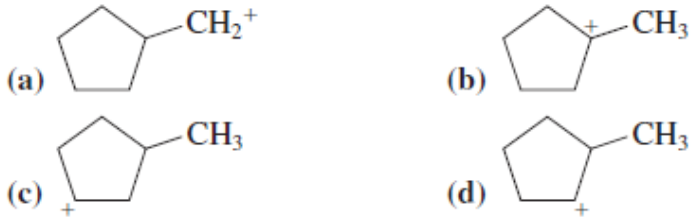
(c) Using curved arrows, show the electron movement that connects the three resonance contributors. (5 marks)

2. The four π-MOs of butadiene are shown. Now consider the following reaction in which a nucleophile attacks butadiene. There are two possible intermediates (A and B) as shown in the reaction scheme. Based on the MO approach, explain which intermediate is the more probable one. You can't use resonance concept. (4 marks)





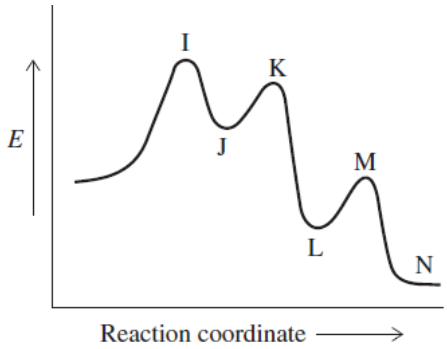
3. Which of the following isomeric carbocations is most stable? Explain based on σ-conjugation (MO argument). (3 marks)



4. Which of the following transformations (A or B) matches the reaction profile shown here? Draw the structures of the species present at all points on the energy curves marked by capital letters. (6 marks)

(A) $CH_3CH_2Br + NaI \longrightarrow$

(B) $(CH_3)_3CBr + CH_3CH_2OH \longrightarrow$



5. Butadiene is colorless but β-carotene (eleven double bonds in conjugation) present in carrot has reddish-orange color. Explain. (2 marks)

6. A possible Lewis-Dot structure of the molecule C_2 is shown below:

$$\bullet C \equiv C \bullet$$

Draw a full MO diagram of C_2 using only atomic orbitals. Draw another MO diagram of C_2 using sp hybrid orbitals. Which one of the MO diagrams best describe the Lewis structure shown above? Explain. (4 marks)

7. The following table gives the bond strengths ($kJmol^{-1}$) for the homonuclear diatomics of p-block of the second row. Rationalize the trends in the bond strengths for crossing the period from left to right. Your answer should include a consideration of the bond

orders present in each group. Even though C_2 and O_2 have the same bond order, the bond strength of O_2 is weaker then C_2. Why? (3 marks)

group	13	14	15	16	17
	B_2	C_2	N_2	O_2	F_2
	297	607	945	498	159

8. Using the data on orbital energies given below, place the following compounds on the van Arkel Diagram: $CaCl_2$, TiB_2, S_4N_4 and AlN. Consider the (-) valence orbital energy of Cs to be 4 eV and F to be 26 eV to construct the triangle. (3 marks)

element	B	C	N	Al	S	Cl	Ca	Ti
minus valence orbital energy / eV	11.8	15.2	18.8	9.05	15.8	18.2	5.34	8.44