

Student Name (first, last):

Student Number:

CHEMISTRY 3311
FIRST MIDTERM EXAMINATION

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1. (20 points) Check the correct statements only:

- An electrostatic potential map (EPM) is a picture of the total electron density in a molecule, color coded to show areas of negative charge in red and areas of positive charge in blue.
- Trifluoroacetic acid, CF_3COOH , has a higher pK_a than acetic acid, CH_3COOH .
- The methyl cation, CH_3^+ , has an sextet of valence electrons on the carbon atom.
- Isobutane is a different name for 2-methylpropane.
- In general, secondary carbocations are more stable than tertiary carbocations.
- The H-Cl molecule contains a non-polar σ bond.
- Chlorine is a more electronegative atom than sulfur.
- The molecule of boron trifluoride, BF_3 , is planar.
- A molecule of propene contains a $\text{C}=\text{C}$ bond with approximately sp^2 hybridized carbon atoms.
- In the ground electronic state, the σ bonding orbitals of ethane contain 14 valence electrons.
- An orbital is a region of space where an electron is likely to be found.
- According to the Hammond postulate, energies of transition states for reactions involving unstable intermediates resemble the energies of the intermediates themselves.
- When the free energy of activation of a reaction is increased, the reaction proceeds faster.
- The fastest step in a multistep reaction sequence is called the rate determining step.
- A catalyst is a compound whose presence slows down a reaction and which is consumed irreversibly in the reaction.
- An electrostatic potential map (EPM) is a picture of the energy released when a positive point charge is brought from infinity to various locations on a surface surrounding a molecule (red, more energy gained, and blue, less energy gained); the surface consists of points at all of which electron density is equal (isodensity surface).
- CO_2 has a smaller dipole moment than H_2O .
- The molecule of ammonia, NH_3 , is not planar.
- 1-Hexene and cyclopentane have the same unsaturation number.
- 1-Butene has a more negative heat of formation than 2-methylpropene.

2. (30 pts) (a) Write a plausible mechanism for the acid-catalyzed hydration of isobutylene (include all steps and intermediates and use curved arrows to indicate electron movement in each step).
- (b) Draw a schematic free energy reaction profile for the hydration reaction and indicate the chemical structures of the organic reactants, intermediates, and products. Label all transition states with double daggers.

3. (10 pts) Propose a reaction sequence for the synthesis of 1-bromo-1-methylcyclopentane from 1-methylcyclopentene and inorganic reagents. Show all steps and all reagents (no mechanisms, no curved arrows, no solvents).

4. (10 pts) Draw the Newman projection of the most stable conformer of *n*-pentane (view along the C(2)-C(3) axis) and write down the name of this conformation.

5. (10 pts) Draw the structural formula of (*E*)-1-cyclopropyl-5-*sec*-butyl-6-*tert*-butyl-3-decene.

6. (20 pts) Write the structures of the principal organic product in the following reactions. You do not need to show solvents, mechanisms, or curved arrows.

