

Part I (1-10) are True or False. (Put **T** or **F** on lines at left.) 10points

F ___ 1) Orbitals are regions where electrons are found

F ___ 2) Entropy is a measure of the return to equilibrium in an open system.

T ___ 3) Polar compounds are formed between atoms of different electronegativities

F ___ 4) Chlorine is more electronegative than Oxygen

F ___ 5) The activation energy E_a depends on temperature.

T ___ 6) $\text{CClF}=\text{CClF}$ can exist as cis and trans isomers

F ___ 7) A π bond places its electron density directly between two nuclei and is thus stronger than a σ bond.

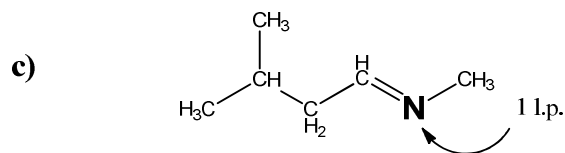
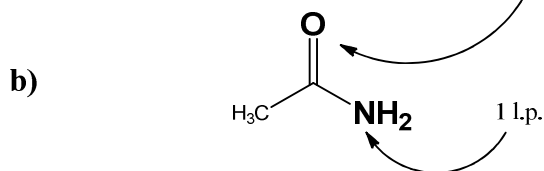
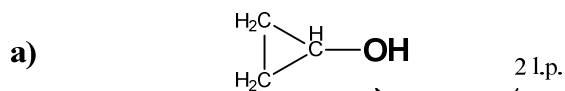
F ___ 8) The sp^2 hybrid orbitals give rise to bond angles of 109.5°

F ___ 9) The **p** orbital has a positive and negative charge.

T ___ 10) A 2s orbital is spherical in shape.

Part II Answer all the questions.

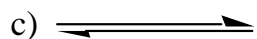
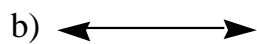
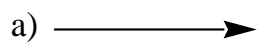
1. Draw the complete Lewis structures (put dots for all lone pairs, include missing hydrogens) for the following molecules: (8 pts)



2. What is the hybridization of: (8 pts)

- (i) The oxygen in (1a) sp^3 ___
- (ii) The oxygen in (1b) sp^2 ___
- (iii) The nitrogen in (1c) sp^2 ___
- (iv) The carbon in (1d) sp^3 ___

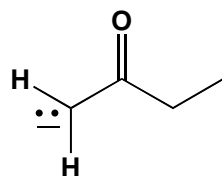
3. Explain in a word or simple phrase what is meant in a chemical sense by the following arrows. (5 pts)



See exams 2008,9

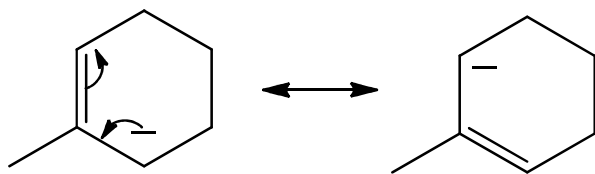
4. (i) Write all the resonance forms for the following two species.
(ii) Indicate which are major and minor contributors (or if they are the same energy).
(iii) Use curly arrows to show the movement of electrons which converts one into the others. (8 pts)

See exams 2008,9

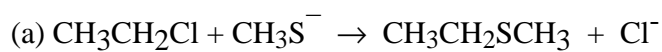


b)

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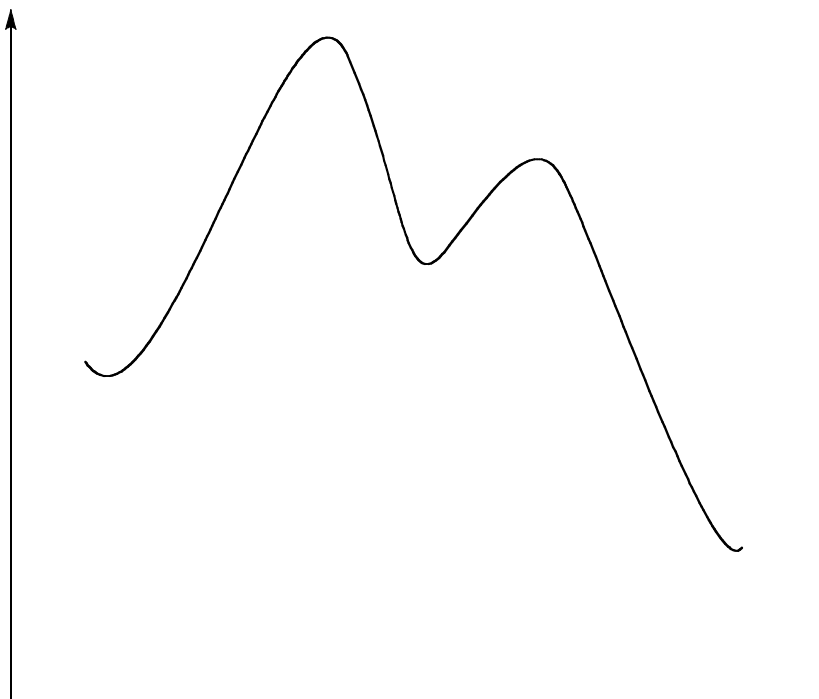
5. Indicate which reactant is acting as a BASE and which is acting as an ACID for the following reactions. (2 pts)



Acid

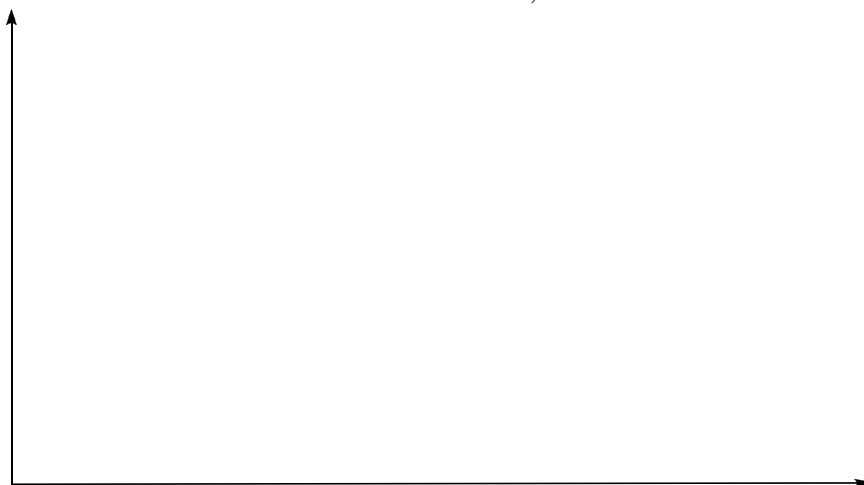
Base

6. On the below energy level diagram, label or draw (a) the axes (b) the reactants and products (R and P) (c) transitions states (TS or \ddagger) (d) intermediates (I), (e) activation barriers E_a , (f) ΔH° for the overall reaction (g) the rate determining step, and (g) is this reaction exothermic or endothermic? (7 pts) See exams 2008,9



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7. Show with the aid of a distribution graph how reaction rates go up with temperature. (4 pts)
See exams 2008,9



8. a.) Draw the methyl cation and methyl carbanion and explain why CH_3^+ has a different three-dimensional geometry than CH_3^- . (4 pts)
See exams 2008,9

- b.) Which of CH_3^+ or CH_3^- is a better electrophile; which is a better Lewis acid? Give a chemical equation for the reaction of the electrophile reacting with H_2O . (6pts)

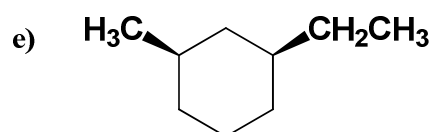
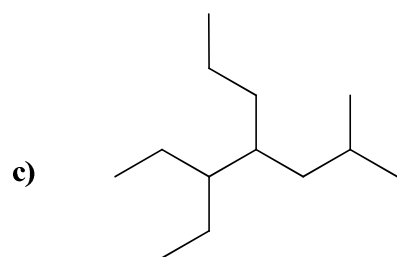
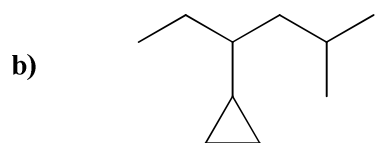
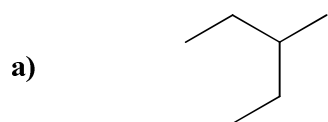
electrophile: CH_3^+

Lewis acid: CH_3^+

Points were not taken off for incorrect answer to reaction below:

Reaction: $\text{H}_2\text{O} + \text{CH}_3^{\text{?}}(\text{fill in the charge}) \rightarrow \text{?CH}_3\text{OH} + \text{?H}^{\text{?}}$ (products)

9. Name the following compounds in **IUPAC** form: (15 pts)



3-methylpentane

4-cyclopropyl-2-methylhexane

5-ethyl-2-methyl-4-propylheptane

Bicyclo[2,2,2]octane cis-1-ethyl-3-methylcyclohexane

10. (a) Butane is stable in which two conformations, and which is more stable? (2 pts)

Gauche, anti (more stable)

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(b) Draw the Newman projections for these two conformations (2 pts)
See notes and text

11. What two factors contribute to ring strain? (2 pts)

Angle strain, eclipsing

12. *Trans*-1-ethyl-3-methylcyclohexane exists as two chair conformations that are in equilibrium.
(i) Clearly draw the chair conformations, and name the positions that the ethyl and methyl groups are in. (5 pts-) See prior exams for ring structures

Anti-ethyl equatorial-methyl and equatorial-ethyl axial-methyl

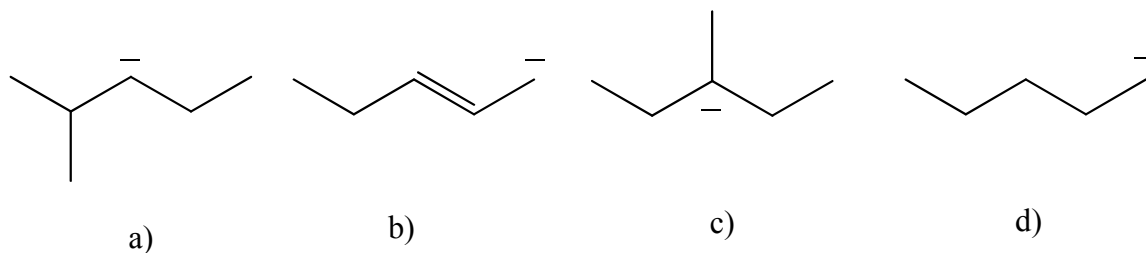
(ii) In a **sentence** explain why one specific conformation is more stable. (2 pts)

The equatorial-ethyl,axial-methyl configuration has the larger substituent in the more stable equatorial position

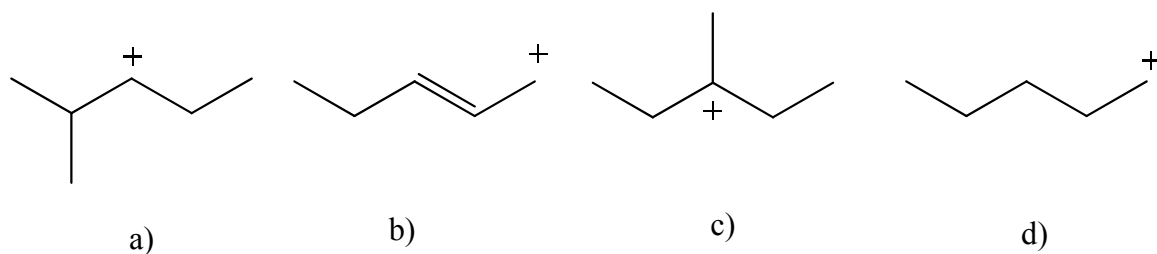
13. The Hammond Postulate predicts that the transition state in an exothermic reaction will more closely resemble the *reactants* or *products* in structure? (Circle correct word). State the Hammond Postulate. (2 pts) reactants

The structure of the transition state resembles more the state that is nearer to it in energy.

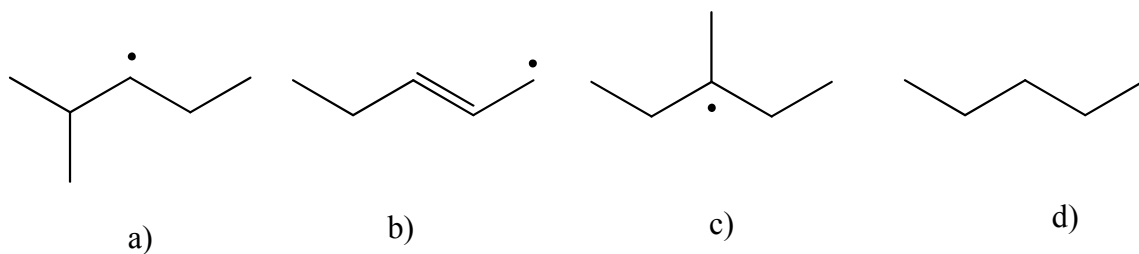
14. Rank the following radicals and ions in **increasing** stability. (4 pts)
See exams 2008,9



least stable: ____, ____, ____, ____) :most stable



least stable: ____, ____, ____, ____) :most stable



least stable: ____, ____, ____, ____) :most stable



(ii) Identify each as a primary, secondary, tertiary or allylic radical. (4 pts)

Every a) _____ Every b) _____

Every c) _____ Every d) _____

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Bonus: (3 pts) The mathematical function for the Hydrogen 1s atomic orbital is $e^{-|x|}$.

a) Draw a graph for the H_2 σ molecular orbital function when the 1s atomic orbitals are placed at $e^{-|1-x|}$ and $e^{-|1+x|}$.

b) Then draw the graph of the H_2 σ molecular orbital function when the 1s atomic orbitals are at $e^{-|2-x|}$ and $e^{-|2+x|}$.

c) Then draw the graph of the H_2 σ^* molecular orbital function when the 1s atomic orbitals are at $e^{-|2-x|}$ and $e^{-|2+x|}$.