

Chemistry 351
Exam #1
October 9, 2019

Name: _____

Student Number: _____

Section Number: _____

TA: _____

INSTRUCTIONS:

This examination consists of 26 questions on 10 pages. Please make certain that your examination is complete.

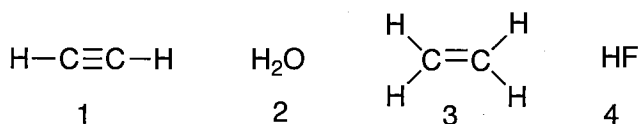
Write your name, student number, and section number **on both the examination and answer sheet. Be certain to bubble in your PID digits on the answer sheet. The absence of any of these identification items will result in the deduction of 2 points from your score.**

Questions 1-19 are each worth 3 points. Point totals for Questions 20-26 are indicated on the exam.

Write your answers to Questions 1- 19 on the enclosed answer sheet. **Write your answers to Questions 20-26 in the space provided on this examination.**

When you complete the examination, insert your answer sheet into your examination and then hand both in on the bench in front of the lecture hall in the spot indicated by your section number.

1. Order the following acids from the most acidic to the least acidic:



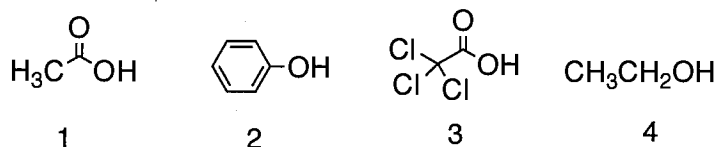
- | | |
|---|---|
| a. (most acidic) $4 > 3 > 2 > 1$ (least acidic) | b. (most acidic) $3 > 4 > 2 > 1$ (least acidic) |
| c. (most acidic) $3 > 1 > 2 > 4$ (least acidic) | d. (most acidic) $1 > 3 > 2 > 4$ (least acidic) |
| e. (most acidic) $1 > 2 > 3 > 4$ (least acidic) | f. (most acidic) $4 > 2 > 1 > 3$ (least acidic) |
| g. (most acidic) $2 > 4 > 3 > 1$ (least acidic) | h. (most acidic) $2 > 3 > 1 > 4$ (least acidic) |
| i. (most acidic) $2 > 4 > 1 > 3$ (least acidic) | j. (most acidic) $3 > 2 > 4 > 1$ (least acidic) |

2. Order the following acids from the most acidic to the least acidic:



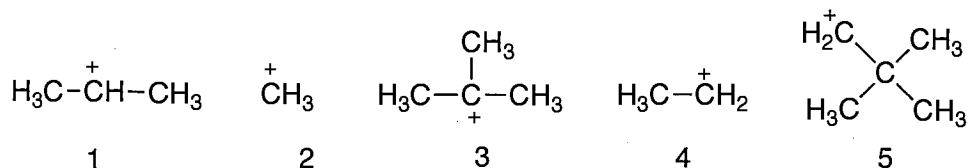
- | | |
|---|---|
| a. (most acidic) $4 > 3 > 2 > 1$ (least acidic) | b. (most acidic) $3 > 4 > 2 > 1$ (least acidic) |
| c. (most acidic) $3 > 1 > 2 > 4$ (least acidic) | d. (most acidic) $1 > 3 > 2 > 4$ (least acidic) |
| e. (most acidic) $1 > 2 > 3 > 4$ (least acidic) | f. (most acidic) $4 > 2 > 1 > 3$ (least acidic) |
| g. (most acidic) $2 > 4 > 3 > 1$ (least acidic) | h. (most acidic) $2 > 3 > 1 > 4$ (least acidic) |
| i. (most acidic) $2 > 4 > 1 > 3$ (least acidic) | j. (most acidic) $3 > 2 > 4 > 1$ (least acidic) |

3. Order the following acids from the most acidic to the least acidic:



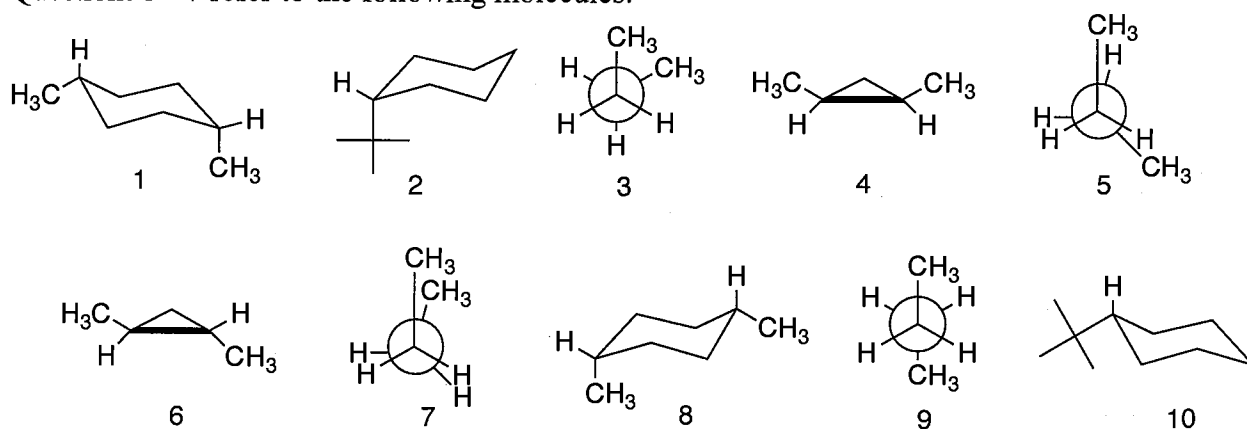
- | | |
|---|---|
| a. (most acidic) $4 > 3 > 2 > 1$ (least acidic) | b. (most acidic) $3 > 4 > 2 > 1$ (least acidic) |
| c. (most acidic) $3 > 1 > 2 > 4$ (least acidic) | d. (most acidic) $1 > 3 > 2 > 4$ (least acidic) |
| e. (most acidic) $1 > 2 > 3 > 4$ (least acidic) | f. (most acidic) $4 > 2 > 1 > 3$ (least acidic) |
| g. (most acidic) $2 > 4 > 3 > 1$ (least acidic) | h. (most acidic) $2 > 3 > 1 > 4$ (least acidic) |
| i. (most acidic) $2 > 4 > 1 > 3$ (least acidic) | j. (most acidic) $3 > 2 > 4 > 1$ (least acidic) |

4. Of the following carbocations, identify the two carbocations that are NOT stabilized by hyperconjugation with C-H sigma bonds:



- (a) 1,2 (b) 1,3 (c) 1,4 (d) 1,5 (e) 2,3 (f) 2,4 (g) 2,5 (h) 3,4 (i) 3,5 (j) 4,5

Questions 5 - 7 refer to the following molecules:



5. Identify the conformational pair where the two conformers are of equal energy.

- (a) 4, 6 (b) 3, 7 (c) 7, 9 (d) 3, 9 (e) 5, 7 (f) 5, 9 (g) 2, 10 (h) 3, 5 (i) 1, 8

6. Identify the *cis*-substituted molecule containing sp^2 -hybridized carbon atoms.

- (a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) 6 (g) 7 (h) 8 (i) 9 (j) 10

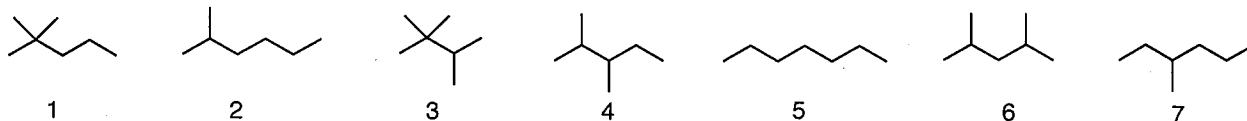
7. Identify the SECOND most stable conformer of butane.

- (a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) 6 (g) 7 (h) 8 (i) 9 (j) 10

8. Identify the two molecules with identical molecular formula that have different boiling points.

- (a) 4, 6 (b) 3, 7 (c) 7, 9 (d) 3, 9 (e) 5, 7 (f) 5, 9 (g) 2, 10 (h) 3, 5 (i) 1, 8

Question 9 and Question 10 are to be answered from the following possibilities:



9. Identify the structure that does not contain any methylene carbon atoms.

- (a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) 6 (g) 7

10. Identify the alkane having the lowest boiling point.

- (a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) 6 (g) 7

11. Which of the following fractions of petroleum refining does NOT distill?

- (a) methane (b) heavy naphtha (c) gas liquids (d) heavy gas oil (e) light naphtha
 (f) lubricating oil (g) diesel (h) asphalt (i) kerosene

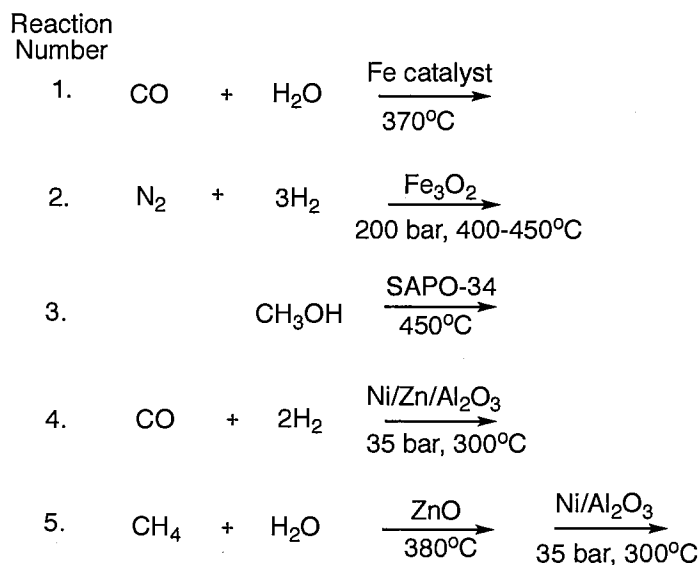
12. Of the following steps in fracking operations:

- Step #1 Drill vertically into shale layer.
- Step #2 Continue to drill horizontally to intersect vertical fractures.
- Step #3 Line drill hole with steel piping.
- Step #4 Blow holes in horizontal pipe walls with a perforation gun.
- Step #5 Seal sections of the horizontal pipe.
- Step #6 Pump high pressure water into sealed sections.
- Step #7 Pump sand/water gel containing various chemicals into fracked sections.
- Step #8 Drain shale gas and shale oil from fracked sections and pump to surface.

Identify the step that is essential to keeping microfractures open in order to drain the maximum amount of methane, gas liquids, and shale oil:

- (a) Step #1 (b) Step #2 (c) Step #3 (d) Step #4 (e) Step #5 (f) Step #6 (g) Step #7 (h) Step #8

Question 13 and Question 14 are to be answered from the following reactions:



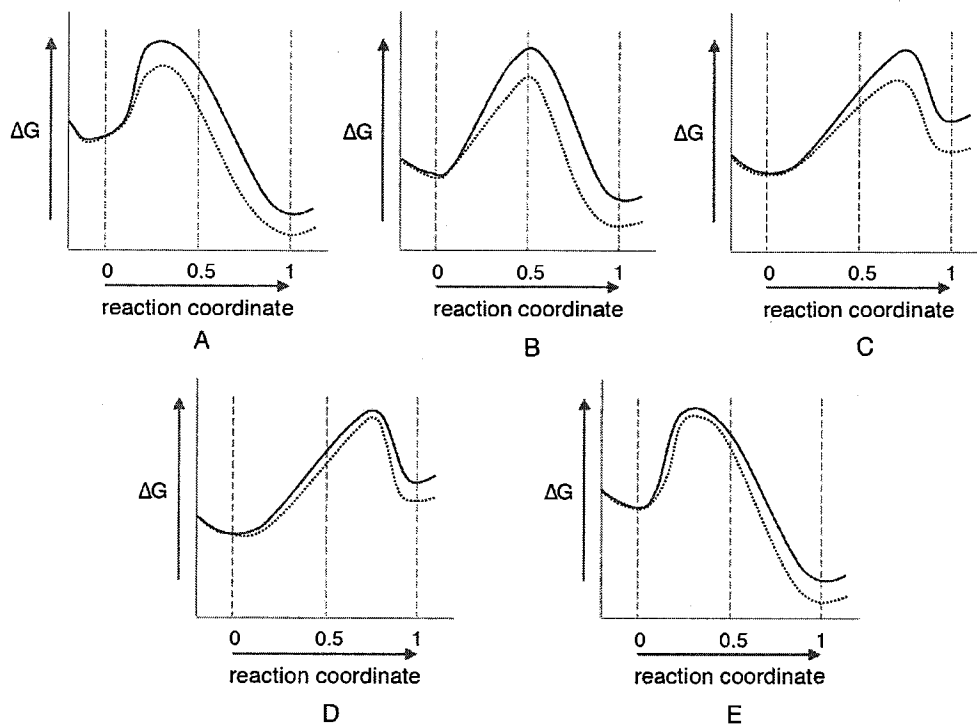
13. Identify the three reactions used to provide 50-75% of the N atoms in your body.

- a. 1,2,3 b. 1,3,4 c. 1,4,5 d. 2,3,4 e. 2,4,5 f. 3,4,5 g. 1,2,4 h. 1,2,5 i. 1,3,5

14. Identify the three reactions that are being used in the People's Republic of China to synthesize propene and ethene from methane:

- a. 1,2,3 b. 1,3,4 c. 1,4,5 d. 2,3,4 e. 2,4,5 f. 3,4,5 g. 1,2,4 h. 1,2,5 i. 1,3,5

Question 15 and Question 16 refer to the following potential energy diagrams:



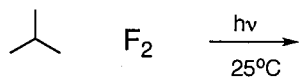
15. Based on the Hammond postulate, which potential energy diagram corresponds to a very exothermic reaction.

16. Based on the Hammond postulate, which potential energy diagram corresponds to an endothermic reaction.

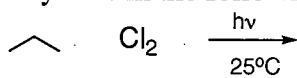
Questions 17-19 are to be answered from the following possibilities

| | | | | |
|------------------|------------------|------------------|-------------|------------------|
| A. 75% 25% | B. + | C. 14% 86% | D. + | E. 43% 57% |
| F. + | G. 86% 14% | H. 10% 90% | I. + | J. 90% 10% |

17. Identify the product and product yields in the following reaction:



18. Identify the product and product yields in the following reaction:



19. Identify the reactive intermediate and product formed in the following reaction:



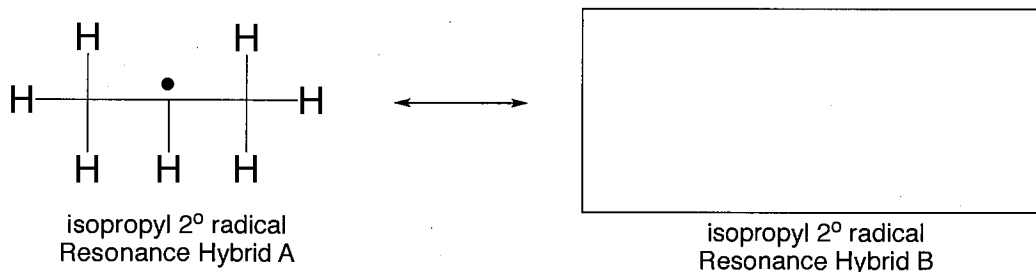
h. Every step in the conversion of 2-bromo-2-methylhexane into the Product is an equilibrium reaction. In the box below, write a short answer (NO MORE THAN 10 WORDS) explaining what to do to achieve a 100% yield of the desired Product (HINT: Le Chatelier's Principle teaches this strategy).

Short Answer - must be less than 10 words

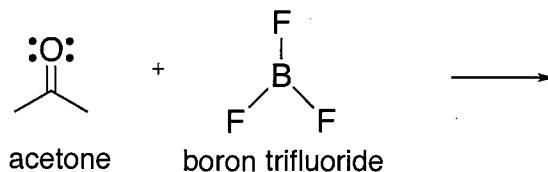
21. (3 points total)

a. (1 pt) Draw arrows that shows the flow of electrons during hyperconjugative stabilization of isopropyl 2° radical Resonance Hybrid A.

b. In the labeled box, provide the structures of isopropyl 2° radical Resonance Hybrid B.



22. (6 points total) For the reaction of boron trifluoride with acetone:

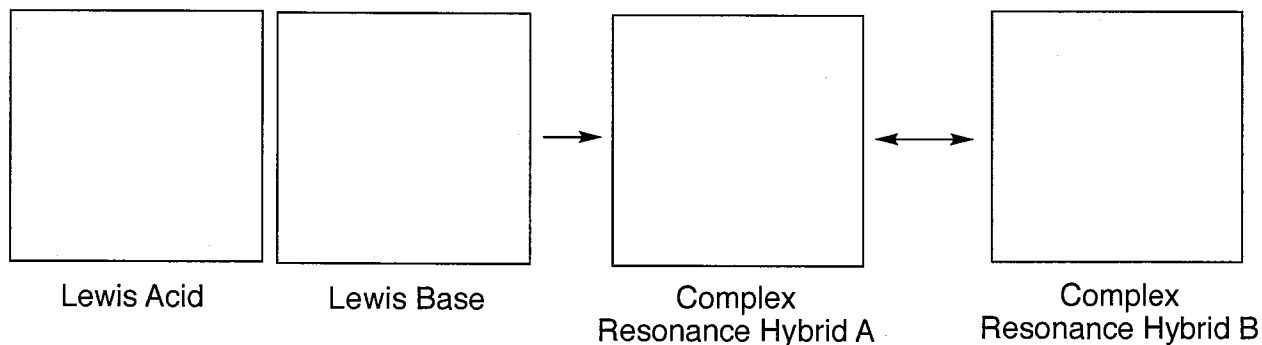


a. In the appropriate labeled boxes, provide the structures of the Lewis Acid and the Lewis Base.

b. Draw the arrow or arrows that show the flow of electrons during the reaction.

c. Provide the structures of the two resonance hybrids of the Complex that is formed.

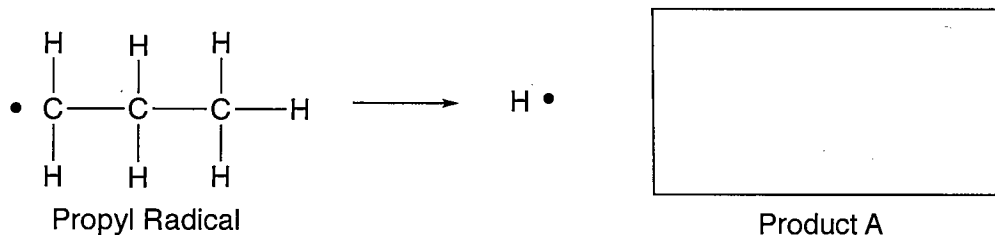
d. Draw the arrow or arrows that show the flow of electrons linking the two resonance hybrids.



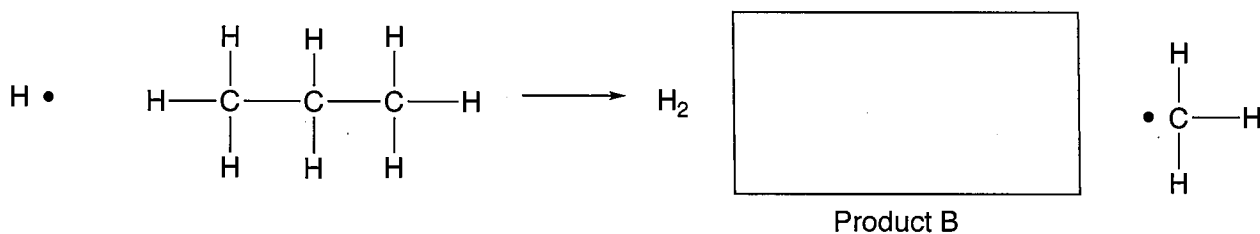
23. (6 points total) The following questions refer to the following list of products formed during cracking of propane and the mechanisms associated with their formation.



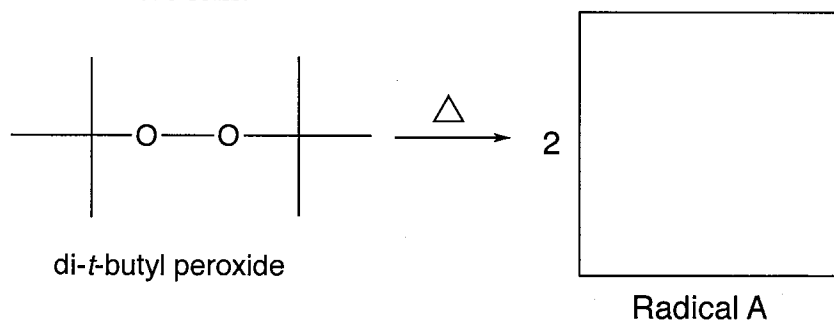
a. For the following chain propagation step, insert all of the arrows required to depict the flow of electrons during conversion of propyl radical to hydrogen atom and Product A. In the labeled box, provide the structure of Product A listed as a product of propane cracking.



b. For the following chain propagation step, insert all of the arrows required to depict the flow of electrons during reaction of hydrogen atom with propane leading to the formation of hydrogen, methyl radical and Product B. In the labeled box, provide the structure of Product B listed as a product of propane cracking.



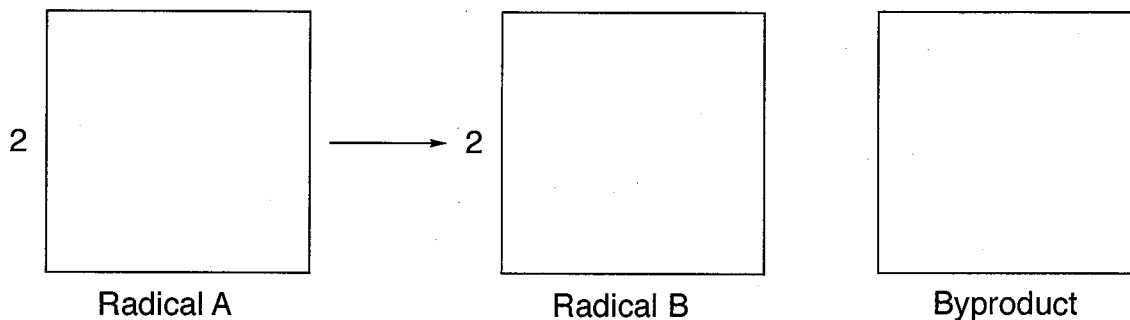
24. (6 points total) Fragmentation of di-*t*-butyl peroxide leads to formation of free radicals that can initiate radical chain reactions.



a. In the provided structure of di-*t*-butyl peroxide, insert the arrows that depict the flow of electrons during its fragmentation.

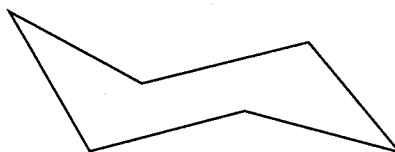
b. Provide the structure of the resulting Radical A in the labeled box.

- c. In the structure you have provided for Radical A below, insert the arrows that depict the flow of electrons during its fragmentation.
- d. Provide the structure of the Radical B in the labeled box that results from the fragmentation of Radical A.
- e. Provide the structure of the Byproduct formed along with Radical B. The Byproduct is NOT a radical.

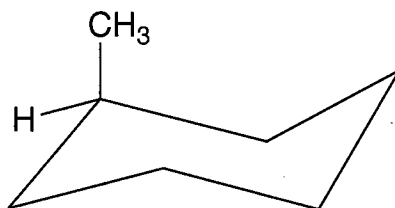


25. (6 points total)

- a. In the chair conformer of cyclohexane provided below, draw in all of the axial hydrogen atoms in their correct positions and orientations.

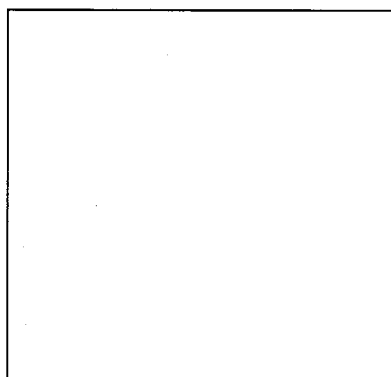
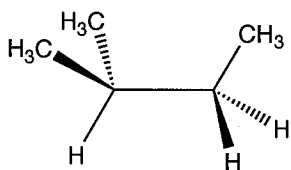


- b. In the methylcyclohexane conformer provided below, draw in the hydrogen atoms that have steric interactions with the methyl group.



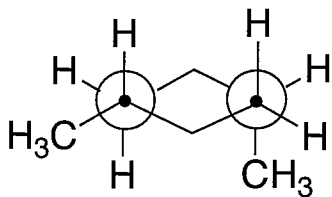
26. (6 points total)

a. In the labeled box, draw the Newmann Projection that corresponds to the provided dash-wedge structure.



Newman Projection

b. Draw the methyl groups on the provided cyclohexane ring in the correct position (1,2; 1,3 or 1,4) and spatial orientation (equatorial, axial) corresponding to the provided Newman projection of dimethylcyclohexane.



Newman Projection

