General Instructions:

(i) Use scratch paper at back of exam to work out answers; final answers must be recorded at the proper place on the exam itself for credit. Models are allowed.

(ii) Print your name on each page.

(iii) Please keep your paper covered and your eyes on your own work. Misconduct will lead to failure in the course.

1. (15 points) Draw a structure that corresponds to each of the following names. Show all atoms in each structure, including hydrogen atoms.

(a) 2-chloroheptane

(b) Z-3-bromo-3-nonene

(c) cyclopentyl-cyclohexane
2. (14 points) For each set of structures shown below, redraw the structures in the order of DECREASING basicity, left to right. (Note: Negative charges are balanced by a sodium (Na) counterion (positive charge).)

(a) \( \text{CH}_3\text{NH}_2 \quad \text{CH}_3\text{OH} \quad \text{CH}_3\text{NH}_2 \quad \text{Na}^+ \quad \text{CH}_3\text{NH} \quad \text{CH}_3\text{NH}_2 \quad \text{CH}_3\text{OH} \quad \text{Na}^+ \quad +7 \)

(b) \( \text{O}^\circ \quad \text{O}^\circ \quad \text{Na}^+ \quad \text{O}^\circ \quad \text{O}^\circ \quad \text{Na}^+ \quad \text{Cl}^- \quad \text{Na}^+ \quad +7 \)

3. (7 points) On the structure shown below, indicate for EACH CARBON ATOM whether that atom is 1°, 2°, 3° or 4°.

\[ +1 \text{ for every 2 correct} \]

\[ \text{All triangles } = 2^\circ \]
4. (20 points)

(a) Shown below is 1,1,1-tribromopentane; draw the energy diagram for rotation about the bond between carbon-1 and carbon-2. Provide an appropriate drawing to identify at least one maximum and at least one minimum in this energy function.

(b) Draw a Newman projection of the most stable conformation about the bond between carbon-2 and carbon-3.
5. (14 points) Provide a mechanism (curved arrows) for the reaction shown below. Show all atoms, bonds and lone pairs in each structure in your mechanism. [Note: The chloride counterion is just a 'bystander' in this process.]

Each correct structure = +2
(+8 total)
+2 pt. wrong structure
- 1 pt. missing charge
- 1 pt. incorrect charge

Each correct curved arrow = +3
(+6 total)
-3 pts. wrong arrow

H₂N\text{Cl}^- + \text{HO}^+ \rightarrow \text{H₃N}^- + \text{HOCl}
6. (30 points)

(a) A hydrocarbon with the formula C₈H₁₂ is exposed to excess H₂ in the presence of Pd/C as catalyst. TWO equivalents of H₂ are consumed, to generate a product with formula C₈H₁₆ (this product does not react further with H₂ in the presence of Pd/C).

Propose THREE possible structures for the starting material C₈H₁₂ (via appropriate drawings).

Many possible correct structures (2 π-bonds + 1 ring) [7] for each correct structure. Examples:

(b) A different hydrocarbon with the formula C₈H₁₂ is exposed to excess H₂ in the presence of Pd/C as catalyst. ONE equivalent of H₂ is consumed, to generate a product with formula C₈H₁₄ (this product does not react further with H₂ in the presence of Pd/C).

Propose THREE possible structures for the starting material C₈H₁₂ (via appropriate drawings).

Multiple correct possibilities (1 π-bond, 2 rings). Violations of Bredt's rule OK. [7] for each correct structure. Examples: