1. Name the following compound. Use the IUPAC system and include stereochemical designations.

\[
\begin{align*}
&\text{CH}_2\text{CH}_2\text{CO}_2\text{H} \\
&\text{H} \quad \text{CH}_2\text{CH}_2\text{CH}_2\text{CHO} \\
&\text{H} \quad \text{CO}_2\text{H} \\
&\text{CH}_2\text{Br}
\end{align*}
\]

2. a) Complete the Newman projection diagrams to show the most stable conformations of meso (on the left) and the (R,R) stereoisomer (on the right) of 2,2,3,4,5,5-hexamethylhexane.

\[
\begin{align*}
&\text{R,S (meso)} \\
&\text{R,R}
\end{align*}
\]

b) Using your answer in part a as the source of information which would you expect to give off more heat when burning 1 mole of the compound, meso or (R,R)? What is your reasoning?

\[
\text{C}_{12}\text{H}_{26} + 13.5 \text{O}_2 \rightarrow 12 \text{CO}_2 + 13 \text{H}_2\text{O}
\]

3. Trinitromethane, \( \text{HC(NO}_2\text{)}_3 \), is a stronger acid than methane. Provide two explanations for the increased acidity. Resonance structures and formal charges should be included in your answer.
4. For each of the following equilibria is the value of the equilibrium constant, K, less than one (L) or more than one (M).

a. \((\text{CH}_3)_3\text{C}^+ + \text{H}_2\text{O} \rightleftharpoons (\text{CH}_3)_3\text{COH}_2^+\)

b. \(\text{HNO}_3 + \text{CH}_3\text{O}^- \rightleftharpoons \text{NO}_3^- + \text{CH}_3\text{OH}\)

c. \(\text{HF} + \text{I}^- \rightleftharpoons \text{F}^- + \text{HI}\)

5. An unknown compound, \(\text{C}_5\text{H}_{11}\text{Br}\), is optically active. Upon reaction with Mg followed by treatment with water \text{2-methyl butane} is produced. The original unknown is unreactive towards alcoholic silver nitrate solution. Suggest a structure for the original unknown compound consistent with the data.

6. A sample of \text{R 2-bromobutane} has a specific rotation of 60.0 degrees and is 50% optically pure. It is reacted with an excess of hydroxide ion to yield \text{2-butanol}.

Optically pure \text{R 2-butanol} has a specific rotation of 80.0 degrees.

If the reaction proceeds with 60% inversion of configuration and 40% racemization predict the specific rotation of the 2-butanol produced by the reaction.
For the following reactions give the missing reactants or products. Show the stereochemistry. Write "NR" if there is no reaction. Put answers on the answer sheet. In some questions you are provided with templates for the answer. Use as many of the templates as needed. If additional templates are needed you should draw identical structures. If you are unsure about the notation ask the monitor.

7.

8.
9. 

\[
\text{CH}(\text{CH}_3)\text{CH}(\text{CH}_3)\text{CH}(\text{CH}_3)\text{OH} \rightarrow \text{TsCl} \rightarrow \text{acetic acid} \rightarrow \text{CH}_3\text{CH}(\text{CH}_3)\text{CH}(\text{CH}_3)\text{OH}
\]

10. 

\[
\text{Cl}_2 \rightarrow \text{light} \rightarrow \text{3 products}
\]

11. 

\[
\text{HO} \rightarrow \text{acid} \rightarrow \text{heat} \rightarrow \text{2,3-Dimethyl-butane-2,3-diol}
\]
Provide efficient synthesis of the following compounds. You may use any alcohols or halides of five or fewer carbons, any inorganic, and any solvent as starting materials. Additionally you may a product requested in an earlier problem in a later problem even if you were not able to provide a synthesis in the earlier problem.

12. *meso* 3,6-dimethyloctane.

13. CH₃CHDCH₃ (You must insert the D into the molecule.)

For the reactions below sketch the transition state of the rate determining step. Be sure to show relative bond strengths and charges.

14. propane + bromine yielding 2-bromopropane (heat, gas phase)

15  a) cyanide ion and methyl iodide to yield CH₃CN

b) [Diagram of reaction between a compound with a iodine at a specific position and acetic acid resulting in an ester with a methyl group and an ethyl group.]
16. Draw two potential energy curves on the provided diagram for the rate determining step in the following reaction. One curve, a solid line, should be for a low polarity solvent while the other, a dashed line, should show the effect of increasing solvent polarity. In which solvent will the reaction occur faster?

\[
\begin{array}{c}
\text{Reactant} \\
\text{low polarity solvent} \\
\text{high polarity solvent} \\
\text{Product}
\end{array}
\]

17. An aqueous solution is made up from 5.0 grams of adipic acid dissolved in 100 mL of water. You wish to extract the aqueous solution with ether so that no more than 0.50 g of the adipic acid remains in the water. The distribution coefficient, \( K_D \), for the ether/water solution is 10.0. What is the minimal amount of ether that will accomplish the task?
Answer Sheet
Your name ____________________

1(6)

2. (6) a b

\[
\begin{array}{c}
\text{C(CH}_3\text{)}_3 \\
\text{R, S (meso)} \\
\end{array}
\quad
\begin{array}{c}
\text{C(CH}_3\text{)}_3 \\
\text{R, R} \\
\end{array}
\]

3 (6)

4 (6) 5(6) 6(6)

A

B

C

7 (6)
Reactant | Product
---|---

- **16 (6)**
  - Reactant: low polarity solvent
  - Product: high polarity solvent

**Legend:**
- --- high polarity solvent
- -- low polarity solvent