1. (5) Name the following compound:

![Chemical structure image]

2. (23) Give the major products of the following reactions. a-e, 3 pts ea.; f and g, 4 pts ea.:

   a) \[
   \text{Li, NH}_3(l) \quad -78^\circ C
   \]

   b) \[
   \text{HgSO}_4, \text{H}_2\text{O} \quad \text{H}_2\text{SO}_4
   \]

   c) \[
   \text{H}_2, \text{Lindlar's cat.} \quad \text{(assume excess H}_2\text{)}
   \]

   d) \[
   \text{C} \equiv \text{CH} \quad \text{excess HBr}
   \]

   e) \[
   \text{HC} \equiv \text{CH} \quad 1) \text{NaNH}_2, \text{NH}_3(l) \quad 2) \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}
   \]

   f) \[
   \text{HC} \equiv \text{CH} \quad 1) \text{Br}_2, \text{hv} \quad 2) \text{2 Li} \quad 3) \text{CuI} \quad 4) \text{(CH}_3)_2\text{CHCH}_2\text{CH}_2\text{I}
   \]

   g) \[
   \text{HC} \equiv \text{CH} \quad 1) \text{Br}_2, \text{hv} \quad 2) \text{Mg in ether} \quad 3) \text{D}_2\text{O}
   \]
3.(12) Propose a sequence of steps (use numbers to distinguish between separate steps) to carry out the following syntheses:

a) \[ \text{HC=CCCH}_{2}\text{CH}_{3} \rightarrow \quad \text{CH}_{3}\text{CH}_{2}\text{CH}_{2}\text{CH}_{2}\text{CH}_{2}\text{CH}_{2} \text{CH}_{2}\text{CH}_{3} \]

b) \[ \text{HC=CH} \rightarrow \quad \text{H}_{2}\text{BrBr} \]

4.(10) A hydrocarbon A has a formula of \( \text{C}_8\text{H}_8 \). Upon treatment with \( \text{H}_2 \) on a Lindlar catalyst, compound B (\( \text{C}_8\text{H}_{12} \)) forms. Further treatment of B with \( \text{H}_2/\text{Pd on carbon} \) (standard hydrogenation) yields C (\( \text{C}_8\text{H}_{16} \)).

a) How many sites of unsaturation does A have? _________

b) How many triple bonds does A have? __________

c) How many double bonds does A have? __________

d) How many rings does A have? __________

\[ \begin{array}{c}
\text{A} \xrightarrow{\text{H}_2, \text{Lindlar's cat.}} \text{B} \\
\text{C}_8\text{H}_8 \quad \text{C}_8\text{H}_{12} \\
\end{array} \]

\[ \begin{array}{c}
\text{B} \xrightarrow{\text{H}_2, \text{Pd on carbon}} \text{C} \\
\text{C}_8\text{H}_{12} \quad \text{C}_8\text{H}_{16} \\
\end{array} \]

Propose structures for A, B and C that fit the above criteria (there are several possibilities).

5.(12) 2-Methylbutane undergoes a free radical chlorination reaction by treatment with \( \text{Cl}_2 \) and light (hv). Draw zig-zag structures of 2-methylbutane and all the possible monochlorination products (disregarding stereoisomers - all are \( \text{C}_5\text{H}_{11}\text{Cl} \)). If the relative reactivity of C-H at \( 1^\circ : 2^\circ : 3^\circ \) positions is \( 1 : 3.5 : 5 \), predict the ratios of the products and show how you arrived at your answer (show work).
6.(28) Draw the major product or products of the following reactions and state the mechanism through which each reaction proceeds (e.g. E2).

a) \[ OTs \quad \text{KCN in DMSO} \quad \text{room temp.} \]

b) \[ \text{OH} \quad \text{H}_2\text{SO}_4, \text{ cat.} \quad \text{distill} \]

c) \[ \text{CH}_3\text{CH}_2\text{C}((\text{CH}_3)_2)\text{Br} \quad \text{ethanol} \]

d) \[ \text{NaOCH}_3 \text{ in CH}_3\text{OH} \quad \text{heat at reflux} \]

e) \[ \text{CH}_3\text{OMs} + \text{OCH}(\text{CH}_3)_2 \quad \text{in acetone} \]

f) \[ \text{Cl} \quad \text{CH}_3\text{OH, warm} \]

g) \[ \text{Br} \quad \text{NaOCH}_2\text{CH}_3 \quad \text{in boiling ethanol} \]

7.(8) Consider the reaction of 3-methyl-1-pentene with N-bromosuccinimide (NBS) and light. Draw the initially formed free radical intermediate, a resonance structure of this intermediate and the two possible bromination products. Circle the major product.

\[ \text{hv} \quad \text{in CCl}_4 \]
The reaction of 1-(1-iodoethyl)-1-methylcyclopentane (A) in methanol gives several products, one of which (compound D) is shown below. The potential energy profile of the reaction is also shown for the formation of this product. Draw the mechanism (use arrows to show electron flow) for the formation of D. In your mechanism, identify intermediates B and C as shown on the reaction profile.