1. Name the following compound. Use the IUPAC system and include configurational (R,S) designations.

\[
\begin{align*}
\text{CHO} & \quad \text{CHO} \\
\text{O} & \\
\text{OH} & \quad \text{CHO}
\end{align*}
\]

2. For the positive ion below draw two additional resonance structures. Of the three resonance structures which is the most stable?

\[
\begin{align*}
\Theta & \quad \text{CHO} \\
\text{OCH}_3 &
\end{align*}
\]

3. Which of the following compounds may be optically active? Answer by letter.

A) meso 2,3 dibromobutane
B) FHC\(=\)C\(=\)C\(=\)CHF
C) FHC\(=\)C\(=\)CHF
4 There are two stereoisomers of 1,6 difluoro bicyclo [4.4.0] decane. Complete either diagram A or B below to represent the stereoisomer having a molecular dipole moment of zero.

5) Consider the reaction of permanganate ion and ethanol to yield acetate ion and manganese dioxide in alkaline solution.

\[ \text{C}_2\text{H}_5\text{OH} + \text{MnO}_4^- \rightarrow \text{CH}_3\text{CO}_2^- + \text{MnO}_2 \]

a) Write the balanced organic half reaction.

b) Write the balanced overall reaction.
6) Squaric acid, shown below, with two acidic hydrogens is more acidic than acetic acid. 
Pka for the first ionization is 1.5 and 3.4 for the second. Account for the acidic nature of 
the compound.

\[ \text{O} \]
\[ \text{HO} \]
\[ \text{O} \]
\[ \text{OH} \]

7. The following compounds are catalytically reacted with excess hydrogen to yield 2-
methyl hexane. Which has the highest heat of hydrogenation (most exothermic) and 
which the smallest (least exothermic). Answer by letter.

![Compounds A, B, C, D]

8. Consider the methane molecule which is shown in diagrams below. Using the 
diagrams clearly indicate the position of the following symmetry elements.

![Methane molecule with labels A, B, C]

A) A reflection plane  
B) A 120 degree proper rotational axis  
C) A 90 degree improper rotational axis
9. Consider the free radical halogenations of alkanes with bromine or fluorine. Here are typical bond dissociation energies (kJ/mol).

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Explain why bromination is a more selective reaction than fluorination.

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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 may be 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.

10. but-2-yne  \[ \text{H}_2 \text{Lindlar catalyst} \]  \[ \text{Br}_2 \]

11. \[ \text{Cl}_2 \text{light} \]

All unique monochloro products
(show stereochemistry)

**Indicate the fraction of each product in the mixture.** (1:4:5)
Provide a synthesis of the following compounds using propyne as the sole source of carbon atoms. You may use a target molecule from an earlier question in a later question even if you were not able to synthesize it in the earlier question. Do not repeat a synthesis of an earlier compound, simply refer to it by letter. (7 points each)

12. propan-2-ol

13. *trans* 4-methylpent-2-ene

14. propylene oxide,

15. 2-isopropoxypropan-1-ol,

16. A simple distillation of an ideal mixture of methanol (25 mole percent) and water (75 mole percent) is done under standard pressure (760 torr). The mixture starts to boil at 75 degrees. The initial distillate is found to be 50 mole percent methanol. What is the vapor pressure of pure methanol at 75 degrees?

(Be sure to put answers on answer sheet.)
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Organic half reaction:

Overall reaction

Highest (most exothermic)

Lowest (least exothermic)
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