What are the missing reactants or final products in the following reactions? Show stereochemistry as appropriate. Write NR for no reaction.

1. 

$\text{dichromate} \rightarrow \text{SOCl}_2 \rightarrow \text{benzene} \rightarrow \text{Zn(Hg)}$

2. 

$\text{CHO} \rightarrow \text{Excess EtOH} \rightarrow \text{dry HCl}$

Cyclohexanecarbaldehyde

3. 

$\text{H}_3\text{C} - \text{Br} \rightarrow \text{base} \rightarrow \text{cold dilute KMnO}_4$
4. CHO

2

conc. NaOD
heat

5. 2-Methyl-but-2-ene

HBr

gas phase, light

6.

O

NaOI

SOCl₂

Et₂CuLi

7.

excess H₂

catalyst
8. 

Answer using as many templates as needed. If you need more than four they should be identical to those above.

9. 

9. 

10. 

an alkene containing one oxygen
11.  ![Chemical structure](image)

12.  

\[
\text{acid} \quad \text{1,1-diphenylethene} \quad \rightarrow \quad \text{compound containing 28 carbons}
\]

Using ethanol and benzaldehyde, PhCHO, as the only source of carbons in the target molecules synthesize the following. **Note:** you **may use** a product from an earlier problem even if you were not **able to synthesize** the earlier compound.

13.  1-phenyl-1-propanol, CH₃CH₂CH(OH)Ph

14.  propyl benzene, CH₃CH₂CH₂Ph

15.  1,2-diphenylethene

16.  An unknown compound, X, has the formula C₆H₁₂O₂. Upon treatment with NaOI a bright yellow precipitate is produced. The Tollens test was negative and there was no reaction with periodic acid. Reaction with DNPH yielded a yellow orange precipitate. There was no reaction with dichromate (acidic) at room temperature. Propose a structure for X.

17.  Propose a reasonable mechanism for the following transformation. Used curved arrows to show electron "motion".

\[
\text{CH₃CH(OH)₂} \quad \text{dil. acid} \quad \text{CH₃CHO} \quad + \quad \text{water} \quad \rightarrow \quad \text{1,1-ethandiol} \quad \text{ethanal}
\]
18. Which of the following would be expected to have the fastest E1 reaction? Answer by letter.
   a) ethyl fluoride and ethanol.                                          b) phenylbromomethane and hydroxide ion.
   c) 1-bromo-1-phenylpropane in acetic acid

19. The careless chemist was attempting to synthesize cyclohexene from cyclohexanol using hydrobromic acid. The reaction mixture was distilled and the distillate washed with cold concentrated sulfuric acid. The product layer was found not to react with bromine in CCl4. Provide an interpretation of what went wrong.

20. Write balanced half reactions and the balanced overall reaction for the oxidation of 2-hydroxy-3-butanone with periodic acid, HIO4, to yield ethanal, acetic acid and iodate ion, IO3⁻.