1. (a) Draw a mechanism for the following reaction. Clearly show how each stereoisomer is produced.

\[ \text{CHCl}_3 \quad \text{KOT-Bu} \quad \text{Cl} \quad \text{Cl} \quad \text{Cl} \quad \text{Cl} \]

(b) Give two reasons why the reaction below would not proceed with conditions analogous to those above and provide reagents that would complete the desired transformation.

1. No acidic H on CH₃Cl.

2. With CH₄ + KOT-Bu, no stable carbene can form.

(Instead use: CH₂I₂, Zn(Cu) ← Simmons-Smith reaction)

3. CH₂ will undergo C-H bond insertion as well.

2. Propose a synthesis for the transformation shown below. More than one step is required. Show any isolated intermediate products.

\[ \text{OH} \quad \text{KOT-Bu} \quad \text{CH₂I₂, Zn(Cu)} \]

\[ \text{CH₂IO} \quad \text{HO-Bu} \]
5. Fill in the product(s) for the following reactions.

6. Show how you would accomplish the following synthesis. Show all steps with reagents over the arrows and intermediate isolable products.
3. Show how you would accomplish this synthesis in two different ways.

First step for both.

1. $\text{Br}_2$,
   $\text{h}_2\text{u}$

2. $\text{KOH}$
   $\text{NaO}_2$

3. $\text{CH}_3\text{OH}$
   $\text{heat}$

4. Show how you would accomplish this synthesis in two different ways.

Use:

1) $\text{TfO}$, pyridine

2) $\text{NaBr}$

$\text{PBr}_3$ (one step)