These problems are typical of those that will be on the upcoming exams in 3720.

1. **From Chapters 12-14:** Show retrosynthetic analyses for each of the following molecules that go back only to the starting materials given below. Then, using any chemistry seen in 3719 and 3720 so far, give an efficient synthesis of each molecule showing the products formed in each step. Assume that you have access to any of the usual reagents such as Br₂, AlCl₃, Fe, HBr, HNO₃, H₂SO₄, etc.

   a. \[\text{starting materials}\]
   b. \[\text{starting materials}\]
   c. \[\text{starting materials}\]
   d. \[\text{starting materials}\]
   e. \[\text{starting materials}\]

2. **From 14 and 15:** Give structures of the products from each step within the following “roadmap” and match the spectral data to the product.

   - Br₂, heat
   - Mg, ether
   - H₂SO₄, H₂O
   - Na₂Cr₂O₇
   - H₃O⁺
3. From 12-15: Give structures of the products from each step in the following reaction sequences.

a.  
1. Br₂, heat  
2. 2 Li, ether  
3. CH₃CHO  
4. H₃O⁺  
5. HBr

b.  
1. CH₃COCl, AlCl₃  
2. LiAlH₄, ether  
3. H₃O⁺  
4. NaH, ether  
5. CH₃CH₂Br

c.  
1. NaBH₄, CH₃OH  
2. HBr  
3. 2 Li, ether  
4. CH₃CH₂CHO  
5. H₃O⁺

d.  
1. H₂SO₄, H₂O  
2. Na₂Cr₂O₇, H₂SO₄  
3. PhMgBr, ether  
4. H₃O⁺  
5. NaH, ether  
6. CH₃CH₂CH₂Br

e.  
1. PDC, CH₂Cl₂  
2. CH₃Li, ether  
3. H₃O⁺  
4. Na₂Cr₂O₇, H₂SO₄  
5. PhMgBr, ether  
6. H₃O⁺

f.  
1. CH₃COCl, AlCl₃  
2. HNO₃, H₂SO₄  
3. NaBH₄, CH₃OH  
4. NaH, ether  
5. CH₃CH₂CH₂Br
4. From 1-15: Design syntheses of the following molecules using any of the chemistry seen so far in 3719 and 3720 and using only the sources of carbon shown below. Again, assume that you have access to all of the common inorganic reagents (Br₂, AlCl₃, Fe, HBr, etc.).

a. 

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\begin{align*}
\text{O} & \quad \text{Cl} \\
\text{NH₂} & \quad \text{HO} & \quad \text{H} & \quad \text{O} \\
\text{OCH₃} & \quad \text{CH₃Br} & \quad \text{OH} & \quad \text{H} & \quad \text{O} \\
\end{align*}
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b. 

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\begin{align*}
\text{HO} & \quad \text{HO} & \quad \text{HO} \\
\text{CH₃} & \quad \text{OH} & \quad \text{H} & \quad \text{O} \\
\text{CH₃Br} & \quad \text{CH₃Br} & \quad \text{CH₃Br} & \quad \text{CH₃Br} & \quad \text{CH₃Br} \\
\end{align*}
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c. 

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\begin{align*}
\text{OH} & \quad \text{CH₃Br} & \quad \text{CH₃Br} & \quad \text{CH₃Br} & \quad \text{CH₃Br} \\
\text{OH} & \quad \text{OH} & \quad \text{OH} & \quad \text{OH} & \quad \text{OH} \\
\text{CH₃Br} & \quad \text{CH₃Br} & \quad \text{CH₃Br} & \quad \text{CH₃Br} & \quad \text{CH₃Br} \\
\end{align*}
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d. 

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\begin{align*}
\text{OH} & \quad \text{CH₃CH₂OH} & \quad \text{CH₃CH₂OH} & \quad \text{CH₃CH₂OH} & \quad \text{CH₃CH₂OH} \\
\text{OH} & \quad \text{OH} & \quad \text{OH} & \quad \text{OH} & \quad \text{OH} \\
\text{CH₃CH₂OH} & \quad \text{CH₃CH₂OH} & \quad \text{CH₃CH₂OH} & \quad \text{CH₃CH₂OH} & \quad \text{CH₃CH₂OH} \\
\end{align*}
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