“Don’t look back; someone might be gaining on you.”—Satchel Paige, baseball player

1) Bourgenol, shown below, has been found to be a strong chemiotaxis agent for spermatazoa. Starting with benzene and any organic of four or fewer carbons, propose a synthesis.

A relatively straight-forward synthesis. Here is how I saw it:

There were also two alternatives presented, differing only after the synthesis of tert-butylbenzene. Here they both are starting at that point:
2) Identify the reagents represented by the letters a-e in the following scheme:

[Diagram of chemical reactions]

Here are the reagents as I saw them:

- **a** = CH₃CH₂COCl, AlCl₃
- **b** = NH₂NH₂, KOH
- **c** = Br₂, FeBr₃
- **d** = NBS, CCl₄
- **e** = t-butoxide, t-butanol

3) Cyclopentanone, when treated with ammonia, followed by reduction with H₂/Pt, yields **G** (C₅H₁₁N), which, when treated with nitrous acid, yields **H** (C₅H₈) plus other, unidentified products. **H** reacts with buta-1,3,-diene to yield **I** (C₉H₁₄), which reacts with cold, alkaline KMnO₄ to yield **J**. **J**, upon treatment with acetone and aqueous acid, yields **K** (C₁₂H₂₀O₂), which is determined to be a tricyclic compound. Propose structures for **G** through **K**, paying particular attention to stereochemistry.

The biggest issue here is to pay attention to the stereochemistry. Here is how I saw these compounds:
4) Propose a mechanism for the following reaction:

This was a fun mechanism. It took a bit of vision to see the opening of the ring, then the new closure. Here is how I saw it:
5) Draw the expected product from each of the following reactions:
a) 

Even though this is the expected product, I am not totally sure I agree with it insofar as I can see other products; however, it is correct.

b) 

Try not to over analyse this one, as it is simply a reduction of a carboxylic acid

c) 

Did you forget that both carboxylic acids and terminal alkynes are acidic? That consumes 2 of the three equivalents, leaving only one to do any addition chemistry:
Here, a simple hydrolysis of an ester.

One equivalent goes in simple acid-base chemistry, and the second removes the $\alpha$-proton. Addition yields the *endo* product, as shown:

6) Draw the expected Claisen rearrangement product from each of the following compounds:
Did you forget to tautomerize, and regain the *ca.* 30 kcal/mol aromatic stabilization energy? Here is the product.

7) Propose a mechanism for the following reaction:
Well, since conditions aren’t given, there are two possibilities: a [2+2] pathway, and a [4+2] pathway. I’ll give both, since I gave credit for both:

[2+2] pathway

[4+2] pathway

retro [2+2]