1) Explain the reason for the different chemical reactivity of cyclopentadiene and cycloheptatriene toward bromine.

Both no doubt start by the addition of bromine in the usual fashion to one of the double bonds, giving (ultimately) a cyclic bromonium ion. In the case of cyclopentadiene, there are, in fact, two bromonium ions: one arising from the formal 1,2-addition of bromine (1 below), and one arising from formal 1,4 addition of the bromine (2 below). Normal nucleophilic attack of the bromide ion floating around, as shown, yields the two different products.
In the case of cycloheptatriene, however, addition in the formal 1,2 sense gives a cation which, in addition to being resonance stabilized, is also just an hydrogen cation loss away from being aromatic. Remember that aromatic stabilization is quite a driving force. (Shown below)

2) Cyclopropenone is a surprisingly stable molecule. Draw another resonance form for cyclopropenone and explain how it might contribute to the overall stability of this molecule.
After what we did in class the other day, this one should have been easy. The polar resonance form, as shown, puts the negative charge on the oxygen (where it belongs, in a commonsense way) and the positive charge on the carbon, forming an aromatic cation.

3) Pyridine and pyrrolidine react rapidly with dilute aqueous HCl to form the corresponding hydrochloride salts. However, pyrrole, which is another nitrogen containing heterocycle, does not react under these conditions. Explain.

In pyrrole, the lone pair on the nitrogen which normally would be basic is also part of the aromatic system; use of this lone pair in a basic fashion would disrupt the aromatic sextet, and lead to a huge loss of energy.

4) Experimental evidence suggests that borazine is a planar molecule with identical B-N bonds lengths and bond angles. On the basis of this information, make any
corrections of additions to the drawing shown below to complete the structure of borazine (B$_3$N$_3$H$_6$).

![Borazine structure](image)

Basically, just need a picture.

![Birch reduction](image)

5) Depending on the electronic nature of the group G, Birch reduction gives either A or B as the major (often the only) product in the following reduction:

![Birch reduction reaction](image)

If G is electron-donating, B is formed; if G is electron-withdrawing, A is produced. Provide a mechanistic explanation for the observed regiochemistry of the Birch reduction.

Remember that the last step of the Birch reduction is addition of H$^+$ to an anion. Therefore, anything which can stabilize an anion adjacent to it (such as an electron-withdrawing group) will make that a better reaction. Conversely, anything which destabilizes an adjacent anion makes that a worse reaction. Therefore, an anion ipso (Latin for same) to an electron-withdrawing group is good, and ipso to an electron-donating group is bad. Mechanistically, it is:
Electron-withdrawing

Electron donating

Electron-withdrawing
6) γ-Pyrone is protonated much more readily (= more basic) than acetone. Explain why.

Protonation of the carbonyl of pyrone leaves an empty p-orbital in the ring, which completes the cyclic periphery of p-conjugation.

7) Cyclobutadiene not only is not aromatic, but also is extremely unstable. However, it has been generated as a short-lived intermediate that rapidly reacts with itself to give a new compound with the molecular formula C₈H₈. Identify this compound and explain how it is formed.

The molecular formula looks like exactly twice the molecular formula for cyclobutadiene; perhaps a dimer forms. The question then is: how does this dimer form? We have a diene which must be in the s-cis form, and an ene (part of the diene), both of which want to escape their horrible plight. Here is the structure, and a pseudo-mechanism:

8) Propose a synthetic sequence needed to synthesize the following bicyclic product from the starting material indicated. You may also use any other necessary organic or inorganic reagents for your synthesis.
Well, forming a six-membered ring usually involves Diels-Alder reaction, so we know we need to make one. The scheme below should work.