1. For the following hydrocarbon, **NAME** each type of proton (e.g. $2^\circ$ alkyl, vinylic, etc.) in the spaces provided below. Secondly, put the protons in order of their ease of abstraction/removal (i.e. lowest bond dissociation energy)?

   $\text{Ha} =$  
   $\text{Hb} =$  
   $\text{Hc} =$  
   $\text{Hd} =$  

   **Ease of abstraction:**  
   $\text{____} > \text{____} > \text{____} > \text{____}$  
   **Bond energy:**  
   $\text{____} > \text{____} > \text{____} > \text{____}$

2. The following steps are in a random order. Using the spaces provided to the right, identify the following steps as either *initiation (I)*, *propagation (P)*, or *termination (T) steps* in the following free radical mechanism.

   A.  
   B.  
   C.  
   D.  
   E.  
   F.  

3. Arrange the following radical intermediates in order of stability. (What did we say that “Ph” stands for?)

   A  
   B  
   C  
   D  
   E  

   $\text{____} > \text{____} > \text{____} > \text{____} > \text{____}$
4. Draw the propagation mechanism steps for each of these reactions.

   a. butane + bromine $\rightarrow$ HBr + 1-bromobutane
   b. butane + bromine $\rightarrow$ HBr + 2-bromobutane
   c. butane + chlorine $\rightarrow$ HCl + 1-chlorobutane
   d. butane + chlorine $\rightarrow$ HCl + 2-chlorobutane

5. Using BDE tables from the book, calculate the change in enthalpy for each step in these reactions, and the overall change in enthalpy for the reactions.

6. Use the Hammond Postulate to explain why 2-bromobutane is formed in preference to 1-bromobutane.

7. Use the Hammond Postulate to explain why bromination of butane is more selective than chlorination of butane.

8. Provide the major product(s) for the reaction conditions provided below (showing stereochemistry if necessary).