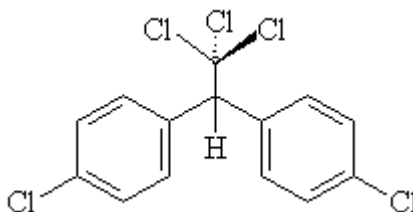


WUCT: Chemistry of Farming Sample Questions

1. DDT, or dichlorodiphenyltrichloroethane, is an organochlorine which was developed as an insecticide. It has become infamous in history for its detrimental environmental impacts. Although DDT contains several components, the major component (77%) is the *p,p'* isomer, which is shown below.

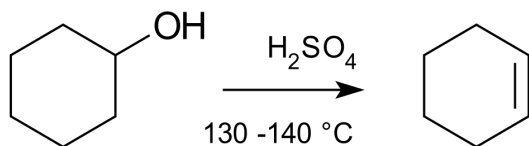


- a. DDT is highly hydrophobic and insoluble in water, despite the existence of several chlorine atoms. Using the structure above, explain this phenomena.

- b. On the structure above, label every carbon atom with its hybridization and geometry.

- c. Write the molecular formula for the DDT structure shown above.

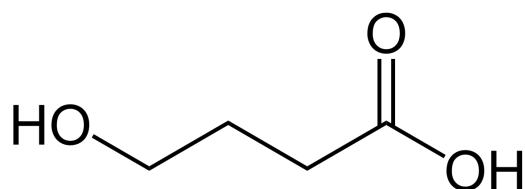
- d. An elimination reaction is an organic reaction in which two substituents are removed from a molecule and a double bond is formed between the two. An example of an elimination reaction is shown below, where the two substituents are hydroxide and hydrogen groups.



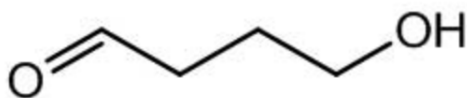
DDT can undergo an elimination reaction, where the two substituents that are lost are hydrogen and chlorine. **Using structures, show the elimination reaction that DDT undergoes and the resultant molecule.**

- e. When DDT is synthesized, there are several impurities that must be removed before use. Agricultural chemists often use distillation to separate compounds. Explain the purpose of **vacuum distillation, boiling chips, and Bunsen burners** in distillation **respectively**.

- f. Say that two compounds are involved in these agricultural separations are 4-hydroxybutanal and 4-hydroxybutanoic acid. The structures are shown below. Each is kept in a flask and distillation is performed to separate the two. Which compound will be remaining in the flask after the procedure is completed? Hint: think boiling points and polarity.



4-hydroxybutanal



4-hydroxybutanoic acid

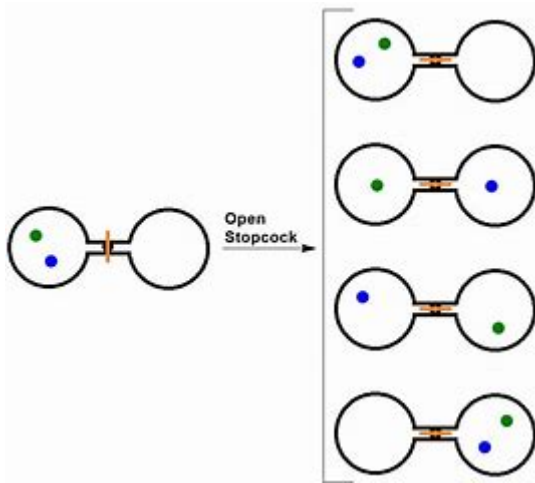
2. Determining favorabilities of different chemical reactions in agricultural chemistry is extremely important, whether this is in the form of Gibb's free energy, K_{sp} values, or entropy.
- a. Dissolving compounds is extremely important in agricultural chemistry. The molar solubilities and K_{sp} values for different compounds is important in understanding how much of a compound will dissolve in a solution.

The K_{sp} value of PbI_2 in pure water at room temperature is $1.4 \cdot 10^{-8}$. An excess PbI_2 is added to two solutions.

Solution 1 contains 50 mL of 0.10 M $Pb(NO_3)_2$ aqueous solution. Solution 2 contains 600 mL of 0.005 M KI aqueous solution.

In which solution will more PbI_2 dissolve? Show all work.

- b. The following diagram shows the possible number of microstates for a two chamber container with two gas particles.



For two gas particles, there are four possible microstates. For a five atom system, how many possible microstates exist? Show all work

- c. The efficiency of photosynthesis is a topic of great interest for agricultural chemists.

The reduction of each mole of CO_2 to hexose level requires 2 moles of NADPH. Forming 2 mol of NADPH needs 4 mol of electrons by photosystem I. Hence, eight photons total are needed to generate the required NADPH for reducing a single mole of CO_2 to the level of hexose.

The ΔG° for the reduction of CO_2 to the level of hexose is 477 kJ/mol. A mole of 660 nm photons has an energy content of 199 kJ.

Determine the energy efficiency of photosynthesis under standard conditions.