1. $^1\text{H}$, $^{13}\text{C}$, and HSQC spectra of 5-hexen-2-ol are (CH$_2$=CHCH$_2$CH$_2$CHOHCH$_3$) shown on the accompanying pages. Make as many assignments as you can on all the spectra, including measuring J values.

see figures

2. Drawing a COSY spectrum like you would expect for this compound. Briefly explain why the different cross peaks would appear where they do.
3. a. Write a stepwise mechanism for the following ester forming reaction. Include several curved arrows to show the direction of electron flow.

b. The reaction is not balanced as written. What is missing? H₂O on right side.

c. This type of reaction establishes an equilibrium between reactants and products. How would one drive this reaction to completion? How is this reaction different from the ester synthesis carried out in lab (in terms of what technique you would use to drive it to completion)?

The acid and alcohol are built into one molecule. You cannot drive the reaction to completion by adding a large molar excess of carboxylic acid, as we did in lab with the acetic acid. One would need to “forcibly” remove water, for example using a drying agent of some kind. Often a Sohlet extractor is used in which the reaction solvent refluxes up to a condenser, then drips back down into a porous cup containing anhydrous magnesium sulfate, or similar solid drying agent. The cup allows dry solvent to run back into the reaction flask. Or, a Dean-Stark trap can be used to remove water by azeotropic distillation.

4. Once the above reaction was done, what steps would you take to separate the product ester from unreacted starting material and acid catalyst, and prepare the sample for analysis by IR or NMR?
Extract the reaction with aqueous NaHCO₃ and (most likely) an organic solvent such as ether, separate phases, dry the organic phase with anhydrous magnesium sulfate, filter, evaporate solvent in a tared rb flask.

5. Draw three isomers with the formula C₆H₁₂O and tell how you would distinguish them using infrared spectroscopy.

One possible set, among many (frequencies in wavenumbers cm⁻¹):

![Chemical structures](attachment:image.png)

OH 3300
C=C str 1600
C=C-H 3000
C-O 1100
C=O 1715
C-O 1100

6. What are three important, potential hazards in the organic lab? How do we protect ourselves from these hazards?

a. Exposure to volatile inhaled toxic compounds. Handle volatile chemicals in the fume hood, making sure the sash is down and air flow not obstructed.

b. Exposure to toxic compounds through absorption through the skin. Wash hands frequently; use neoprene gloves (not light blue exam gloves) in cases that warrant extra protection. (Gloves have their own hazard of decreased manual dexterity, which can lead to spillage or breakage.)

c. Fire. Flames are banned from the lab. Volatile solvents are handed in fume hood, and in small quantities. Minimum amounts of chemicals, which could act as fuel for a fire, are stored in the lab.

others possible.
NB there are only TWO J-values here, because this is two doublets, overlapping.