

CHEM-342 Introduction to Biochemistry

Prof. Essigsauere's Dilemmas

(Taken from the mid-term exams in 1997, 2000, and 2002)

1. Professor Essigsauere returned to his lab one night to prepare for a lecture demonstration based on the experiment presented in the second paragraph of Section 11 in Stokes' 1864 article. Within minutes he was looking high and low for the glacial acetic acid and mumbling angrily about associates who don't replace the things they use up. Frustrated, but undaunted, he figured any acid would do and substituted concentrated hydrochloric acid. After all, he reasoned, a stronger acid should work even better. — Not so. Sure enough the hemoglobin solution turned brown immediately upon addition of HCl but, much to his initial puzzlement, the resulting hematin did not extract into the ether layer.

Please explain in chemical terms why HCl cannot be substituted for glacial acetic acid in this experiment. Please feel free to draw chemical structures and diagrams to support your argument. If you are uncertain of the explanation, please outline the possibilities you would consider as explanations or how you analyzed the problem.

2. Professor Essigsauere is back in the lab playing around with paper chromatography this time. Having failed in his initial quick-and-dirty attempts at getting hematin to migrate using diethyl ether or distilled water as a solvent system, he has started rummaging around the lab looking for other solvents to try. Unfortunately, his impatience is getting in the way of a more systematic approach.

Based on your experience and understanding:

Why didn't diethyl ether or water work as a chromatography solvent for hematin?

What solvents or solvent mixtures do you think Dr. Essigsauere should try next?

Provide a clear explanation for your recommendations.

3. When Professor Essigsauere first tried to repeat the experiment in Section 11 of Stokes' article he was in a hurry (as usual) and tried to cut corners. As described, he added an equal volume of ether to his dilute solution of blood. Then he added the glacial acetic acid to the mixture until the color turned brown and mixed it gently until the hematin extracted into the ether phase. After washing the ether layer once, his patience began to wear. Rather than washing the ether layer until the hematin precipitated at the interface, he went directly to the last step and added some bicarbonate solution expecting to have the hematin transfer into the aqueous layer. Fortunately, he was wearing lab goggles and protective gloves because the solution erupted in froth and overflowed the container spilling all over his hands.

What is the purpose of washing the ether layer? Draw a picture or equation of what is happening.

Why did the solution erupt when the bicarbonate was added? Write an equation to help explain your answer.

Would the solution have erupted in froth had Prof. Essigsauere used a dilute ammonia solution rather than bicarbonate? Explain.