University of Massachusetts Boston June 17, 2008
Department of Chemistry
Chemistry Doctoral Program
Green Chemistry Track
Written Qualifying Exam
Physical Chemistry

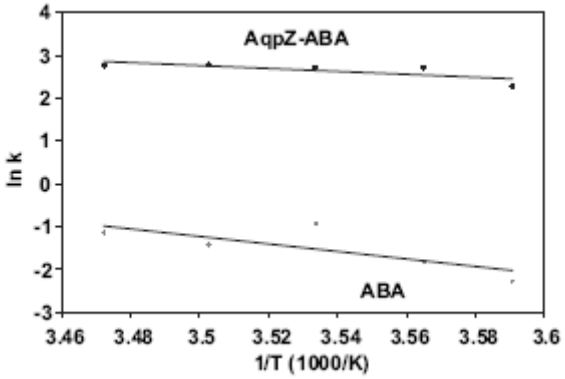
Questions are based on the following article:
Kumar M, Grezalowski M, Zilles J, Clark M, Meier W (2007) *Proc Natl Acad Sci USA* 104:20719-20724.

1. The transport of molecules across a membrane may be *active* (using input energy the molecules move against a concentration gradient) or *passive* (molecules spontaneously move from one region of higher concentration to one of lower concentration). Describe briefly the thermodynamics of passive transport. *(2 points)*

2. Peter Agre (John Hopkins University) was awarded the 2003 Nobel Prize in Chemistry for his discovery of Aquaporins. What are the Aquaporins? *(2 points)*

3. Kumar *et al.* have reconstituted bacterial Aquaporin Z (AqpZ) into synthetic lipid-bilayer-like PMOXA-PDMS-PMOXA (ABA) membranes. They have used *microscopic and light scattering techniques* to investigate the solute and water transport properties and physical characteristics of these polymer/protein hybrid (AqpZ-ABA) vesicles. What are the fundamentals of these techniques and what type of information were gained by each technique? Propose at least one additional experimental method that might be used for characterization of polymer vesicles. *(3 points)*

4. Using the relevant equations explain how the following *Arrhenius plots* have helped to decide whether the water transport across vesicle membranes is diffusion-driven or channel-mediated? *(3 points)*



5. ***(Green Chemistry Question)*** What properties make Aquaporins incorporated into synthetic polymer membranes attractive candidates for sustainable water treatment applications? *(2 points)*