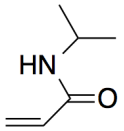
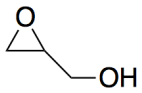
Problem 1 Polymer chemistry (20 points)

(a) For each of the following monomers, give the preferred method of polymerisation (including type of reaction, reagents and conditions needed), and the structure of the resulting polymer (give only one answer per case, also when more answers are possible) (6pts).





(b) Thermal polymerisation of a mixture of 1,6-diaminohexane and 1,6-hexanediodic acid in 1:1 molar ratio leads to a solid polymer product. For this reaction, answer the following questions and explain your answers : (6pts)

(i) Give the chemical structure of the polymer,
(ii) Explain how the molecular weight increases with conversion
(iii) How does an excess of 1,6-diaminohexane influences the molecular weight of the polymer product when conversion is complete.

(c) Analysis revealed that the product of the above polymerisation reaction consist of the following weight fractions:

Fraction	Mass (mg)	mw						
1	1.23	12500						
2	1.145	25000						
3	1.01	40000						
4	0.95	80000						
5	0.88	120000						
6	0.74	160000						

From these data calculate the number averaged molecular weight, the weight averaged molecular weight, and the polydispersity index (you can use the empty columns in the Table above) (4pts)

(d) Is the polydispersity index in line with your expectations for this particular polymerisation reaction? Explain your answer (4 pts).

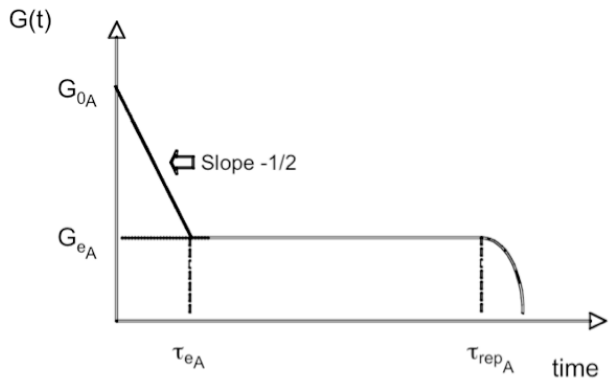
QUESTION 2: Polymer properties (20 points) (4x5)

a) A polymer chain as a given size in theta conditions. It is then placed in a good solvent. If the Khun length remains the same, would the chain in good solvent expand or shrink? Express the size of the chain in good solvent in terms of the size of the chain in theta conditions.

b) For two different cooling rates, draw schematically what you would expect for the variation of the volume of a polymer melt sample if you would cool it down through the glass transition.

c) A step-strain experiment is carried out on a polymer melt and data is schematically plotted on the figure. on a semi-log scale. Is this an entangled polymer melt? Explain.

d) A second step-strain experiment is carried out on a polymer melt with same chemical structure but 2 times longer. Plot schematically on the figure of the first polymer melt what you believe the the response of the second experiment would be.



QUESTION 3': Colloids (25 points) (3x5 + 10 for last one)

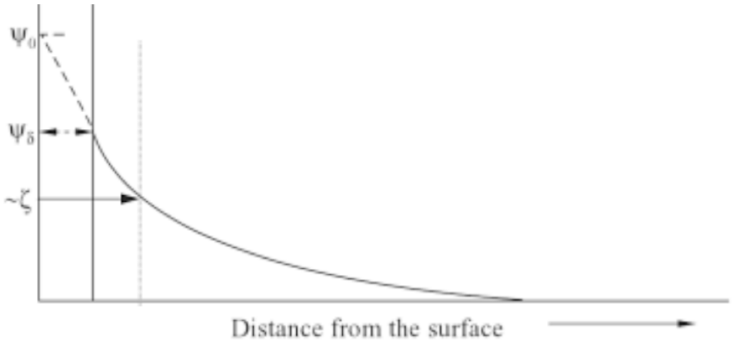
a) Explain what is coagulation and what is flocculation. Explain the difference between them?

b) An ionic colloidal dispersion is prepared in water. Plot on the same graph three curves representing the total potential energy between two colloidal particles versus separation between their surfaces for the following situations: a) unstable dispersion. b) critical dispersion and c) stable dispersion.

Note: plot curves a, b and c on the same graph.

c) What is depletion zone and depletion interaction ?

d) The figure represents the electrostatic potential as a function of distance starting at the surface of a charged colloidal particle. Draw on the same curve what will you expect for this potential if salt is added to the dispersion.



Problem 4 Interfaces and surfactants (25 pts)

(a) Rank the following liquids in order of increasing surface tension, and explain your answer briefly in terms of the relevant intermolecular interactions (5 pts):
ethanol, pentane, acetic acid, water

A common method to change the interfacial properties is to cover the surface with a monolayer of an organic substance, for instance by adsorbing alkyl thiols to a gold surface. One way to characterise such monolayers is to measure the contact angles of droplets of liquids placed on the surface.

(b) The formation of self-assembled monolayers like alkyl thiols on gold proceeds through at least 3 characteristic stages. Describes each of these stages in terms of intermolecular contacts, molecular surface area, monolayer thickness and order, and illustrate your answer with a schematic drawing (5 pts).

(c) Give a schematic drawing of a liquid droplet on a solid surface with the proper directions of the interfacial tensions $\gamma_{liquid\text{-}air}$, $\gamma_{liquid\text{-}solid}$, $\gamma_{solid\text{-}air}$ (5pts), and give the expression for the contact angle θ as function of $\gamma_{liquid\text{-}air}$, $\gamma_{liquid\text{-}solid}$, $\gamma_{solid\text{-}air}$.

(d) Show that $\gamma_{solid\text{-}air} > \gamma_{liquid\text{-}air} + \gamma_{liquid\text{-}solid}$ is the boundary condition for complete wetting of the surface by the liquid (5 pts).

(e) Rank the liquids of question 4a according to their wettability of a dodecylthiol monolayer on gold. Explain your answer (5pts)