

Midterm, Engineering Chemistry, CHE F214, Karthik Chethan V., BITS-Pilani, Hyderabad Campus, Oct 31, 2022, Duration: 90 minutes, open book, Total Marks: 60. There is a total of six questions. PS: 1) If any question contains the word JUSTIFY, then it means, reasoning is required. 2) keep answers short, you can use phrases it is sufficient and writing chemical structures is required wherever necessary. Do not simply cut and paste mindlessly from ppt or other sources and write it as answers. While illustrating plots, make sure the 'x' and 'y' axes are labelled properly with units, comprehensive and short answers are highly valued.

1. a) Develop a mind map for esterification reaction- and write in landscape format, similar to class discussions, the mind map should be complete, logical and relevant. A mind map that contains the important issues discussed in class in regards to esterification will be highly valued. **[Total = 10 M]**

2. a) Ludwig Boltzmann played a huge role in describing a material property (the most probable macrostate) as one that contains the highest number of microstates (contribution from individual molecules or particles). The statistical approach was significant in regards to accounting for huge number of molecules or particles in materials and also in being able to visualize how individual molecules or particles combine to describe the macroscopic material property. Since statistical approach involves a lot of molecules or particles and a lot of combinations of their individual attributes, rolling of dice, arranging of books in shelves, playing cards etc. have been used as common examples to understand statistical entropy.

With this as the preamble, consider a scenario wherein 3 dice are rolled (obviously the dice have six sides and are rolled simultaneously, assume that a large number of attempts are made),

a) determine the total number of combinations that are possible when 3 dice are rolled **[1 M]**

b) determine the total of the dice that is repeated highest number of times (if two different values of dice total are possible wherein they are repeated highest number of times, then just consider one value of the dice total, it is your choice) **[2 M]**

c) list all the combinations that are possible in obtaining that dice total **[3 M]**

d) determine the number of combinations that are possible to obtain that dice total **[1 M]**

e) calculate the probability for that dice total **[1 M]**

f) determine individual probabilities of each dice in obtaining the probability for that dice total and justify with a short explanation the values of the individual probability of the 3 dice **[4 M]**

g) since rolling of dice are common examples for statistical understanding of material property, in one word, answer the following, what does dice refer to, what does the six different values of dice refer to, what does the number of combinations in obtaining the dice total refer to, what does the dice total refer to and finally what does the total number of attempts of rolling the dice refer to **[3 M]**. **[Total = 15 M]**

3. a) Illustrate a Langmuir type of isotherm wherein mass transfer difficulties and diffusional constraints are significant for a certain adsorbate and adsorbent pair that exhibit good degree of compatibility **[3 M]**. b) Since increasing temperature has been one of the common ways in overcoming mass transfer difficulties, assume the temperature has been increased significantly and now on the same plot illustrate a second Langmuir isotherm for that higher temperature for the same adsorbate and adsorbent pair. Justify your illustration with a short explanation, consider issues encountered in increasing temperature **[5 M]**.

[Total = 8 M]

4. Epoxy and phenol formaldehyde (PF) crosslinking polymers dominate in aerospace and defence industries. a) Illustrate the crosslinked final structure of both epoxy and PF, label the reactants neatly **[2 M]**, b) on those illustrations, indicate the crosslink or network points **[2 M]**, c) list the similarities between epoxy and PF crosslinking reaction and final crosslinked structure **[3 M]** and d) list the differences between epoxy and PF crosslinking reaction and final crosslinked structure **[3 M]**.

[Total = 10 M]

5. Illustrate a sugar-water phase diagram wherein the 'x' axis is the wt% of sugar in water and ranging from 0% to 100% and 'y' axis is temperature in Celsius, label the regions and phases on the phase diagram.

[Total = 7 M]

6. a) In general, for the same molecule (for ex: diatomic molecules like chlorine, iodine, bromine, HCl), write the order of heat capacity for solid, liquid and gaseous states for the same molecule in descending order of its value (highest to lowest) **[1 M]**. b) Justify your heat capacity order for the various states with a short explanation **[4 M]**. c) for each of the functional groups discussed in class, list two molecular compounds that contain these functional groups, proper nomenclature is valued, writing structure is not required **[5 M]**.

[Total = 10 M]