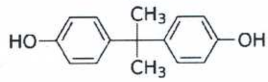
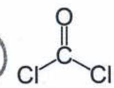
National Chung Hsing University / Polymer Synthesis / Spring 2013
Homework 2

Name________________________

1. Polycarbonate is made by mixing 20 kg bisphenol A with 15 kg phosgene in a batch reaction. What are the maximum number-average chain length, $\bar{x}_n$, and maximum number average molecular weight, $\bar{M}_n$, of this polymer? (1 point)

(A)  M.W. = 228 (B)  M.W. = 99

Bisphenol A — Phosgene

moles of bisphenol A : $2\times10^4 (g) / 228 (g/mol) = 87.7$ moles
moles of phosgene : $1.5\times10^4 (g) / 99 (g/mol) = 151.1$ moles
⇒ A is the monomer limits the reaction.

$\bar{X}_n = \frac{r+1}{-2rP_A+r+1}$, $r = N_{A0}/N_{B0} = 0.58$, for $\bar{X}_{n\,max}$, $P_A \to 1$

$\Rightarrow \bar{X}_{n\,max} = \frac{0.58+1}{-0.58+1} = 3.76$ #

$\bar{M}_{n\,max} = \bar{X}_{n\,max} \times$ (molecular weight of repeat unit) $= 3.76 \times (228+99-2\times(36.5)) = 955$ g/mol #
(molecular weight of HCl)

2. For 10 moles of ethanediamine ($H_2N\text{-}CH_2CH_2\text{-}NH_2$) were reacted with 10 moles of adipic acid ($HOOC\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}COOH$). After the reaction, a titration was performed using NaOH (which reacts with COOH) and an indicating dye to determine the number of adipic acid groups remaining free after the polymerization. If 100.0 mL of 2.0 M NaOH were required to neutralize the polymer, what is the average molecular weight ($\bar{M}_n$) of the polymer? (1 point)

0.1 L × 2M = 0.2 moles of NaOH → System is with 0.2 moles of -COOH end groups.
→ system is with 0.2 moles of polymer

10 moles of monomers are distributed among 0.2 moles of polymer
→ each polymer is with $10/0.2 = 50$ repeat units on average

$\bar{M}_n = \bar{X}_n \times$ (molecular weight of repeat unit) $= 50 \times (170\ g/mol) = 8500$ g/mol. #

$H\!\left[HNCH_2\text{-}CH_2\text{-}NH\text{-}OC\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}CO\right]_n OH$