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

Name_

Bisphenol A $M \cdot W = 228$ $M \cdot W = 99$		
Bisphenol A Phosgene Moles of bisphenol A: $2 \times 10^{6} (9) \times 28 (9_{md}) = 89.7 \text{ moles}$ The phosgene is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction. The reaction. The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction. The reaction. The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction. The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction. The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 151.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 951.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 951.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 951.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 951.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 951.1 \text{ moles}$ The reaction is $1.5 \times 10^{6} (9) / 99 (9_{md}) = 10.1 \text{ moles}$ The reaction is $1.5 \times 10^{$	1. Polycarbonate is made by mixing 20 kg bisph What are the maximum number-average chaimolecular weight, \overline{M}_n , of this polymer? (1 point)	enol A with 15 kg phosgene in a batch reaction. n length, \overline{x}_n , and maximum number average
moles of bisphenol $A: 2\times 10^{6}(9)/228(m_{N}) = 87.7 \text{ moles}$ moles of phosgene: $1.5\times 10^{6}(9)/99(g_{mol}) = 151.1 \text{ moles}$ The reaction. $1.5\times 10^{6}(9)/99(g_{mol}) = 151.1 \text{ moles}$	A HO-CH3 OH CH3 OH MA) = 228 B C C M.W.=99
$\begin{array}{l} -2rP_{A}+V+1 \\ \Rightarrow \overline{X_{n_{pow}}} = 3.76 \text{ mosc} \\ \hline M_{n_{mow}} = \overline{X_{n_{mow}}} \times \text{Molecular weight of repeat unit}) = 3.76 \times (2-8+99-2\times(36-5)) = 955.9 \\ \hline M_{n_{mow}} = \overline{X_{n_{mow}}} \times \text{Molecular weight of repeat unit}) = 3.76 \times (2-8+99-2\times(36-5)) = 955.9 \\ \hline 2. For 10 moles of ethanediamine (H_2N-CH_2-NH_2) were reacted with 10 moles of adipic acid (HOOC-CH_2-CH_2-COOH). After the reaction, a titration was performed using NaOH (which reacts with COOH) and an indicating dye to determine the number of adipic acid groups remaining free after the polymerization. If 100.0 mL of 2.0 M NaOH were required to neutralize the polymer, what is the average molecular weight (\overline{M_n}) of the polymer? (1 point) 0.1L \times 2M = 0.2 \text{ moles} \text{ of } \text{NaOH} \longrightarrow \text{System is with } 0.2 \text{ moles of } -\text{CooH} \text{ end groups.} \\ \rightarrow \text{system is with } 0.2 \text{ moles of } \text{polymer.} \\ \rightarrow \text{system is with } 0.2 \text{ moles of } \text{polymer.} \\ \rightarrow \text{each polymer is with } \frac{10}{0.2} = 50 \text{ repeat units. on average.} \\ \hline M_n = \overline{X_n} \times (\text{molecular weight of repeat units.}) = 50 \times (170) = 8500.9 \\ \hline \text{mol.} \\ \hline \text{mol.}$	Bisphenoi A	rhosgene
$\begin{array}{l} -2rP_{A}+V+1 \\ \Rightarrow \overline{X_{n_{pow}}} = 3.76 \text{ mosc} \\ \hline M_{n_{mow}} = \overline{X_{n_{mow}}} \times \text{Molecular weight of repeat unit}) = 3.76 \times (2-8+99-2\times(36-5)) = 955.9 \\ \hline M_{n_{mow}} = \overline{X_{n_{mow}}} \times \text{Molecular weight of repeat unit}) = 3.76 \times (2-8+99-2\times(36-5)) = 955.9 \\ \hline 2. For 10 moles of ethanediamine (H_2N-CH_2-NH_2) were reacted with 10 moles of adipic acid (HOOC-CH_2-CH_2-COOH). After the reaction, a titration was performed using NaOH (which reacts with COOH) and an indicating dye to determine the number of adipic acid groups remaining free after the polymerization. If 100.0 mL of 2.0 M NaOH were required to neutralize the polymer, what is the average molecular weight (\overline{M_n}) of the polymer? (1 point) 0.1L \times 2M = 0.2 \text{ moles} \text{ of } \text{NaOH} \longrightarrow \text{System is with } 0.2 \text{ moles of } -\text{CooH} \text{ end groups.} \\ \rightarrow \text{system is with } 0.2 \text{ moles of } \text{polymer.} \\ \rightarrow \text{system is with } 0.2 \text{ moles of } \text{polymer.} \\ \rightarrow \text{each polymer is with } \frac{10}{0.2} = 50 \text{ repeat units. on average.} \\ \hline M_n = \overline{X_n} \times (\text{molecular weight of repeat units.}) = 50 \times (170) = 8500.9 \\ \hline \text{mol.} \\ \hline \text{mol.}$	moles of bisphenol A: 2x10 (9)/ 2x8	(9/m) = 87.7 moles
$\begin{array}{l} -2rP_{A}+V+1 \\ \Rightarrow \overline{X_{n_{pow}}} = 3.76 \text{ mosc} \\ \hline M_{n_{mow}} = \overline{X_{n_{mow}}} \times \text{Molecular weight of repeat unit}) = 3.76 \times (2-8+99-2\times(36-5)) = 955 \text{ g}. \\ \hline M_{n_{mow}} = \overline{X_{n_{mow}}} \times \text{Molecular weight of repeat unit}) = 3.76 \times (2-8+99-2\times(36-5)) = 955 \text{ g}. \\ \hline 2. \text{ For 10 moles of ethanediamine} (H_2N-CH_2-NH_2) \text{ were reacted with 10 moles of adipic acid} \\ (HOOC-CH_2-CH_2-CH_2-COOH). \text{ After the reaction, a titration was performed using NaOH} \\ (\text{which reacts with COOH)} \text{ and an indicating dye to determine the number of adipic acid groups} \\ \text{remaining free after the polymerization. If 100.0 mL of 2.0 M NaOH were required to neutralize} \\ \text{the polymer, what is the average molecular weight } (\overline{M_n}) \text{ of the polymer? (1 point)} \\ \hline 0.1 L \times 2M = 0.2 \text{ moles} \text{ of } \text{NaOH} \longrightarrow \text{System is with 0.2 moles} \text{ of } \\ -\text{COOH} \text{ end groups.} \\ \hline \rightarrow \text{system is with 0.2 moles} \text{ of } \\ \text{polymer} \\ \hline \rightarrow \text{each polymer is with } \text{ on average} \\ \hline M_n = \overline{X_n} \times (\text{molecular weight of repeat units. on average} \\ \hline M_n = \overline{X_n} \times (\text{molecular weight of repeat unit.}) = 50 \times (170) = 85003 \\ \text{mol.} \\ \hline mo$	moles of phosgene: 1.5×10(9)/99	(3md) = 151.1 moles the reaction.
$\overline{X_{n_{pow}}} = \overline{X_{n_{max}}} \times (\text{Molecular Weight of repeat unit}) = 3.76 \times (2 - 8 + 99 - 2 \times (36.5)) = 955 \text{ g}$ $\overline{M_{n_{max}}} = \overline{X_{n_{max}}} \times (\text{Molecular Weight of repeat unit}) = 3.76 \times (2 - 8 + 99 - 2 \times (36.5)) = 955 \text{ g}$ $2. \text{ For 10 moles of ethanediamine (H_2N-CH_2CH_2-NH_2) were reacted with 10 moles of adipic acid (HOOC-CH_2-CH_2-CH_2-COOH). After the reaction, a titration was performed using NaOH (which reacts with COOH) and an indicating dye to determine the number of adipic acid groups remaining free after the polymerization. If 100.0 mL of 2.0 M NaOH were required to neutralize the polymer, what is the average molecular weight (\overline{M_n}) of the polymer? (1 point) 0.1 \times 2M = 0.2 \text{ moles of } \text{NaOH} \longrightarrow \text{System is with } 0.2 \text{ moles of } -\text{CooH} \text{ end groups.} 0.1 \times 2M = 0.2 \text{ moles of } \text{MaOH} \longrightarrow \text{System is with } 0.2 \text{ moles of } \text{polymer} 10 \text{ modes of monomers ore distributed among } 0.2 \text{ moles of } \text{polymer} 10 \text{ modes of monomers ore distributed among } 0.2 \text{ moles of } \text{polymer} 20.2 \times 2M = 0.2 \text{ moles of } \text{monomers} \text{ ore distributed among } 0.2 \text{ moles of } \text{polymer} 20.2 \times 2M = 0.2 \text{ moles of } \text{monomers} \text{ ore distributed among } 0.2 \text{ moles of } \text{polymer} 20.2 \times 2M = 0.2 \text{ moles of } \text{monomers} \text{ ore distributed among } 0.2 \text{ moles of } \text{polymer} 20.2 \times 2M = 0.2 \text{ moles of } \text{monomers} \text{ ore distributed among } 0.2 \text{ moles of } \text{polymer} 20.2 \times 2M = 0.2 \text{ moles of } \text{monomers} \text{ ore distributed among } 0.2 \text{ moles of } \text{polymer} 20.2 \times 2M = 0.2 \text{ moles of } \text{monomers} \text{ ore distributed among } 0.2 \text{ moles of } \text{polymer} 20.2 \times 2M = 0.2 \text{ moles of } \text{monomers} \text{ ore distributed among } 0.2 \text{ moles of } \text{polymer} 20.2 \times 2M = 0.2 \text{ moles of } \text{monomers} \text{ ore distributed among } 0.2 \text{ moles of } \text{polymer} \text{ moles of } \text{moles of } mole$	1 -2 r Pa+ r+1 , r= NB0=	2.58., for In max. PA->1
$M_{n,max} = X_{n,max} \times (molecular weight of repeat unit) = 3.76 \times (2=8+99-2\times(36.5)) = 955 g$ 2. For 10 moles of ethanediamine (H ₂ N-CH ₂ -CH ₂ -NH ₂) were reacted with 10 moles of adipic acid (HOOC-CH ₂ -CH ₂ -CH ₂ -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 (\overline{M}_n) of the polymer? (1 point) $AL \times ZM = a \times 2 \text{ moles}$ of $XaOH \longrightarrow System \text{ is with } a \times 2 \text{ moles}$ of $-CoOH \text{ end groups}$. $AL \times ZM = a \times 2 \text{ moles}$ of $XaOH \longrightarrow System \text{ is with } a \times 2 \text{ moles}$ of $-CoOH \text{ end groups}$. $AL \times ZM = a \times 2 \text{ moles}$ of $XaOH \longrightarrow System \text{ is with } a \times 2 \text{ moles}$ of $-CoOH \text{ end groups}$. $AL \times ZM = a \times 2 \text{ moles}$ of $-CoOH \text{ end groups}$. $AL \times ZM = a \times 2 \text{ moles}$ of $-CoOH \text{ end groups}$. $AL \times ZM = a \times 2 \text{ moles}$ of $-CoOH \text{ end groups}$. $AL \times ZM = a \times 2 \text{ moles}$ of $-CoOH \text{ end groups}$. $AL \times ZM = a \times 2 \text{ moles}$ of $-CoOH \text{ end groups}$. $AL \times ZM = a \times 2 \text{ moles}$ of $-CoOH \text{ end groups}$. $AL \times ZM = a \times 2 \text{ moles}$ of $-CoOH \text{ end groups}$. $AL \times ZM = a \times 2 \text{ moles}$ of $-CoOH \text{ end groups}$. $AL \times ZM = a \times 2 \text{ moles}$ of $-CoOH \text{ end groups}$. $AL \times ZM = a \times 2 \text{ moles}$ of $-CoOH \text{ end groups}$. $AL \times ZM = a \times 2 \text{ moles}$ of $-CoOH \text{ end groups}$. $AL \times ZM = a \times 2 \text{ moles}$ of $-CoOH \text{ end groups}$.	958+1	
$\overline{M}_{n,max} = \overline{X}_{n,max} \times \text{Molecular weight of repeat unit}) = 3.76 \times (2 - 8 + 99 - 2 \times (36.5)) = 955 g$ 2. For 10 moles of ethanediamine (H ₂ N-CH ₂ CH ₂ -NH ₂) were reacted with 10 moles of adipic acid (HOOC-CH ₂ -CH ₂ -CH ₂ -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 (\overline{M}_n) of the polymer? (1 point) $O(1 \times 2M) = O(2 \times 2) = O(2 \times$		molecular weight of
-CooH end groups. \Rightarrow system is with 0.2 moles of polymer. To modes of monomers are distributed among 0.2 moles of polymer. \Rightarrow each polymer is with $10/2 = 50$ repeat units on average. Mn = $X_n \times (molecular weight of repeat unit) = 50 \times (170g) = 8500g$ mol.	(HOOC-CH ₂ -CH ₂ -CH ₂ -CH ₂ -COOH). After the (which reacts with COOH) and an indicating dy remaining free after the polymerization. If 100.0 the polymer, what is the average molecular weight	reaction, a titration was performed using NaOH e to determine the number of adipic acid groups \overline{M} mL of 2.0 M NaOH were required to neutralize \overline{M} of the polymer? (1 point)
\rightarrow system is with 0.2 moles of polymer 10 moles of monomers are distributed among 0.2 moles of polymer \rightarrow each polymer is with $1\%_{0.2} = 50$ repeat units on average $M_n = X_n \times (molecular weight of repeat unit) = 50 \times (1709) = 85009$	a/L x ZM = a 2 moles of Na	of -> System is with 0,2 moles of
\rightarrow system is with 0.2 moles of polymer 10 moles of monomers are distributed among 0.2 moles of polymer \rightarrow each polymer is with $1\%_{0.2} = 50$ repeat units on average $M_n = X_n \times (molecular weight of repeat unit) = 50 \times (1709) = 85009$		- COOH end groups.
each polymer is with $1\%_{0.2} = 50$ repeat units on average $M_n = X_n \times (\text{molecular weight of repeat unit}) = 50 \times (1700) = 85000$ mol.		<u> </u>
$M_n = X_n \times (molecular weight of repeat unit) = 50 \times (170g) = 8500g$	10 mdes of monomers are dis	tributed among 0.2 moles of polymer
Mn = Xn x (molecular weight of repeat unit) = 50x (170g) = 8500g, H+HNCHS-CHS-NH-OC-CHS-CHS-CHS-CO+OH	- each polymer is with 1%.	= 50 repeat units on average
H+HNCHS-CHS-NH-OC-CHS-CHS-CHS-CHS-CO+OH	$M_n = X_n \times (molecular weight)$	of repeat unit) = 50×(170g) = 85009
	H+HNCHS-CHS-NH-OC	-CHs-CHs-CHs-CD+OH