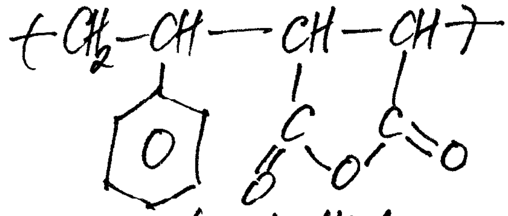
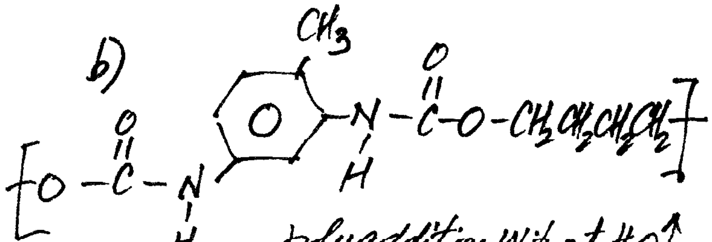
CHEM 654
Problem Set #1
Solutions

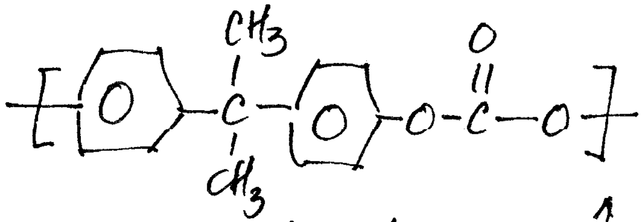
due 02/03/03

1. a) 

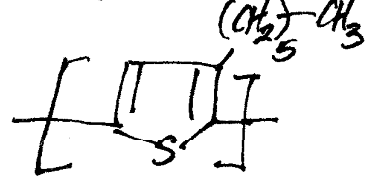
free radical

b) 

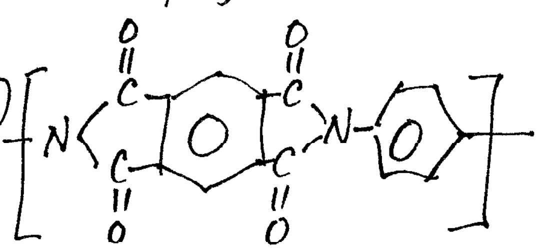
polyaddition without $H_2O\uparrow$

c) 

polycondensation with $HCl\uparrow$

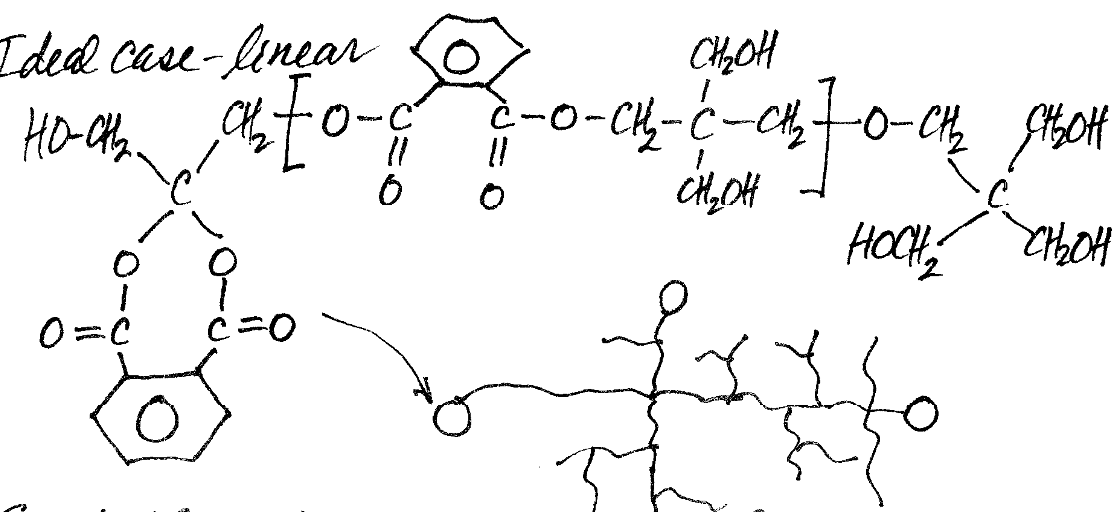
d) 

electrochemical polymerization

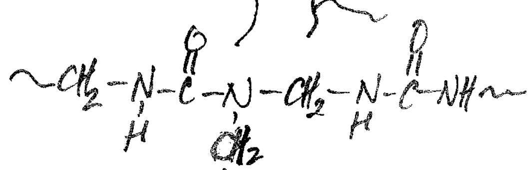
e) 

polycondensation with $H_2O\uparrow$

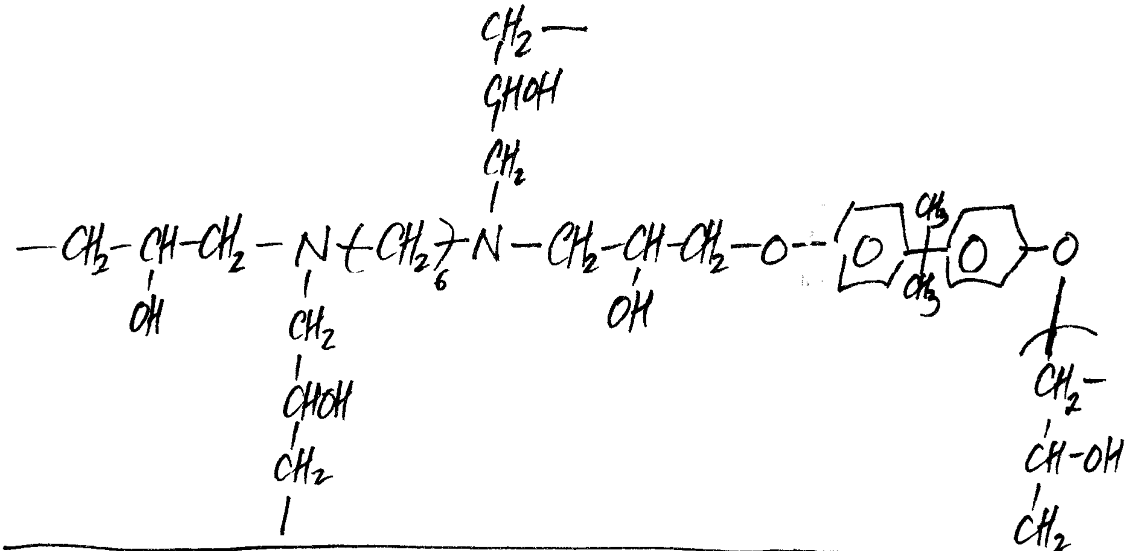
2. a) Ideal case-linear

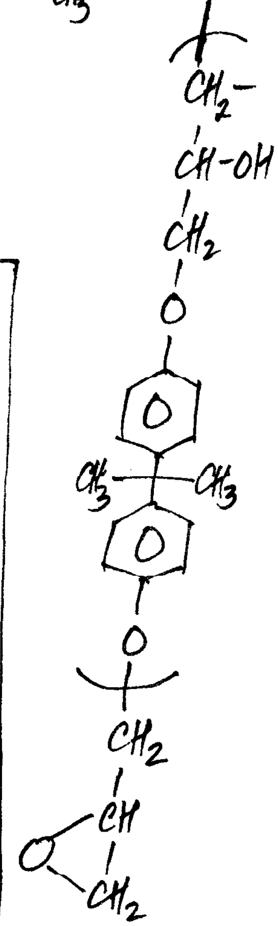


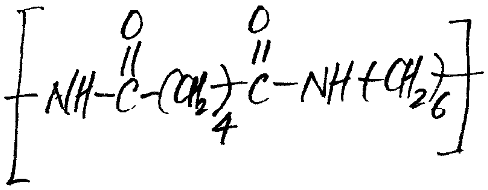
b) See p.48

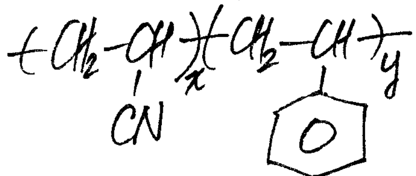
c) 

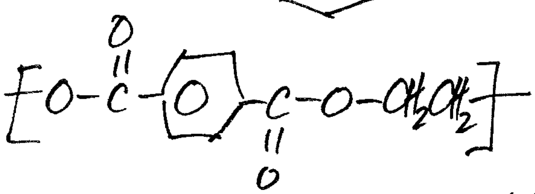
d)

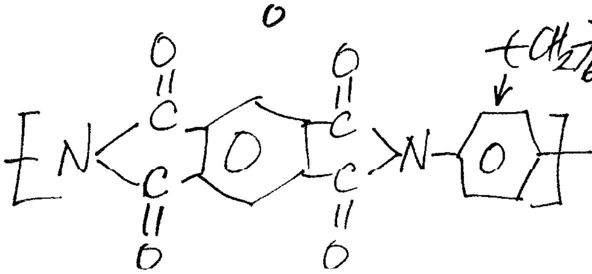


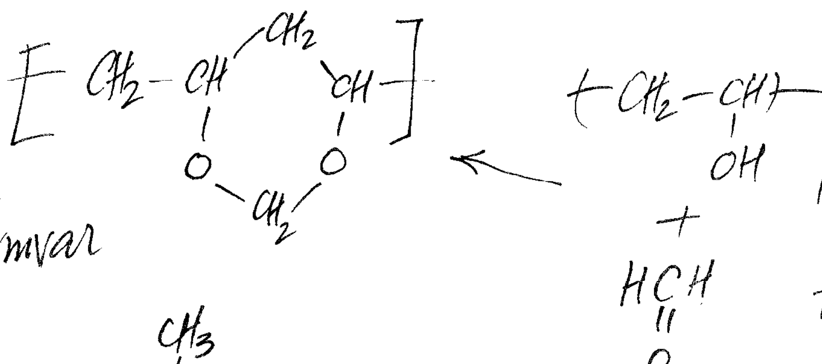


3. a)  Nylon 6,6

b)  orlon

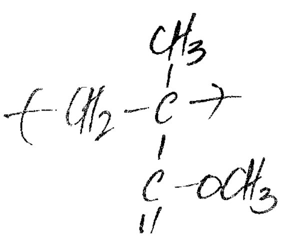
c)
e)  Dacron, Mylar

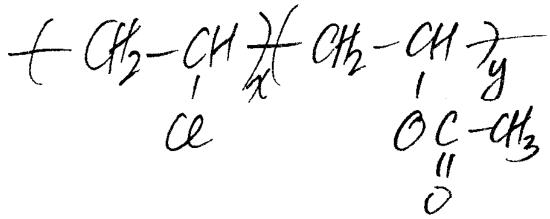
d)  Kapton

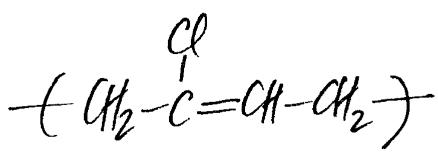
f)  poly(vinylalcohol)

formaldehyde

Formvar

g)  poly(methylmethacrylate), Plexiglas

h)  Tygon, plasticized PVC

i)  Neoprene

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4. a) $$M_n = \frac{\sum w_i}{\sum (w_i/M_i)} = \frac{11 \cdot 10^3}{10+0.1} = 1.1 \cdot 10^3 \,(g/mol)$$

$$M_w = \frac{\sum w_i M_i}{\sum w_i} = \frac{(10+10)\cdot 10^3}{11} = 1.8 \cdot 10^3 \,(g/mol)$$

$$M_z = \frac{\sum w_i M_i^2}{\sum w_i M_i} = \frac{10(10^3)^2 + 1(10^4)^2}{2 \cdot 10^4} = 5.5 \cdot 10^3 \,(\text{''})$$

$$M_{z+1} = \frac{\sum w_i M_i^3}{\sum w_i M_i^2} = \frac{10(10^3)^3 + 1(10^4)^3}{1.1 \cdot 10^8} = 9.2 \cdot 10^3 \,(\text{''})$$

b) $$M_n = \frac{6 \cdot 10^4}{3+1+\frac{1}{3}} = 1.4 \cdot 10^4 \,(g/mol)$$

$$M_w = 10^4 \left(\frac{3+4+3}{6}\right) = 1.7 \cdot 10^4 \,(\text{''})$$

$$M_z = \frac{3\cdot(10^4)^2 + 2(2\cdot 10^4)^2 + 1(3\cdot 10^4)^2}{10^5} = \frac{10^8}{10^5}(3+8+9) = 2\cdot 10^4 \,(g/mol)$$

5. a) $$Z_x = \frac{x W_x}{\sum x W_x} = \frac{x^2 p^{x-1}(1-p)^2}{\left(\frac{1+p}{1-p}\right)} = x^2 p^{x-1}(1-p)^3/(1+p)$$

$$\sum x W_x = (1-p)^2 \sum_{x=1}^{\infty} x^2 p^{x-1} = (1-p)^2 \frac{1+p}{(1-p)^3} = \frac{1+p}{1-p}$$

$$\sum_{x=1}^{\infty} W_x = \sum_{x=1}^{\infty} x p^{x-1}(1-p)^2 = (1-p)^2(1\cdot p^0 + 2p + 3p^2 + \dots) = (1-p)^2 \frac{1}{(1-p)^2} = 1 \text{ (normalized!)}$$

$$\sum_{x=1}^{\infty} Z_x = \frac{(1-p)^3}{(1+p)} \sum_{x=1}^{\infty} x^2 p^{x-1} = \frac{(1-p)^3}{(1+p)}(1\cdot p^0 + 4p + 9p^2 + \dots) = \frac{(1-p)^3}{(1+p)} \cdot \frac{(1+p)}{(1-p)^3} = 1 \text{ (normalized!)}$$

b) $W_x = x\,p^{x-1}(1-p)^2$, $\ln W_x = \ln x + (x-1)\ln p + 2\ln(1-p)$

$$\left(\frac{\partial \ln W_x}{\partial x}\right)_p = \frac{1}{x} + \ln p, \quad \frac{1}{x_{max}} = -\ln p, \quad x_{max} = \frac{1}{\ln(1/p)}$$

$$x_{max} = 1000 = \frac{1}{\ln(1/p)}, \quad 10^{-3} = \ln(1/p), \quad \ln p = -10^{-3}, \quad p = {}^{-0.001}$$

$$\approx 1 - 0.001 + \frac{10^{-6}}{2!} - \dots$$

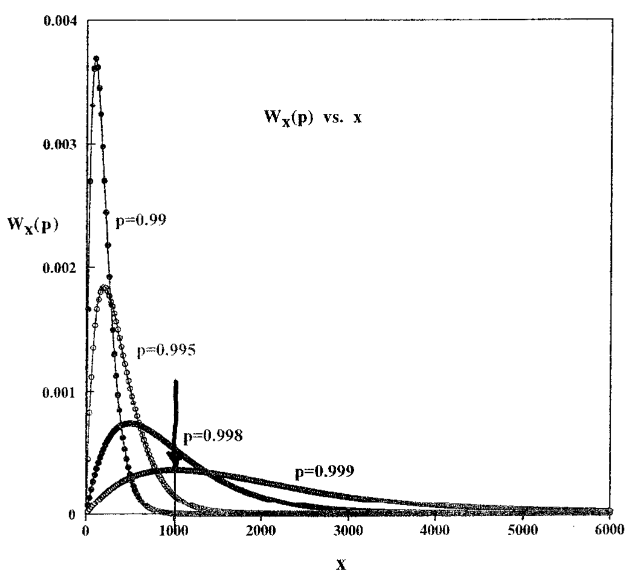
$$\approx \underline{\underline{0.999}}$$

c) $$\left(\frac{\partial \ln W_x}{\partial p}\right)_x = (x-1)\frac{1}{p} + 2\frac{(-1)}{(1-p)}, \quad \frac{x-1}{p_{max}} = \frac{2}{1-p_{max}}$$

$$(x-1)(1-p_{max}) = 2p_{max}$$

$$x = 500, \quad p_{max} = \frac{499}{501} = \underline{\underline{0.996}}$$

d)



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