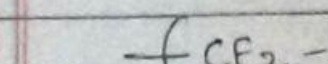
Tutorial-2

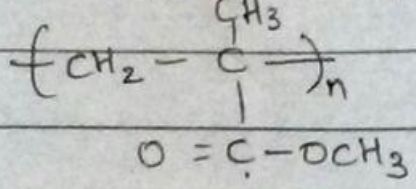
Sukeerth

1.1 a) Polytetrafluoroethylene



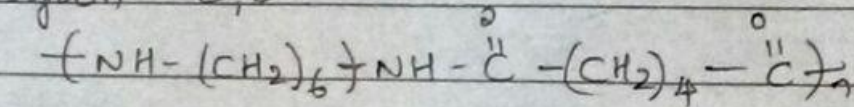
Molecular Weight = 100 g/mol

b) Poly (Methyl Methacrylate)



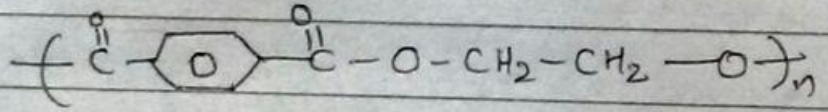
Molecular weight = 100.12 g/mol

c) Nylon 6,6



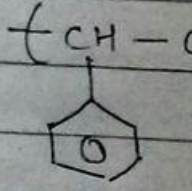
Molecular weight = 226 g/mol

d) Poly (Ethylene terephalate



Molecular Weight = 192 g/mol

2) Given,

Polystyrene 

Number average Molecular weight = $\bar{M}_n$ = 500,000 g/mol.

Molecular weight of Repeating Unit = m = 10^4 g/mol

Degree of polymerisation = $\frac{\bar{M}_n}{m} = \frac{500,000}{104}$

= 4807.69

The degree of polymerisation of polystyrene is 4807

3) Given,

Weight of polyethylene rope = 15.12 g/cm

No. of units in each chain = 7000 units

Distance between carbon atoms in each chain = 0.15 nm

a) Length of rope of polyethylene = 3m = 300cm

Molecular weight of a unit of polyethylene $\text{(CH}_2\text{–CH}_2\text{)}_n$ = 28 g/mol

Weight of 3m polyethylene rope = 300 × 15.12 = 4536 g

No. of units in 3m polyethylene rope

$= \frac{4536}{28} = 162$ units

No. of polyethylene chains in 3m rope

$= \frac{162}{7000} N_A$

$= 0.023 N_A$ units

$= 1.385 \times 10^{22}$ chain

b) $l = 1.5 \times 10^{-10} \times 10^3 \times 7$

$= 1.05$ Nm

length of chains = $1.385 \times 10^{22} \times 1.05 \times 10^{-6}$

$= 1.45 \times 10^{16}$ m

So, length of 1.385×10^{22} chains in a rope is 1.45×10^{16} m

4) Polytetrafluoroethylene

$\text{(CF}_2\text{–CF}_2\text{)}_n$

Molecular weight = 100 g/mol

Molecular Weight Range (g/mol) Mi			x_i	w_i
10000	-	20000	0.03	0.01
20000	-	30000	0.09	0.04
30000	-	40000	0.15	0.11
40000	-	50000	0.25	0.23
50000	-	60000	0.22	0.24
60000	-	70000	0.14	0.18
70000	-	80000	0.08	0.12
80000	-	90000	0.04	0.07

a) Number avg. molecular weight $\bar{M}_n = \sum M_i x_i$

$= 15000 \times 0.03 \times 25000 \times 0.09$

$+ 35000 \times 0.15$

$+ 45000 \times 0.25 + 55000 \times 0.22 + 65000 \times 0.14$

$+ 75000 \times 0.08 + 85000 \times 0.04$

$= 49800$ g/mol

b) Weight average molecular weight $= \bar{M}_w$

$= 15000 \times 0.01 + 25000 \times 0.04 + 35000 \times 0.11$

$+ 45000 \times 0.23 + 55000 \times 0.24 + 65000 \times 0.18$

$+ 75000 \times 0.12 + 85000 \times 0.07$

$= 55200$

c) Degree of Polymerisation $= \frac{\bar{M}_n}{M} = \frac{49800}{100}$

$= 498$

5) Given,

Polyethylene ~~$(CH_2 - CH_2)_n$~~

Molecular weight of a unit = 28 g/mol

$\theta = 109°28'$

$d = 0.154\,nm$

N = Degree of Polymerization

$= \frac{3 \times 10^5}{28} = 21,390$

$L = Nd\sin(\theta/2) = 2686.4\,nm$

$r = d\sqrt{N} = 22.5230\,m$

6) Given

Number average molecular weight

$M_n = 100000$ g/mol

Degree of Polymerization, $D_p = 2210$

Ethylene.

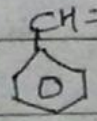
$-(CH_2-CH_2-X)_n-$, Molecular weight = 28

Molecular weight of repeating unit

$= \frac{10^5}{2210} = 45.25$ g

Mass of other unit $= 2 \times 45.25 - 28$

$= 62.5$ g



Styrene 104 g

Propylene 42 g $CH_3-CH=CH_2$

Vinyl Chloride 62.5 g $CH_2=CH-Cl$

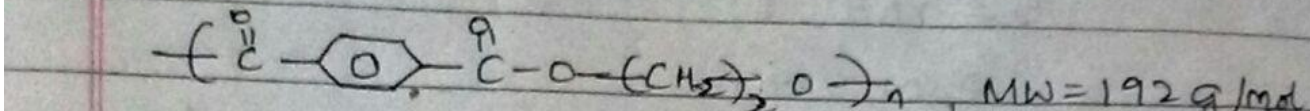
Tetrafluoroethylene 100g $CF_2=CF_2$

Vinyl Chloride is the other polymer

7) Poly (Ethylene Adipate)

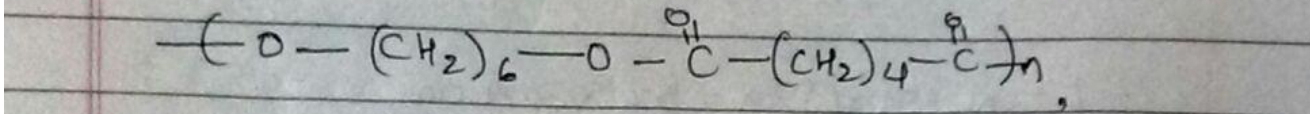
$-(O-CH_2-CH_2-O-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}})_n-$, MW = 172 g/mol.

b) Poly (Ethylene Terephthalate)



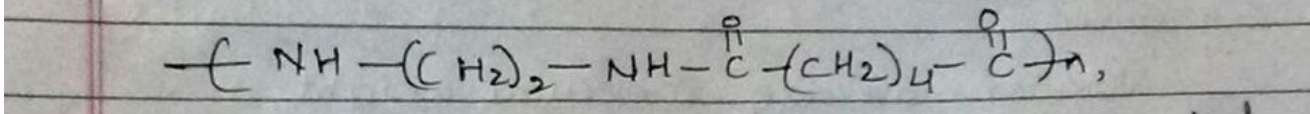
, MW = 192 g/mol

c) Poly (Hexamethylene Adipate)



MW = 228 g/mol

d) Poly (Ethylene Adipamide)



MW = 170 g/mol

Presence of  group and the hinderance due to Benzene ring in Poly (Ethylene Terepthalate) increase its Melting point

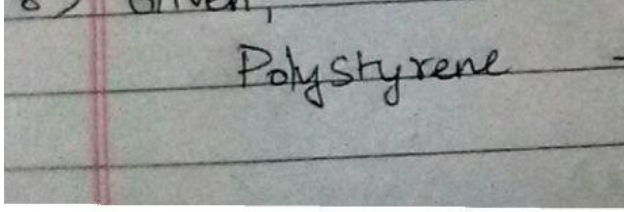
N-H bond in Poly (Ethylene Adipamide) are weaker than O linkage but they provide an extra strength by its lone pair.

Ester linkage causes rotation and reduces Melting Temperature in Poly (Ethylene Adipate) & Poly (Hexamethylene Adipate)

So, order is

$$\boxed{c < a < d < b}$$

8.) Given,

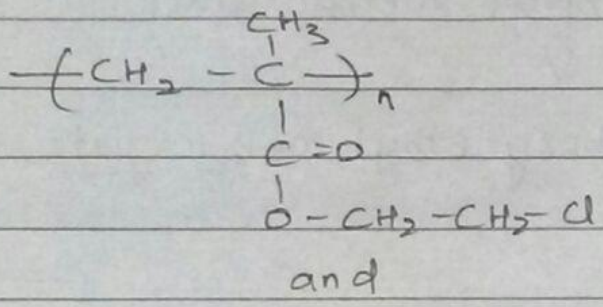
Polystyrene 

Glass Transition temperature $T_g = 100^\circ C = 373 K$

$T_m = \frac{3}{2} T_g = 559.5 K$

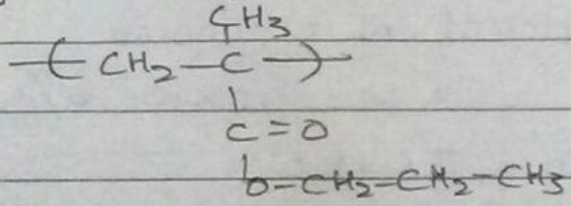
Styrene is assymetric in nature

9. a) Poly (2-chloro ethyl methacrylate)



and

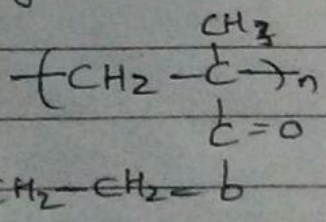
Poly (n-Propyl methacrylate)



Glass transition temperature (T_g) increases with increase in polarity

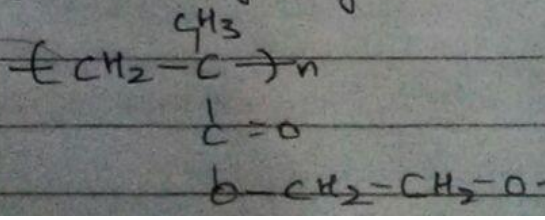
Thus Poly (2-chloro ethyl methacrylate) is having higher T_g due to increased polarity by presence of Cl group.

b) Poly (n-propyl methacrylate



&

Poly (2-methoxy ethyl methacrylate)



-OR group is less polar than -R. So, Poly (n-propyl methacrylate) is more polar and has higher T_g.

Order of T_g in all molecules

→ Poly (2-chloro ethyl methacrylate)

V

→ Poly (n-propyl methacrylate)

V

→ Poly (2-methoxy ethyl methacrylate)

10) Given,

Polystyrene, MW = 104

Volume co-efficient of expansion

$= \alpha = 60 \times 10^{-6}$ cm/cm^3 °C

Temperature - T = 150°C

By net $T_g = 100°C$, $f_g = 0.025$

$f = f_g + \alpha (T - T_g)$

$f = 0.025 + 60 \times 10^{-6} \times 50$

$f = 0.028$ cm/cm^3

Free volume fraction of polystyrene at 150°C is 0.028 cm/cm^3