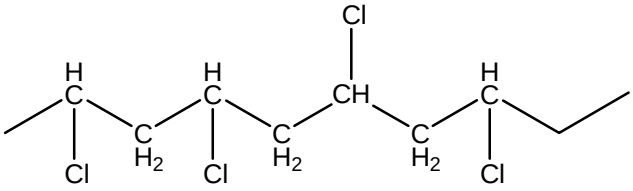
Homework #12 Solution Outlines

Poly-8. The molecular weight of the monomer ($-C_2H_4-$) is 28 amu.
The molecular weight range is:
500 (28) to 50,000 (28) = 14,000 amu to 1,400,000 amu

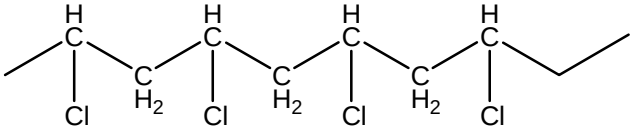
Poly-9. The molecular weight of the monomer ($-C_8H_8-$) is 104 amu.

$$\frac{200{,}000\ \frac{\text{amu}}{\text{chain}}}{104\ \frac{\text{amu}}{\text{monomers}}} = 1.92 \times 10^3\ \frac{\text{monomers}}{\text{chain}} \quad \text{and} \quad \frac{300{,}000\ \frac{\text{amu}}{\text{chain}}}{104\ \frac{\text{amu}}{\text{monomers}}} = 2.88 \times 10^3\ \frac{\text{monomers}}{\text{chain}}$$

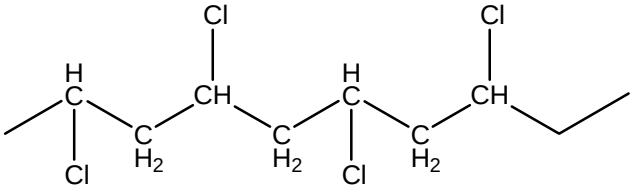
1. (a) atactic:



isotactic:



syndiotactic:



(b) mol. wt. $_{\text{monomer}}$ = $2 \times 12.011 = 24.022$
$3 \times 1.00794 = 3.0238$
$1 \times 35.4527 = 35.4527$ $\therefore$ 4000 mers = 2.500×10^5 g/mol

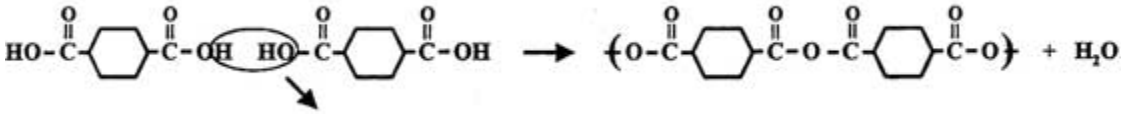
2. (a) – linear is HDPE
– straight chains pack better

(b) HDPE straight chains are capable of some degree of crystallization
$\Rightarrow$ interface between amorphous and crystalline material scatters visible light
$\Rightarrow$ white appearance.

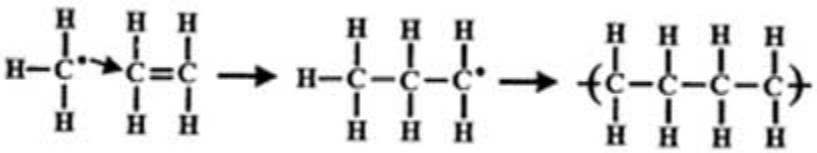
(c) semi-crystalline nature of HDPE adds rigidity
$\Rightarrow$ LDPE is more flexible

(d) partial crystallization leads to better packing which in turn implies a higher degree of secondary bonding within the macromolecule
$\Rightarrow$ HDPE has the higher melting point

3. condensation polymerization



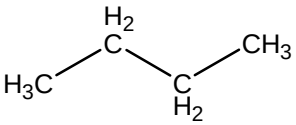
4. addition polymerization



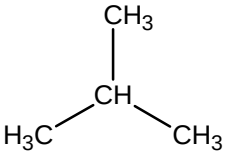
5. PE has no crosslinks; therefore, all inter-chain bonding is secondary. This means the bonds can be broken by heating the material above the glass transition temperature to form a liquid which can be reformed into another shape. Tires are made of rubber which is crosslinked. i.e., covalent bonds forms between chain segments. To break these bonds would require heating to temperatures so high that the backbone of the chain itself would break dowm resulting in the wholesale degradation of the rubber. Thus rubber tires are not recyclable.

6. The glass transition temperature of the polymer must lie between room temperature and ~0ºC.

O1-4. Saturated hydrocarbons contain as many hydrogen atoms as possible. An example is propane, $CH_3CH_2CH_3$. Unsaturated hydrocarbons have fewer hydrogen atoms than the corresponding alkane, and an example would be propene, $CH_2{=}CHCH_3$. In a straight chain hydrocarbon, the carbon atoms form a chain that runs from one end of the molecule to the other without carbon atoms branching off the main chain. Branched hydrocarbons do not form a single chain that runs from one end of the molecule to the other. Examples of both are given below.



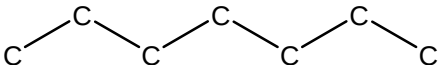
straight-chain



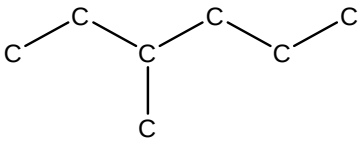
branched-chain

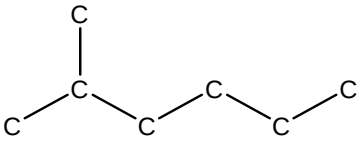
O1-8. Following the pattern suggested by the solution to exercise O-2, we can enumerate the isomers for heptane as:

1 for unbranched chain

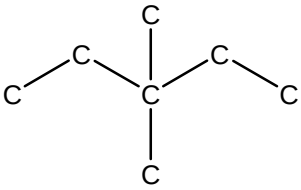


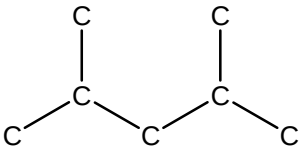
2 for single branched chain

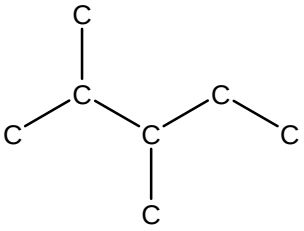


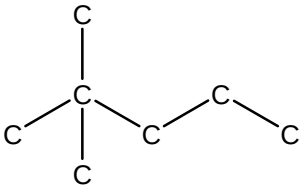


4 for double branched chain

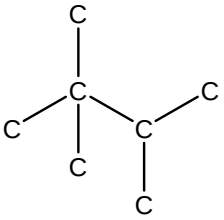








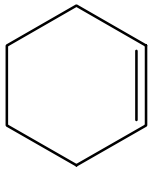
1 for triple branched chain



O1-26. (a) Cannot have cis and trans isomers because only single carbon center is present.
(b) Cannot have cis and trans isomers because all groups on both carbon centers are the same.
(c) Cannot have cis and trans isomers because both groups on one carbon center are the same.
(d) Can have both cis and trans isomers.
(e) Cannot have cis and trans isomers because both groups on one carbon center are the same.

O1-28. Both (a) and (b) are pairs of constitutional isomers, since they have the same formula but different arrangement of atoms. (c) The compounds are the same. (d) The compounds are geometric or stereoisomers.

O1-33.



O1-56. Use the criterion spelled out in Figure O1.23 on p. 31 of the Module chapter. Draw the molecule so that the C–H bond is vertical and decide whether the mirror image can be superimposed after rotation about the vertical axis. Only CHFClBr is chiral and therefore optically active.