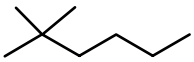
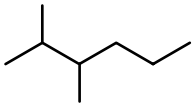
Homework 9

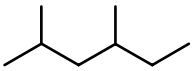
26. a.



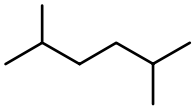
2,2-dimethylhexane



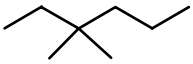
2,3-dimethylhexane



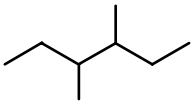
2,4-dimethylhexane



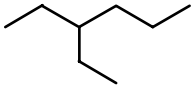
2,5-dimethylhexane



3,3-dimethylhexane

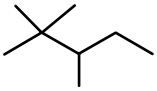


3,4-dimethylhexane

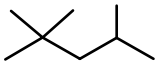


3-ethylhexane

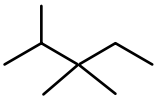
b.



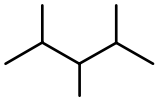
2,2,3-trimethylpentane



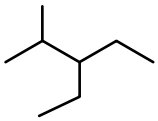
2,2,4-trimethylpentane



2,3,3-trimethylpentane



2,3,4-trimethylpentane

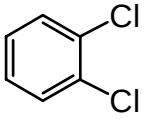


3-ethyl-2-methylpentane

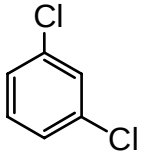
3-ethyl-3-methylpentane

32. a. 2,3-dimethyl-2-butene
    b. 4-methyl-2-hexyne
    c. 2,3-dimethyl-1-pentene

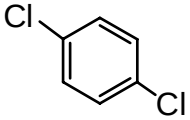
50. a.



ortho



meta



para

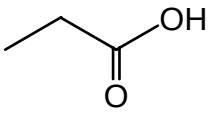
b. There are three trichlorobenzene (1,2,3-trichlorobenzene, 1,2,4-trichlorobenzene and 1,3,5-trichlorobenzene).

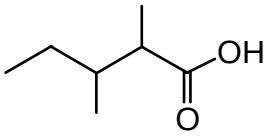
c. The meta isomer will be very difficult to synthesize.

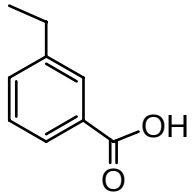
d. 1,3,5-trichlorobenzene will be the most difficult to synthesize since all Cl groups are meta to each other in this compound.

64. When $CH_2=CH_2$ reacts with HCl, there is only one possible product, chloroethane. When Cl_2 is reacted with CH_3CH_3 (in the presence of lioght), there are six possible products because any number of the six hydrogen atoms in ethane can be substituted for by Cl. The light catalyzed substitution reaction is very difficult to control, hence, it is not a very efficient method of producing monochlorinated alkanes.

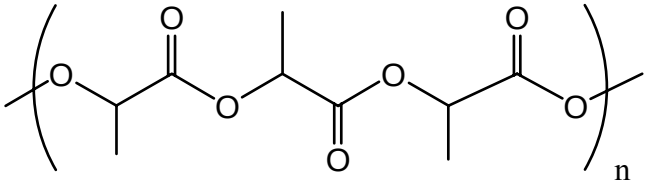
66.

a. 

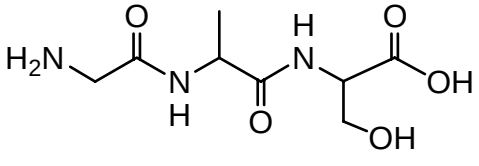
b. 

c. 

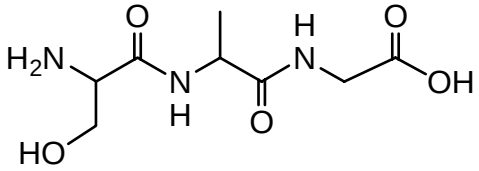
76. This condensation polymer forms by elimination of water. The ester functional group repeats, hence the term polyester.



88.



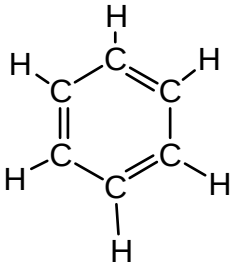
gly ala ser



ser ala gly

There are six possible tripeptides with gly, ala and ser. The other four tripeptides are gly-ser-ala, ser-gly-ala, ala-gly-ser and ala-ser-gly.

136. One of the resonance structures for benzene is:



To break $C_6H_6(g)$ into C(g) and H(g) requires breaking 6 C-H bonds, 3 C=C bonds and 3 C-C bonds:

$$C_6H_6(g) \rightarrow 6\ C(g) + 6\ H(g) \quad \Delta H = 6D_{C\text{-}H} + 3\ D_{C=C} + 3\ D_{C\text{-}C}$$

$$\Delta H = 6(413\ kJ) + 3(614\ kJ) + 3(347\ kJ) = 5361\ kJ$$

The question asks for $\Delta H°_f$ for $C_6H_6(g)$, which is ΔH for the reaction:

$$6\ C(g) + 3H_2(g) \rightarrow C_6H_6(g) \quad \Delta H = \Delta H°_{f,\ C6H6}$$

To calculate ΔH for this reaction, we will use Hess's law along with the $\Delta H°_f$ value for C(g) and the bond energy value for H_2 (D_{H2} = 432 kJ/mol).

$$6C(g) + 6H(g) \rightarrow C_6H_6(g) \quad \Delta H_1 = -5361\ kJ$$

$$6C(s) \rightarrow 6C(g) \quad \Delta H_2 = 6(717\ kJ)$$

$$3H_2(g) \rightarrow 6H(g) \quad \Delta H_3 = 3(432\ kJ)$$

$$6C(g) + 3H_2(g) \rightarrow C_6H_6(g) \quad \Delta H = \Delta H_1 + \Delta H_2 + \Delta H_3 = 237\ kJ;\ \Delta H°_{f,\ C6H6(g)} = 237\ kJ.mol$$

The experimental $\Delta H°_f$ for $C_6H_6(g)$ is more stable (lower in energy) by 154 kJ as compared to $\Delta H°_f$ calculated form bond energies (83 – 237 = -154 kJ). This extra stability is related to benzene's ability to exhibit resonance. Two equivalent Lewis structures can be drawn for benzene. The π-bonding system implied by each Lewis structure consists of three localized π bonds. This is not correct as all C-C bonds in benzene are equivalent. We say the π electrons in benzene are delocalized over the entire surface of C_6H_6 (see Section 9.5 of the text). The large discrepancy between $\Delta H°_f$ values is due to the delocalized π electrons, whose effect was not accounted for in the calculated $\Delta H°_f$ value. The extra stability associated with benzene can be called resonance stabilization. In general, molecules that exhibit resonance are usually more stable than predicted using bond energies.