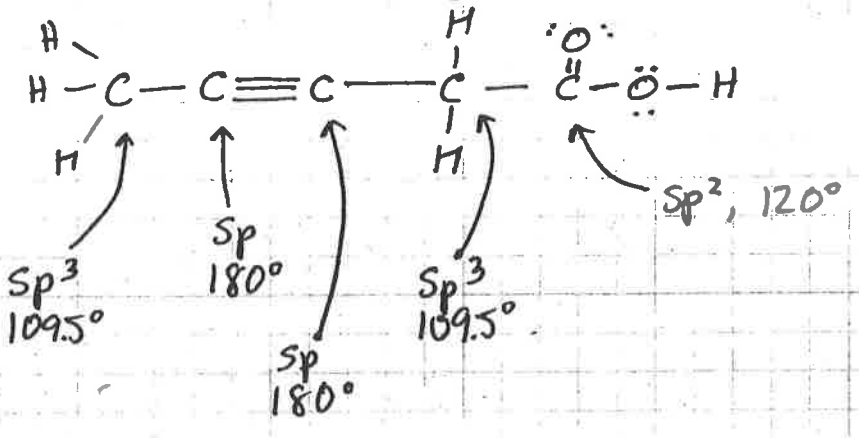
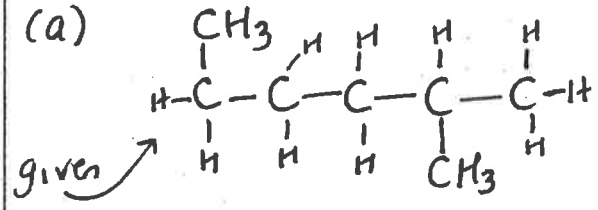
Chapter 24

(9.) predict ideal bond ∠ and hybridization of each C: CH_3CCCH_2COOH

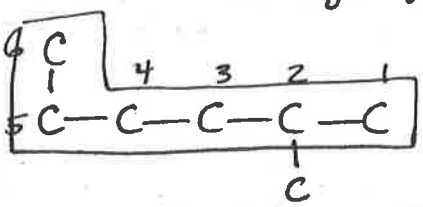


(15) give the missing name or condensed structural formula

(a)

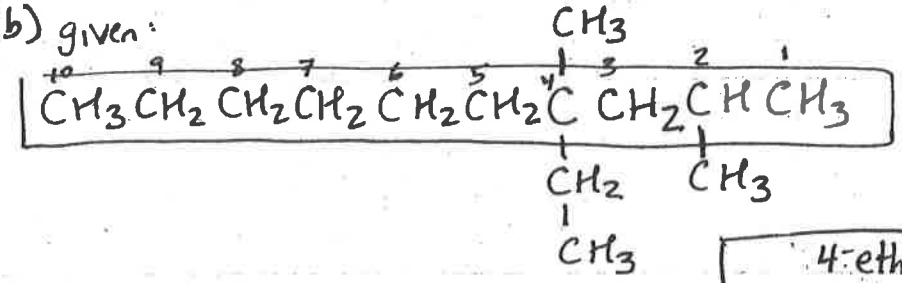


rewritten w/o hydrogens, it is:



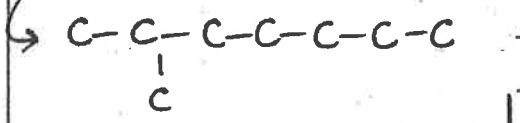
2-methylhexane (a)

(b) given:



4-ethyl-2,4-dimethyldecane
(b) or 2,4-dimethyl-4-ethyldecane

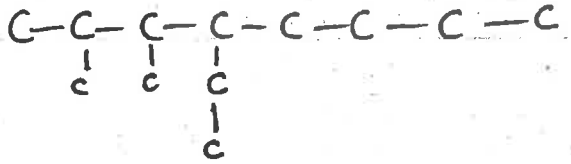
(c) 2-methylheptane

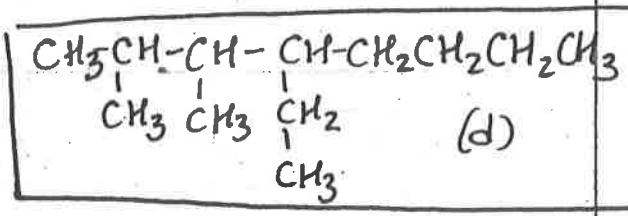


→ condensed structural formula:

$CH_3CH(CH_3)CH_2CH_2CH_2CH_2CH_3$ (c)

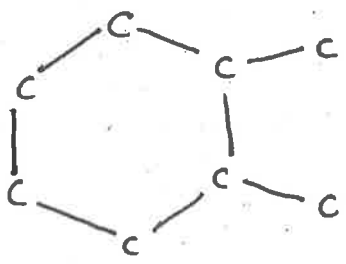
(d) 4-ethyl-2,3 dimethyloctane

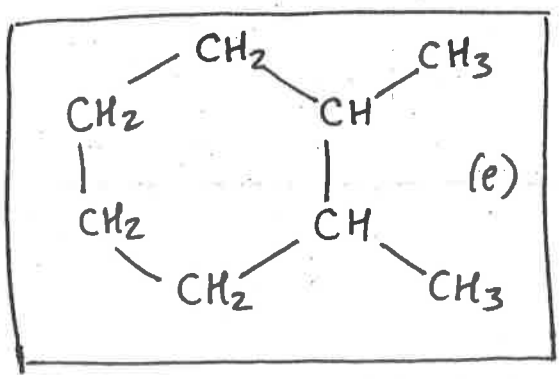




(d)

(e) 1,2-dimethylcyclohexane

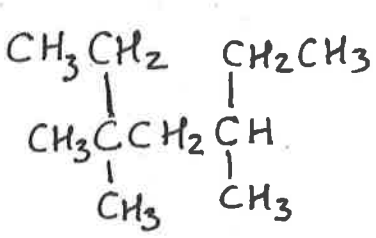


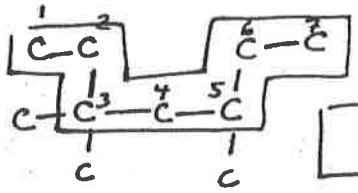


(e)

(16) (OK to leave off hydrogens on #16 and #18)

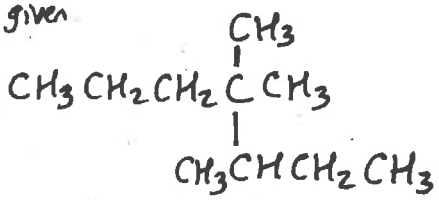
(a) given:

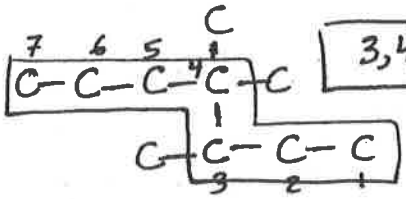




(a) 3,3,5-trimethylheptane

(b) given

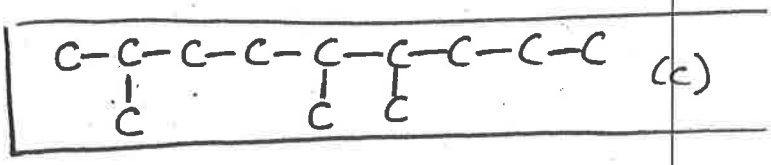




3,4,4-trimethylheptane (b)

(c) given:

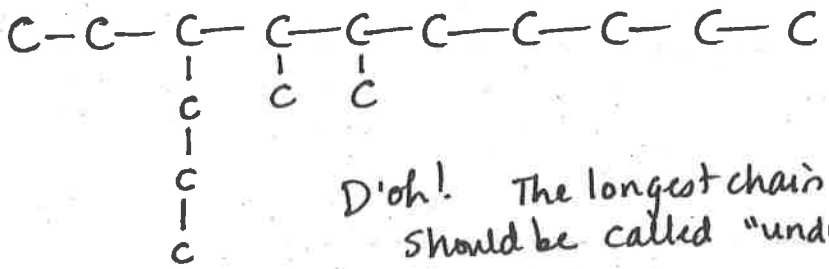
2,5,6-trimethylnonane



(c)

(d) 3-propyl-4,5-methyldecane

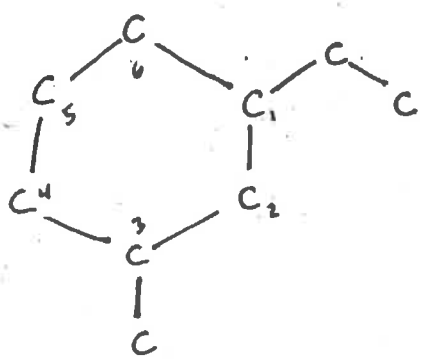
D'oh! there should be a "di" right here...



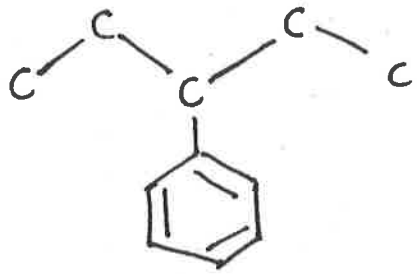
D'oh! The longest chain is 11, not 10... should be called "undecane" not "decane"

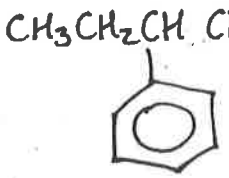
4-ethyl-6,7 dimethylundecane

(e) 1-ethyl-3-methylcyclohexane

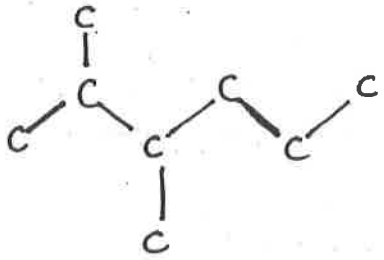


(18) (a) 3-phenylpentane :



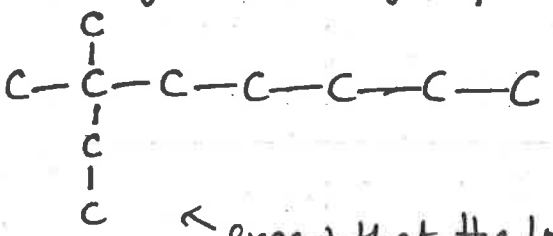
OR  etc

(b) 2, 3-dimethylhexane :



or $CH_3CH(CH_3)CH(CH_3)CH_2CH_2CH_3$

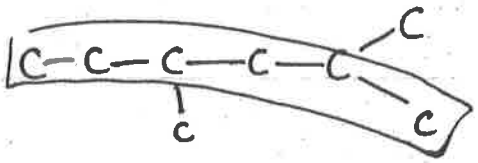
(c) 2-ethyl-2-methylheptane



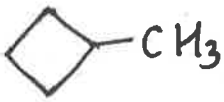
or $CH_3C(CH_2CH_3)(CH_3)CH_2CH_2CH_2CH_2CH_3$

↖ except that the longest chain is 8, so it should actually be 3,3-dimethyloctane ....

(d) $CH_3CH_2CH(CH_3)CH_2CH(CH_3)_2$

or 

2,4-dimethylhexane (d)

(e)  → **methylcyclobutane** (e)

(23) give formula for a compound containing 5 carbons that is....

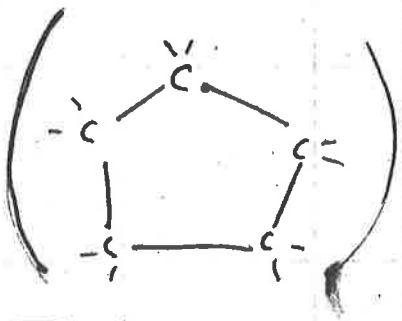
(a) an alkane → C_5H_{12}

if no rings or double or triple bonds, a hydrocarbon will have the formula C_nH_{2n+2}; it will have the maximum number of Hydrogens per the number of carbons.

(b) a cycloalkane

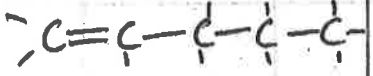
these will have the formula C_nH_{2n} (assuming there is only one ring)

so it will be C_5H_{10}



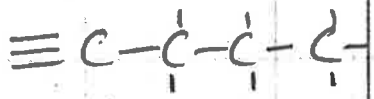
(c) an alkene

this will also be C_nH_{2n} → C_5H_{10} assuming only one double bond.



(d) an alkyne

C_nH_{2n-2} so C_5H_8



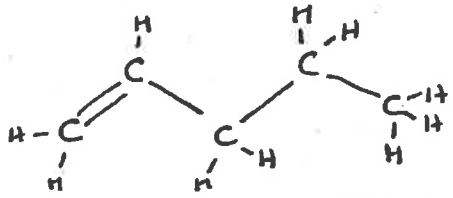
(a) and (b) are saturated since they have the max possible number of H's for their carbon "skeleton" (they have no C=C or C≡C bonds)

(c) and (d) are unsaturated. both of these could react with H_2/Pt to add hydrogens and become saturated, becoming alkanes/cycloalkanes.

(28) Draw all noncyclic structural isomers of C_5H_{10}, and name each one.

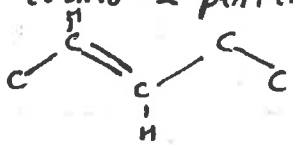
$5(2)+2 = 12$ hydrogens if saturated and no rings (noncyclic)

so since we only have 10 hydrogens, it must have one double bond.

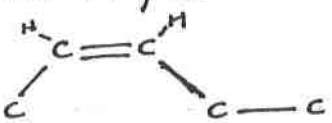


1-pentene

trans-2-pentene



cis-2-pentene



since they only asked for structural isomers, not geometric isomers, you could just do one of these/ don't worry about cis and trans

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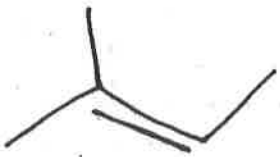
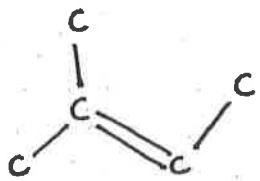
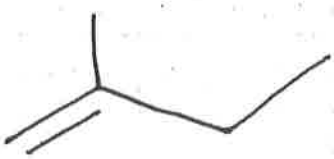
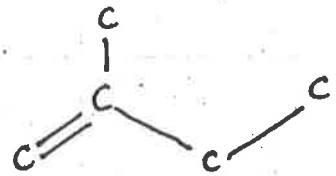


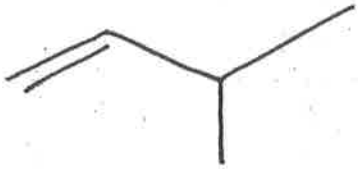


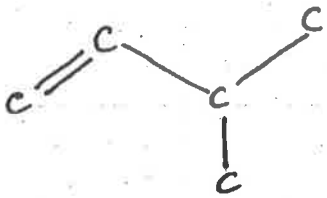
2-methyl-2-butene





2-methyl-1-butene

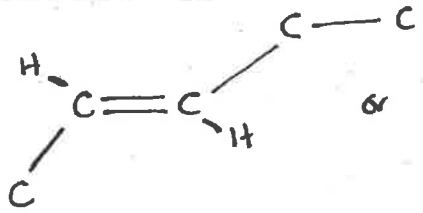




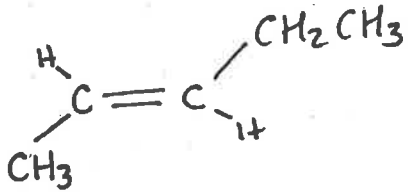
3-methyl-1-butene

(29) trans-2-pentene :

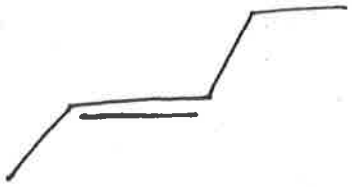
(a)



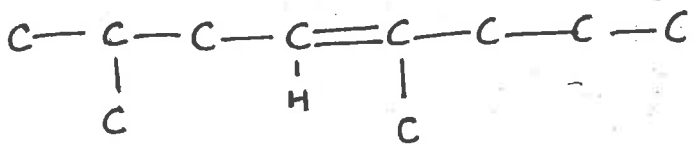
or



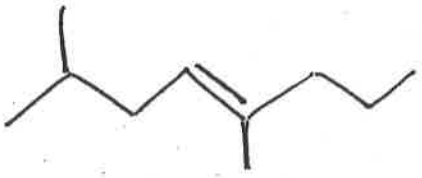
line structure :



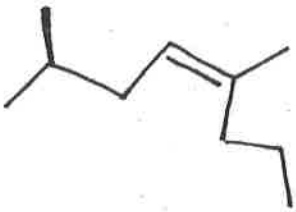
(b) 2, 5 - dimethyl - 4-octene



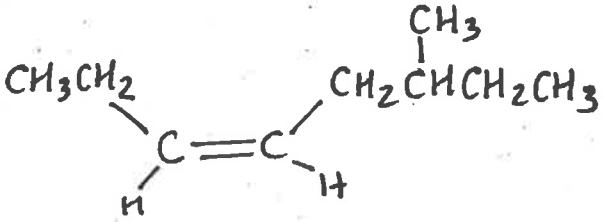
(this would have geometric isomerism but they don't mention it..)



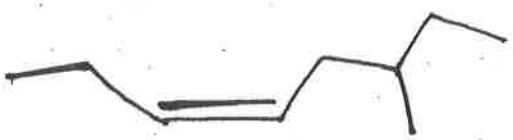
or



(c)



cis - 6-methyl - 3-octene



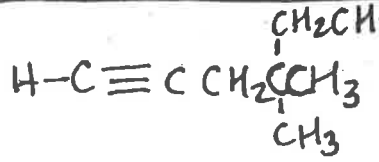
(d)

para - dibromobenzene

or 1,4-dibromobenzene

(already done as a line structure..)

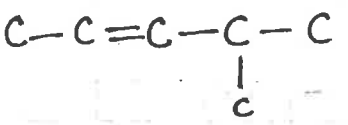
(e)



4,4-dimethyl-1-hexyne

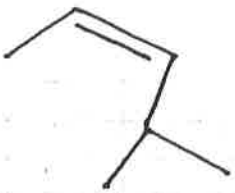
(30) 4-methyl-2-pentene

(a)



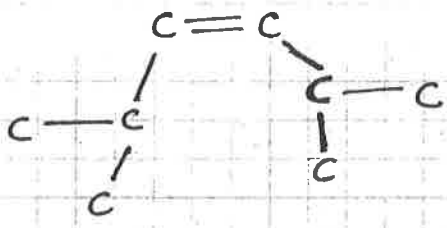
(unclear if cis or trans)

trans version

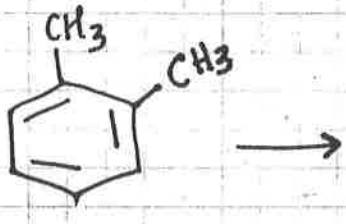


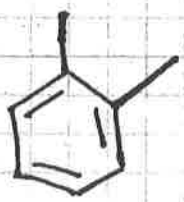
cis version

(b) cis-2,5-dimethyl-3-hexene

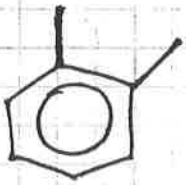


(c) ortho-dimethyl benzene





or



(d) $HC \equiv C CH_2 CH_3$

1-butyne

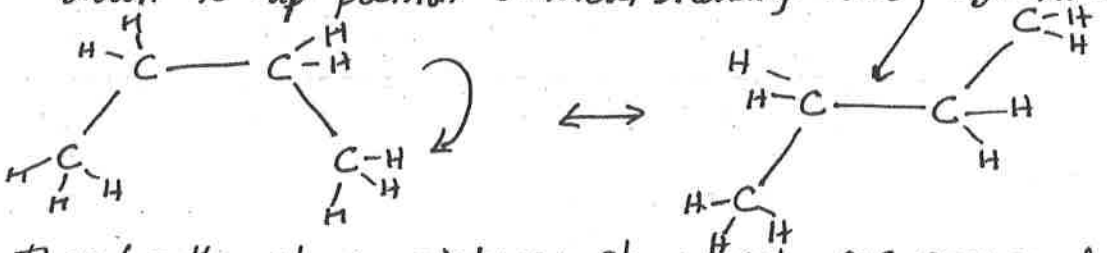
(e) trans - $CH_3CH=CH CH_2 CH_2 CH_2 CH_3$

trans-2-heptene

(31) Why is geometric isomerism possible for alkenes, but not possible for alkanes and alkynes?

Sigma bonds allow for rotation around the internuclear axis; since the electron density is mostly along a cylinder between nuclei, one atom involved in the bond can rotate relative to the other atom without interupting the overlap of the orbitals, and therefore the bond doesn't break in rotation.

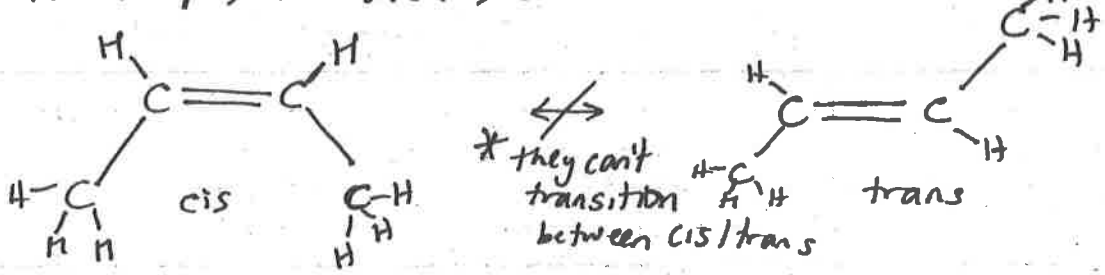
alkanes contain only C–C single bonds, which are sigma bonds, so the molecules can change orientation easily, for example, the fourth carbon on butane can rotate from the "down" to "up" position without breaking this sigma bond.



Therefore the above pictures show only one compound (butane), as opposed to two distinct isomers.

Pi bonds don't allow for rotation; the π bond must break if one of the involved atoms rotates. This is because a π bond is created by the overlap of two half-filled p-orbitals (one from each participating atom), perpendicular to the plane of the double bonded part of the molecule. so if one atom rotates relative to the other, the p orbitals will no longer overlap, and the π bond will be broken.

alkenes contain C=C double bonds; a double bond contains one sigma (σ) bond and one pi (π) bond. for example, in 2-butene, each C involved in the π bond



has a half-filled p-orbital in and out of the page, overlapping with the other carbon's half-filled p-orbital. To go from the "cis" to "trans" configuration, the 3rd carbon's p orbital would end up in the same plane as the page/molecule, when it was halfway rotated toward the "trans" configuration, which would mean the π bond would have to break. Since it can't transition freely between the "cis" and trans" configurations, these are two distinct [geometric] isomers, with different properties (bp, mp, etc).

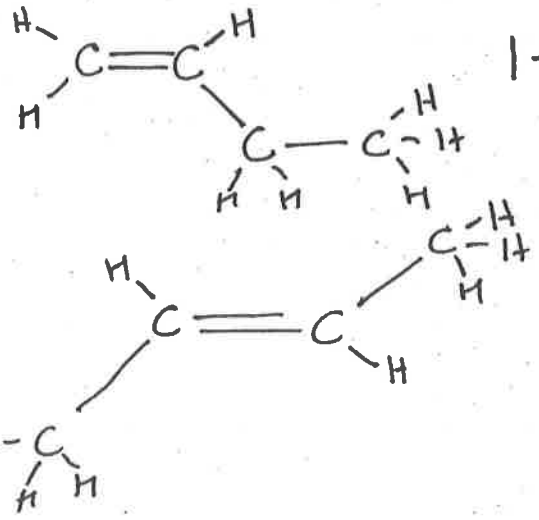
Cont'd, next page.

(31) contd

* Note, the alkenes can't transition between cis/trans without breaking a π bond, so this doesn't happen under "normal" (room temperature) conditions, however, under high temperatures, they have enough thermal energy for the π bond to break occasionally. This occurs during "partial hydrogenation" of unsaturated fats, to become more saturated (H_2 reacts with unsaturated fats at high T and P, so that C=C bonds add 2 H and become C–C single bonds.) Some of the "cis" fats that did not get hydrogenated can turn into "trans" fats, which are very unhealthy, and are associated with heart disease.

Alkynes contain C≡C triple bonds, which contain one sigma and one pi bond. Triple bonds, like double bonds, are not free to rotate, since the π bonds would have to break to do so. but since each C has only one other group attached to it besides the triple bond C, and that group is 180° away from the C≡C bond, only one orientation (along the line) is possible for the groups, so geometric isomerism is not possible.

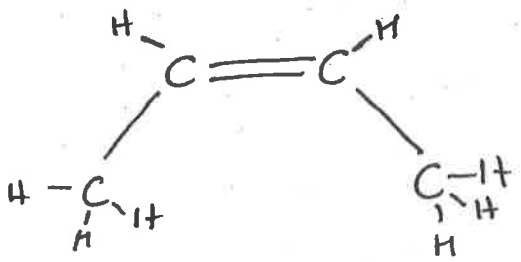
(32) Draw and name all structural and geometric isomers of butene



1-butene

(note: 1-butene is a structural isomer to 2-butene. the cis and trans versions of 2-butene are geometric isomers to each other)

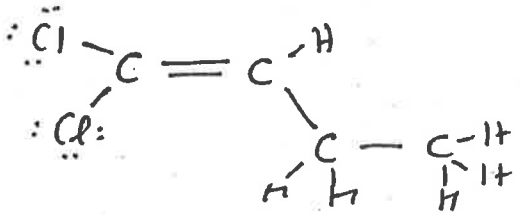
trans- 2-butene



cis- 2-butene

(33) Indicate whether each molecule is capable of cis/trans isomerism. If so, draw.

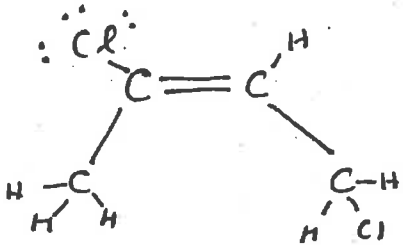
(a) 1,1-dichloro-1-butene



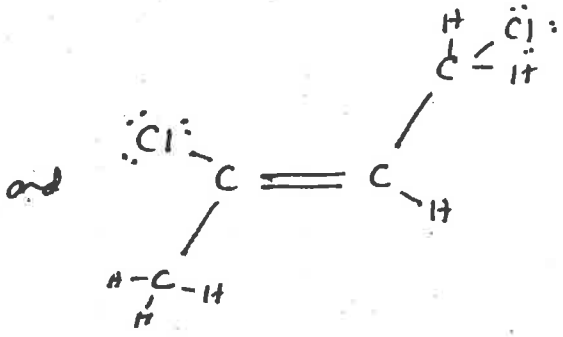
Does NOT have geom. isomers. If either C involved in the double bond (or both) has the same two atoms/groups attached, it will not have geom. isomers. In this case, the left C has the same "group" (chlorine) attached for each single bond.

(b) 2,4-dichloro-2-butene

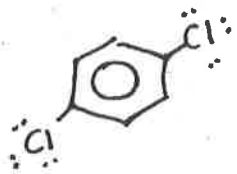
DOES have geometric isomers



and

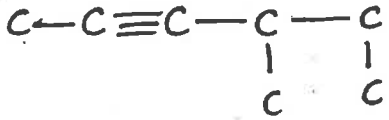


(c) 1,4 dichlorobenzene



Does NOT have geometric isomers. entire molecule is flat in plane of page.

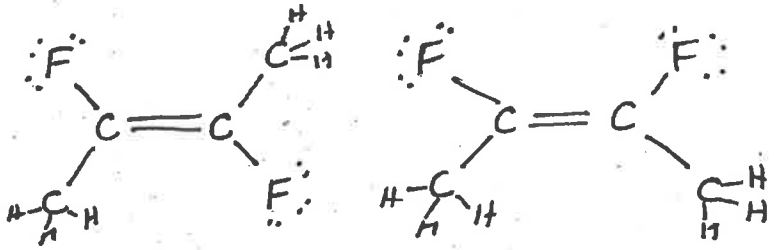
(d) 4,5-dimethyl-2-pentyne



Does NOT have geom. isomers. has no C=C bond. (and shouldn't this be 4-methyl-2-hexyne? jinkies!!!)

(e) Draw 2,3-difluoro-2-butene (both)

(f) label: cis/trans

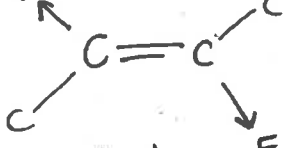


trans-2,3-difluoro-2-butene

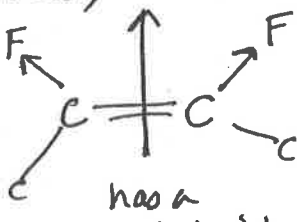
cis-2,3-difluoro-2-butene

(g) I would expect the cis isomer to have the higher b.p. since the cis isomer is polar, whereas the trans isomer is nonpolar due to symmetry.

(the trans isomer only has London Forces. the cis has London and Dipole-Dipole forces)



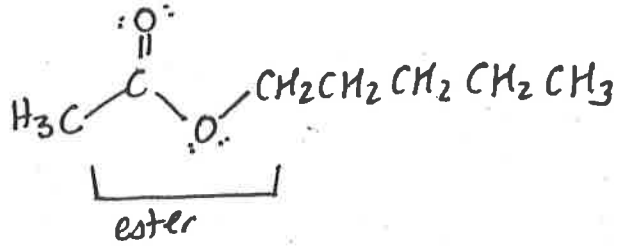
polarity cancels no net dipole



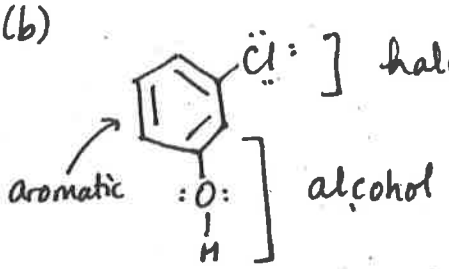
has a net dipole

(44) ID fxl groups:

(a)

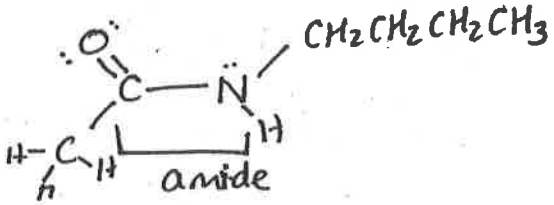


(b)

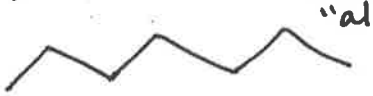


halocarbon or aryl halide or haloarene
(your book mentions "alkyl halide" as a fxnal group, but the "alkyl" is for non aromatic things like alkanes!)

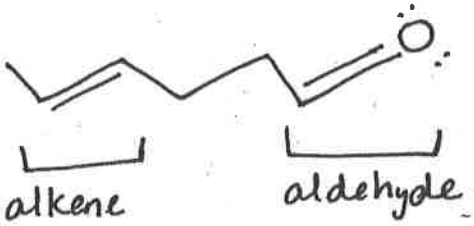
(c)



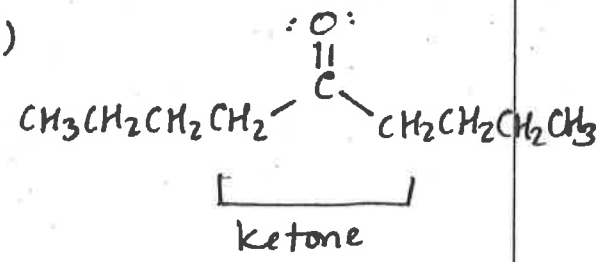
(d) alkane (could also mention "alkane" in (a) (c), (e), and (f) ...)



(e)

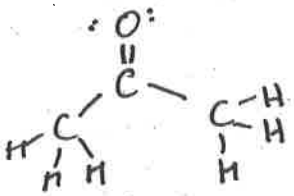


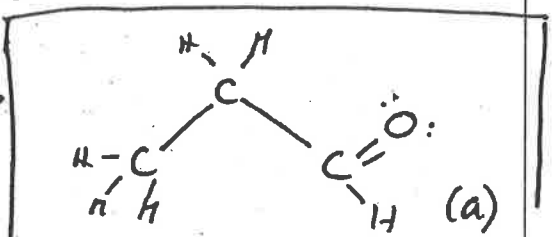
(f)



(45) give structural isomer for (a) an aldehyde that is an isomer of acetone

acetone
(propanone)
(a ketone)



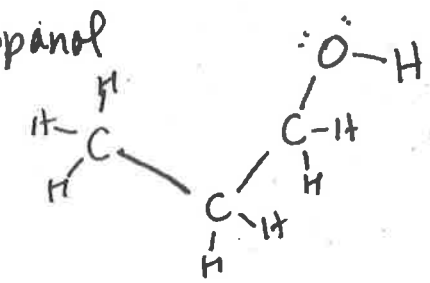


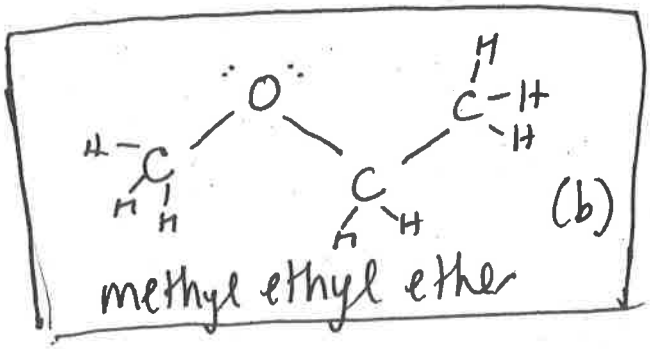
(a)

propanal / propanaldehyde
(an aldehyde!)

(b) an ether that is an isomer of 1-propanol

1-propanol



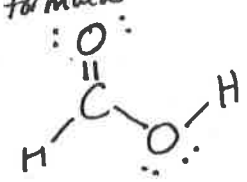


(b)

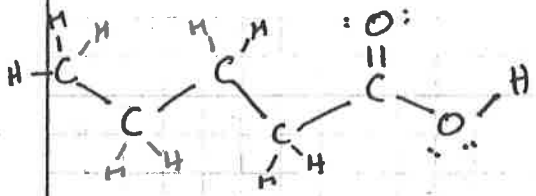
methyl ethyl ether

(47) Draw each acid's structural formula

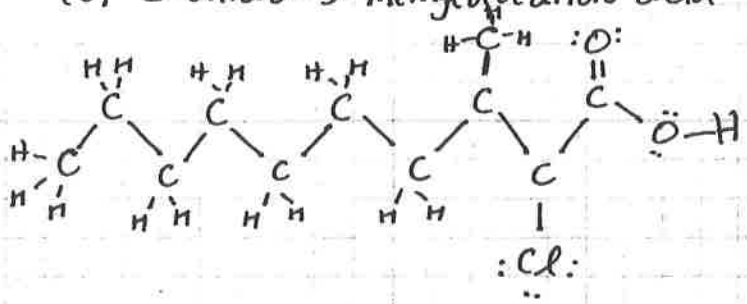
(a) methanoic acid



(b) pentanoic acid

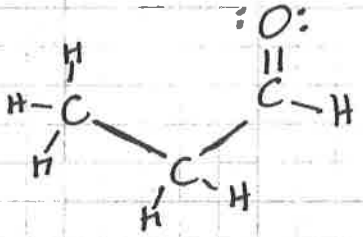


(c) 2-chloro-3-methyldecanoic acid

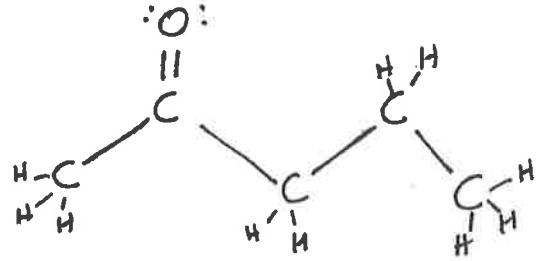


(48) Draw:

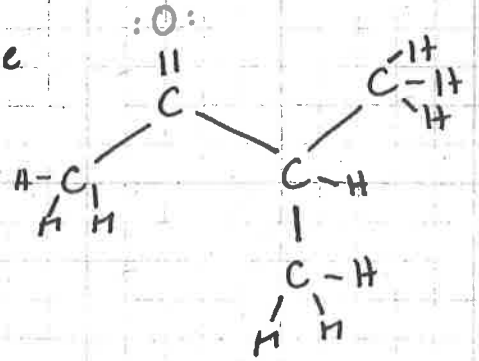
(a) propanal



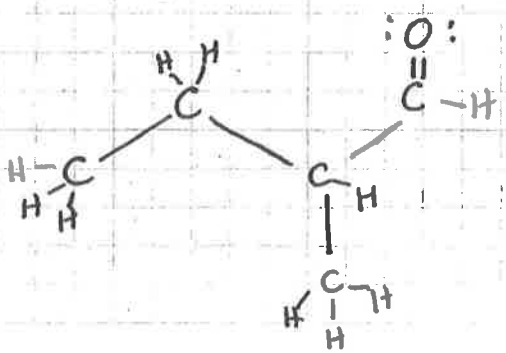
(b) 2-pentanone



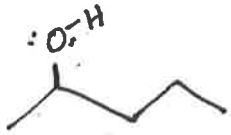
(c) 3-methyl-2-butanone



(d) 2-methylbutanal

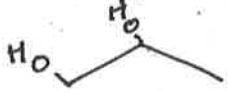


(55) Draw/write condensed structural formula

(a) 2-pentanol  → $CH_3CHOHCH_2CH_2CH_3$ (a)

could put the OH in ( ) : $CH_3CH(OH)CH_2CH_2CH_3$

(b) 1,2-propanediol (aka "propylene glycol")



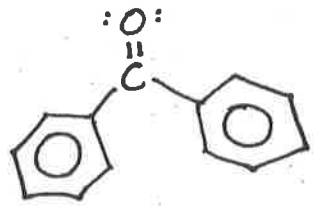
$CH_2(OH)CH(OH)CH_3$ (b)

(parentheses optional)

(c) ethyl acetate

$CH_3COOCH_2CH_3$

(d) diphenyl ketone

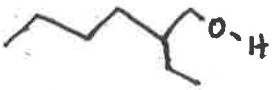


or $C_6H_5C(O)C_6H_5$

(e) methyl ethyl ether

$CH_3OCH_2CH_3$

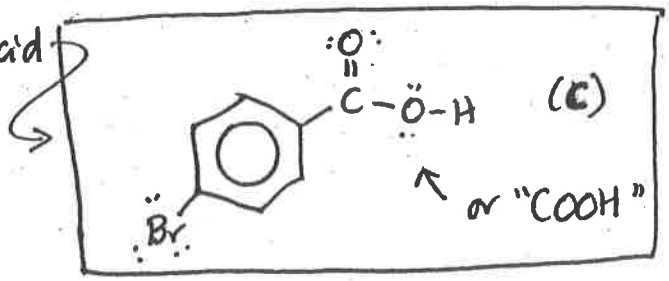
(56) a, c, d

(a) 2-ethyl-1-hexanol 

$CH_3CH_2CH_2CH_2CH(C_2H_5)CH_2OH$ (a)

(or could start at other end..)

(c) para-bromobenzoic acid



(c)

↖ or "COOH"

(d) ethyl butyl ether

$CH_3CH_2OCH_2CH_2CH_2CH_3$ (d)