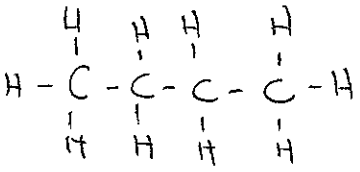
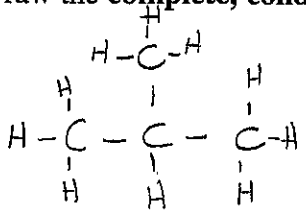
Chemistry 30
Organic Chemistry Workbook

Structural Isomers

1. Build the two isomers of butane, C_4H_{10}. Draw the **complete, condensed** and **line structural diagrams** for each isomer.



butane



methylpropane

$CH_3-CH_2-CH_2-CH_3$

$CH_3-CH(CH_3)-CH_3$

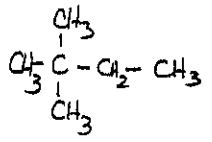
Alkanes

1. Draw and name the five possible noncyclic isomers of C_6H_{14}.

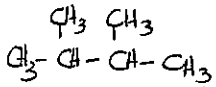
$CH_3-CH_2-CH_2-CH_2-CH_2-CH_3$ hexane

$CH_3-CH_2-CH(CH_3)-CH_2-CH_3$ 3-methylpentane

$CH_3-CH(CH_3)-CH_2-CH_2-CH_3$ 2-methylpentane



2,2-dimethylbutane



2,3-dimethyl butane

2. Name the following compounds:

a) $CH_3-CH_2-CH_2-CH_3$

butane

b) $CH_3-CH_2-CH_2-CH_2-CH(CH_2-CH_2-CH_3)-CH_2-CH_3$

octane

c) $CH_3-CH_2-C(CH_3)_2-CH_2-CH_2-CH_3$

3,3-dimethylhexane

d) $CH_3-CH_2-CH_2-CH_2-CH(CH_3)-CH_3$

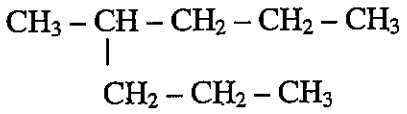
2-methylhexane

e) $CH_3-CH(CH_3)-CH(C_2H_5)-CH(C_3H_7)-CH_2-CH_2-CH_3$

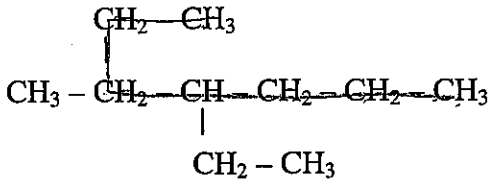
3-ethyl-2-methyl-4-propylheptane

f) $CH_3-CH_2-CH(CH_2-CH_2-CH_3)-CH_2-CH_3$

3-ethylhexane

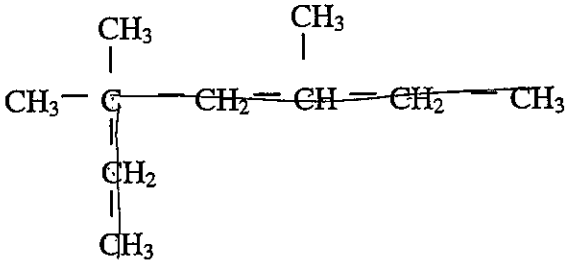
g) 

4- methylheptane

h) 

4-ethyl-3-methylheptane

3. Why is the name 2-ethyl-2,4-dimethylhexane unsuitable for the following compound? What is the correct name of the compound?

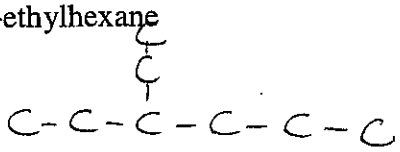


Not the longest branch

3,3,5-trimethylheptane

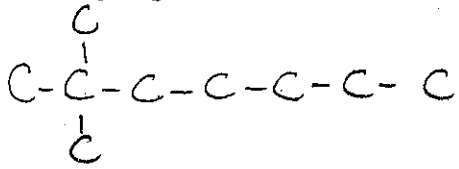
4. Draw each of the following compounds:

a) 3-ethylhexane

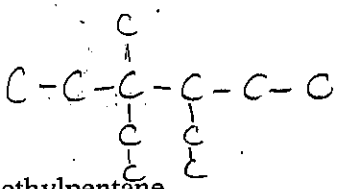


* Be sure to be careful when adding Hs to get each carbon to 4 bonds.

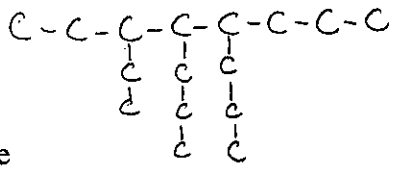
b) 2,4-dimethylheptane



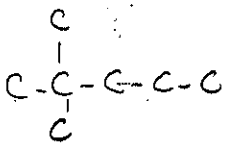
c) 3,4-diethyl-3-methylhexane



d) 3-ethyl-4,5-dipropyloctane

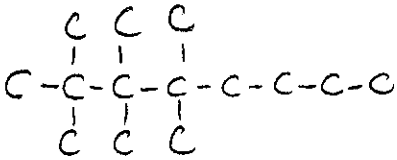


e) 2,2-dimethylpentane

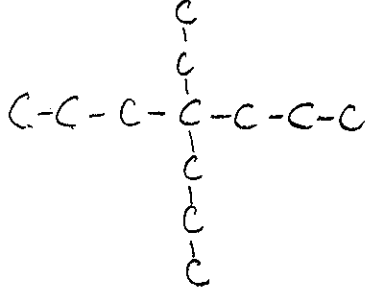


f) octane

g) 2,2,3,3,4,4-hexamethyloctane



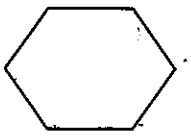
h) 4-ethyl-4-propylheptane



Cycloalkanes

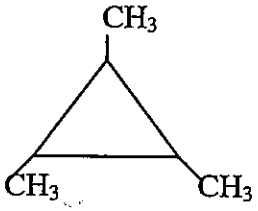
1. Name each of the following compounds:

a)



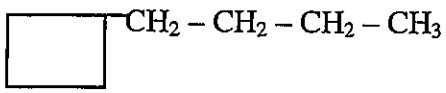
cyclohexane

b)



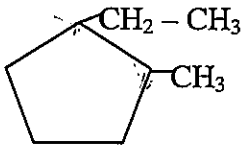
1,2,3 - trimethylpropane

c)



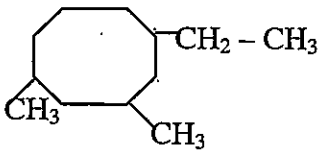
butylcyclobutane

d)



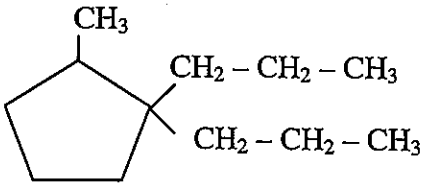
1-ethyl-2-methylcyclopentane

e)



1-ethyl-3,5-dimethylcyclooctane

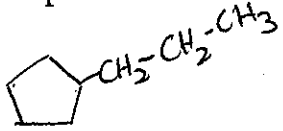
f)



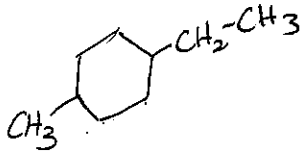
2-methyl-1,1-dipropylcyclopenta

2. Draw each of the following compounds:

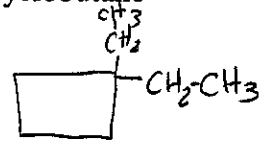
a) propylcyclopentane



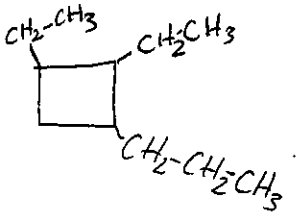
b) 1-ethyl-4-methylcyclohexane



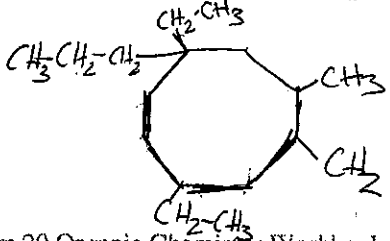
c) 1,1-diethylcyclobutane



d) 1,2-diethyl-3-propylcyclobutane



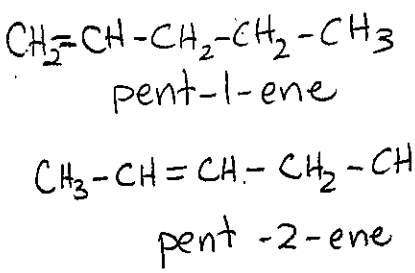
e) 1,6-diethyl-3,4-dimethyl-1-propylcyclooctane

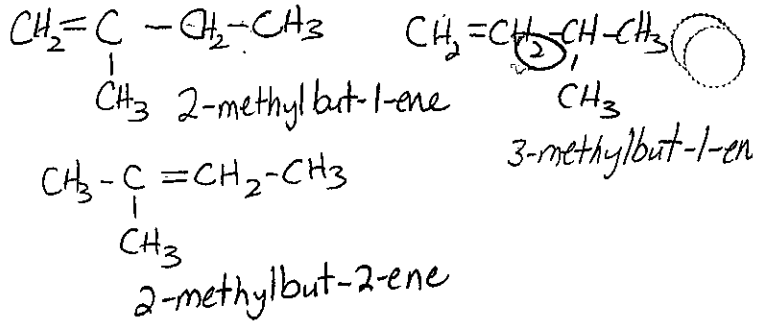


f) cyclobutane

Alkenes

1. Draw and name the five possible noncyclic isomers of C_5H_{10}.





2. Name the following compounds:

a) $CH_2 = CH_2$

ethene (ethylene)

b) $CH_2 = CH - CH_3$

propene

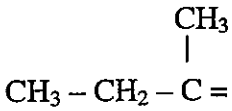
c) $CH_2 = CH - CH_2 - CH_3$

but-1-ene

d) $CH_2 - CH = CH - CH_3$

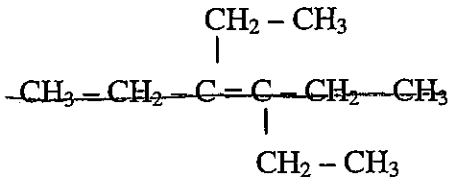
but-2-ene

e)



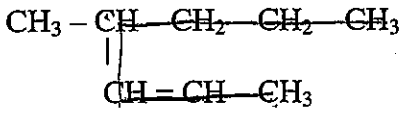
2-methylbut-1-ene

f)



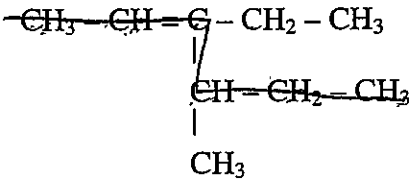
3,4-diethylhex-3-ene

g)



4-methylhept-2-ene

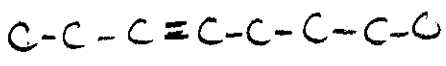
h)



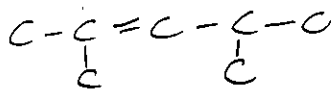
3-ethyl-4-methylhex-2-ene

3. Draw each of the following compounds:

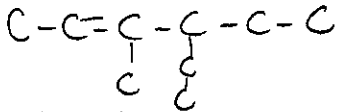
a) oct-3-ene



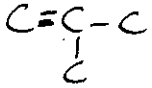
b) 2,4-dimethylpent-2-ene



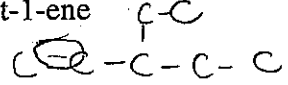
c) 4-ethyl-3-methylhex-2-ene



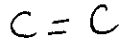
d) methylpropene



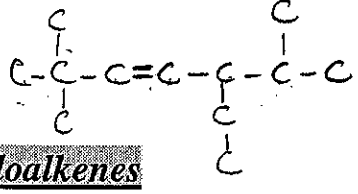
e) 3-ethylpent-1-ene



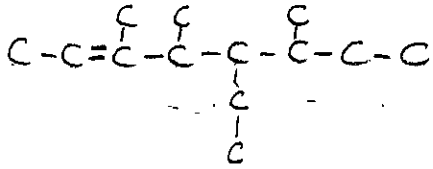
f) ethene



g) 5-ethyl-2,2,6-trimethylhept-3-ene



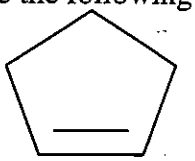
h) 5-ethyl-3,4,6-trimethyloct-2-ene



Cycloalkenes

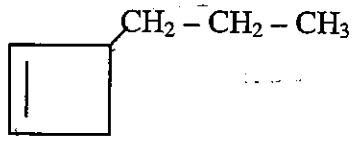
1. Name the following compounds:

a)



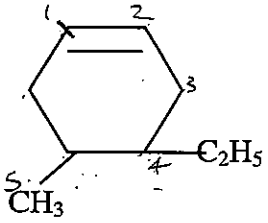
cyclopentene

b)



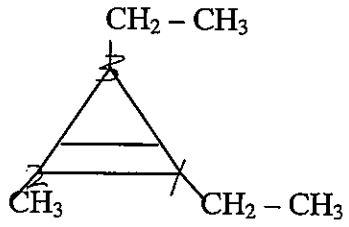
3-propylcyclobutene

c)



4-ethyl-5-methylcyclohexene

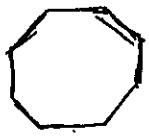
d)



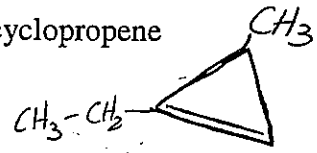
1,3-diethyl-2-methylcyclopropene

2. Draw the following compounds:

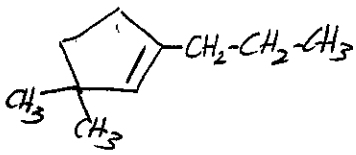
a) cyclooctene



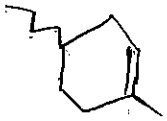
b) 1-ethyl-3-methylcyclopropene



c) 3,3-dimethyl-1-propylcyclopentene

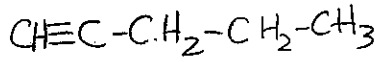


d) 4-butyl-1-methylcyclohexene

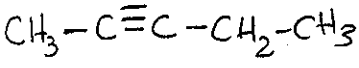


Alkynes

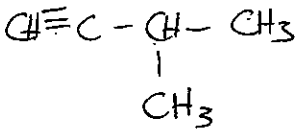
1. Draw and name the three possible noncyclic isomers of C_5H_8.



pent-1-yne



pent-2-yne



3-methylbut-1-yne

2. Name the following compounds:

a)

ethyne

(acetylene)

b)

propyne

c)

$CH \equiv C - CH_2 - CH_3$

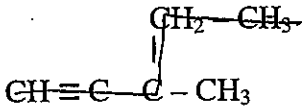
but-1-yne

d)

$CH_3 - C \equiv C - CH_3$

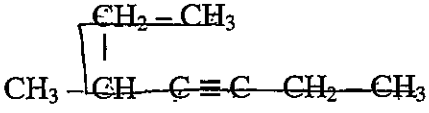
but-2-yne

e)



3-methylpent-1-yne

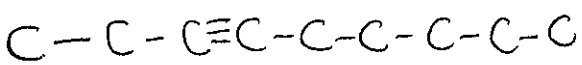
f)



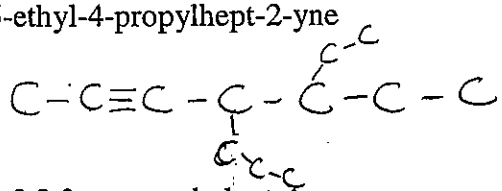
5-methylhept-3-yne

3. Draw the following compounds:

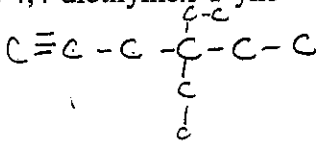
a) non-3-yne



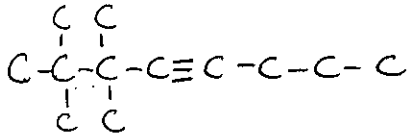
b) 5-ethyl-4-propylhept-2-yne



c) 4,4-diethylhex-1-yne

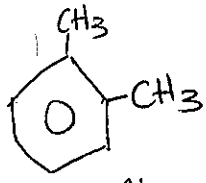


d) 2,2,3,3-tetramethyloct-4-yne

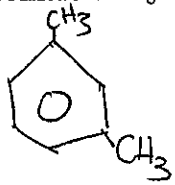


Aromatics

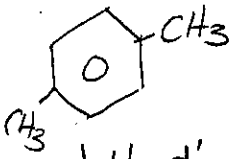
1. Draw and name the three possible isomers of $C_6H_4(CH_3)_2$.



1,2-dimethylbenzene



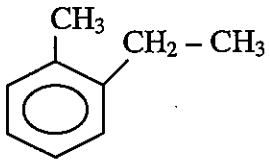
1,3-dimethylbenzene



1,4-dimethylbenzene

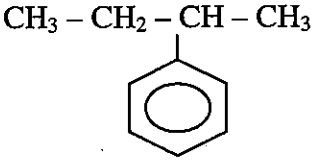
2. Name the following compounds:

a)



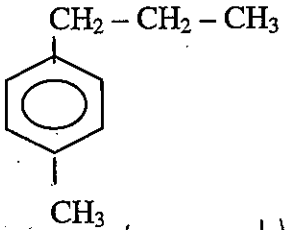
1-ethyl-2-methylbenzene

b)



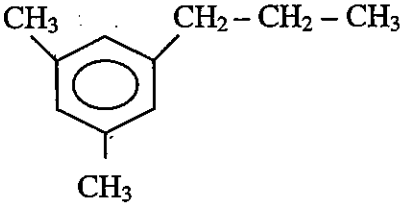
2-phenylbenzene

c)



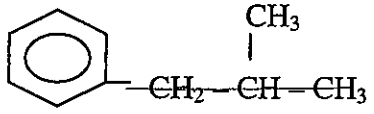
1-methyl-4-propylbenzene

d)



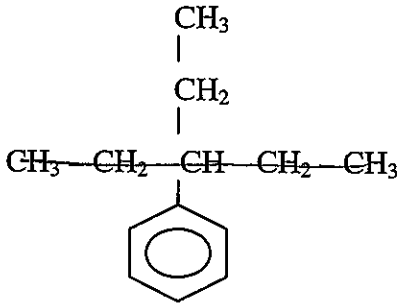
1,3-dimethyl-5-propylbenz

e)



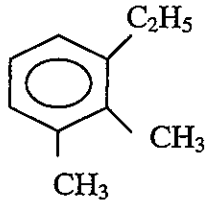
2-methyl-1-phenylpropane

f)



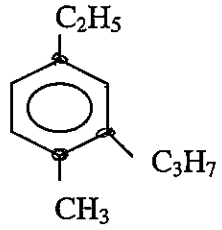
3-ethyl-3-phenylpentane

g)



1-ethyl-2,3-dimethylbenzene

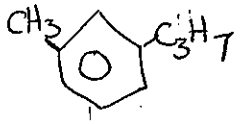
h)



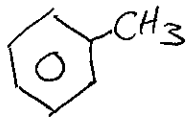
4-ethyl-1-methyl-3-propylbenzene

3. Draw the following compounds:

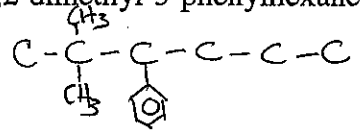
a) 1-methyl-3-propylbenzene



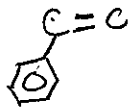
b) methylbenzene (toluene)



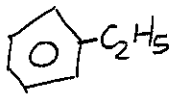
c) 2,2-dimethyl-3-phenylhexane



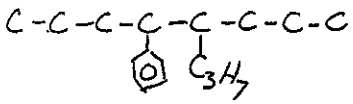
d) phenylethene



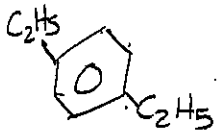
e) ethylbenzene



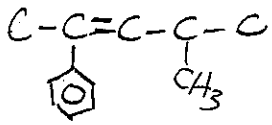
f) 4-phenyl-5-propyloctane



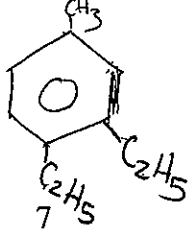
g) 1,4-diethylbenzene



h) 4-methyl-2-phenylpent-2-ene



4. Give two reasons why 1-methyl-3,4-diethylbenzene is an unsuitable name. Draw this compound and give the correct name.



(1) Not alphabetical

(2) Numbers should be 1,2 & 4

Alcohols

1. Name the following compounds:

a)

$CH_3 - OH$

methanol

b)

$CH_3 - CH_2 - OH$

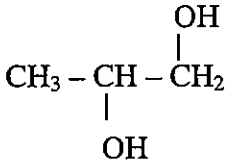
ethanol

c)

$CH_3 - CH_2 - CH_2 - OH$

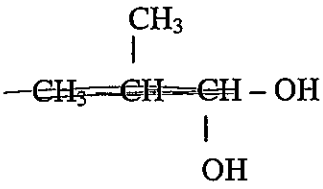
propan-1-ol

d)



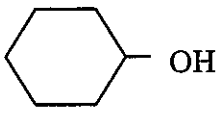
propan-1,2-diol

e)



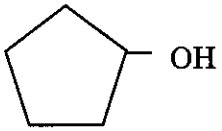
2-methylpropan-1,1-diol

f)



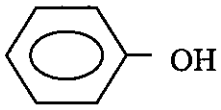
cyclohexanol

g)



cyclopentanol

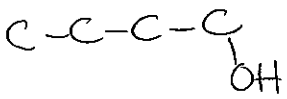
h)



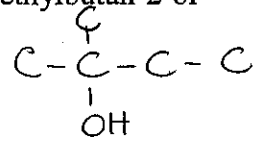
phenol

2. Draw each of the following compounds:

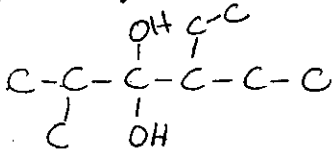
a) butan-1-ol



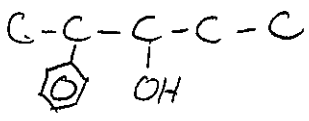
b) 2-methylbutan-2-ol



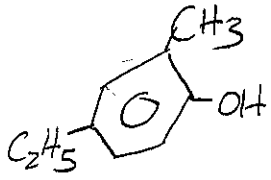
c) 4-ethyl-2-methylhexane-3,3-diol



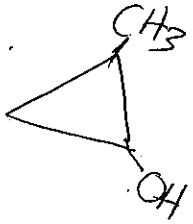
d) 2-phenylpentan-3-ol



e) 4-ethyl-2-methylphenol



f) 2-methylcyclopropanol



Organic Halides

1. Name the following compounds:

a) $CH_2Br - CF_2 - CH_2 - CH_2Cl$

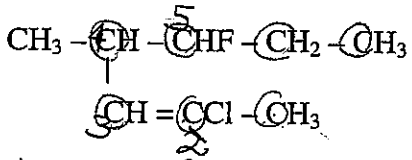
1-bromo-4-chlorobutane

b) $F - CH_2 - CH_2 - CH_2 - CH_3$

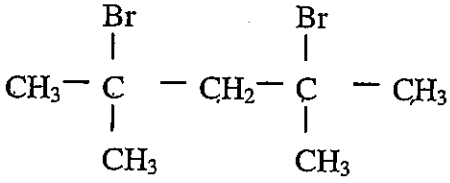
1-fluorobutane

c) $CH \equiv C - CH_2Br$

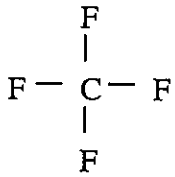
3-bromopropene

d) 

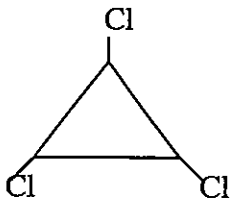
2-chloro-5-fluoro-4methylhept-2-en

e) 

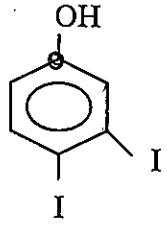
2,4-dibromo-2,4-dimethylpentane

f) 

tetrafluoromethane

g) 

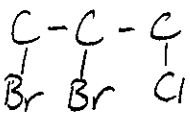
1,2,3-trichlorocyclopropane

h) 

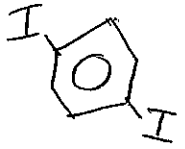
3,4-diiodophenol

2. Draw each of the following compounds:

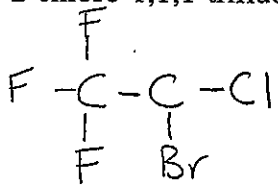
a) 1,2-dibromo-3-chloropropane



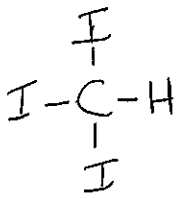
b) 1,4-diiodobenzene



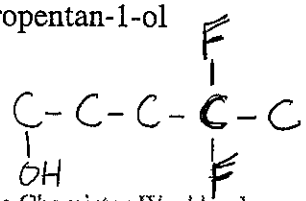
c) 2-bromo-2-chloro-1,1,1-trifluoroethane



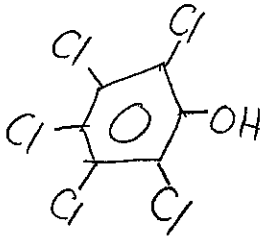
d) triiodomethane



e) 4,4-difluoropentan-1-ol

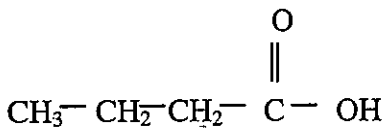


f) pentachlorophenol

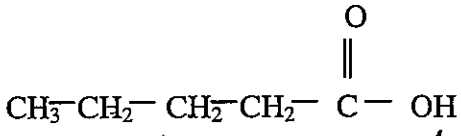


Carboxylic Acids

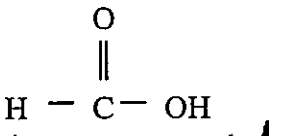
1. Name the following compounds:

a) 

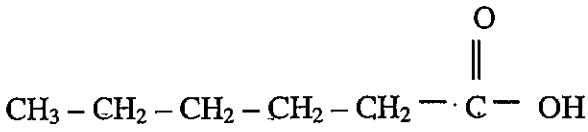
butanoic acid

b) 

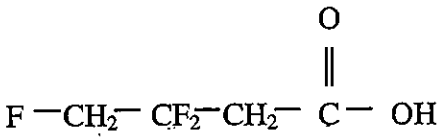
pentanoic acid

c) 

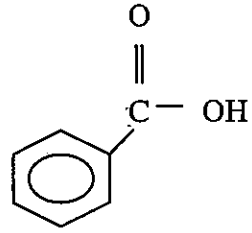
methanoic acid
(formic acid)

d) 

hexanoic acid

e) 

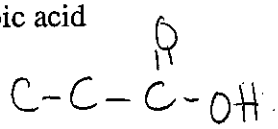
3,4-difluorobutanoic acid

f) 

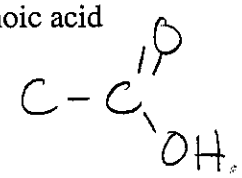
benzoic acid

2. Draw each of the following compounds:

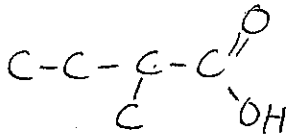
a) propanoic acid



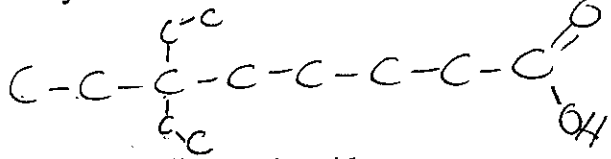
b) ethanoic acid



c) 2-methylbutanoic acid



d) 3,3-diethyloctanoic acid

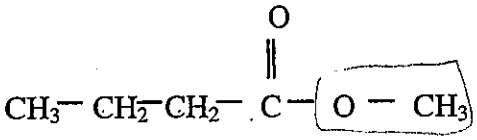


e) 4,4-diiodo-2,2-dimethylpentanoic acid

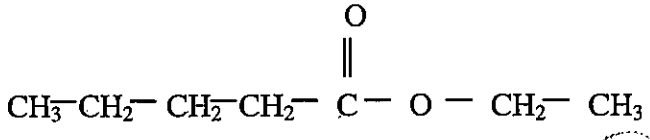
f) 3-bromo-4-methylhexanoic acid

Esters

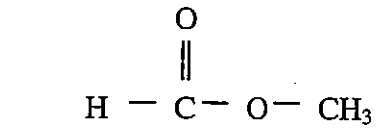
1. Name the following compounds:

a) 

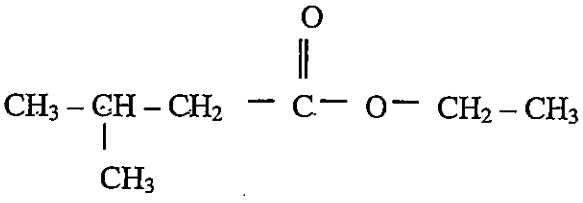
methyl butanoate

b) 

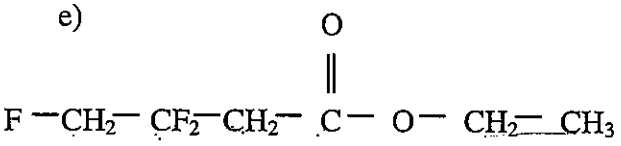
ethyl pentanoate

c) 

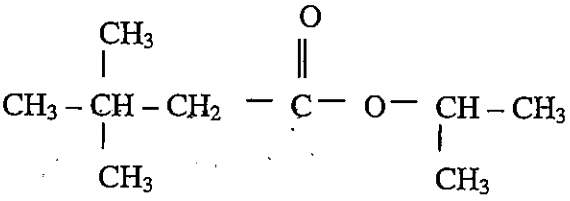
methyl methanoate

d) 

ethyl 3-methylbutanoate

e) 

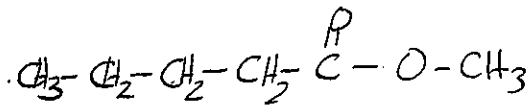
ethyl 3,3,4-trifluorobutanoate

f) 

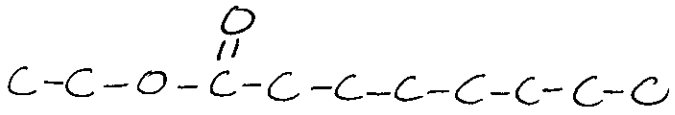
methylethyl 3,3-dimethylbutanoa

2. Draw each of the following compounds:

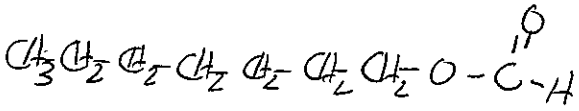
a) methyl pentanoate



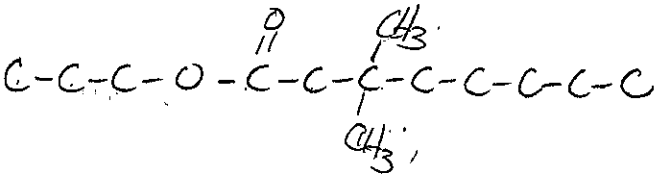
b) ethyl octanoate



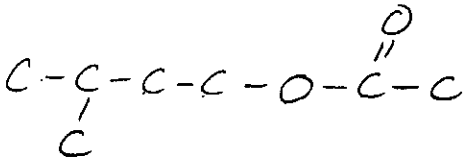
c) heptyl methanoate



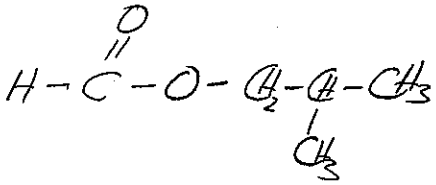
d) propyl 3,3-dimethlyoctanoate



e) 3-methylbutyl ethanoate



f) 2-methylpropyl methanoate



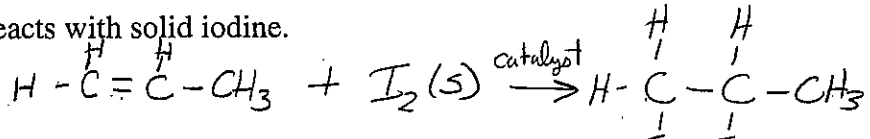
Organic Reactions

For each of the following reactions:

a. *Draw the reaction.*
b. *Give the reaction type.*
c. *Name the organic reactant(s) and product(s) ***10 carbons or less.*

1. Propene reacts with solid iodine.

addition

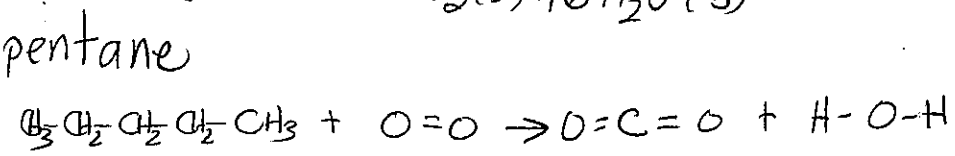


1,2-diiodopropane

2. $C_5H_{12} + 8\ O_{2(g)} \rightarrow 5CO_{2(g)} + 6H_2O_{(g)}$

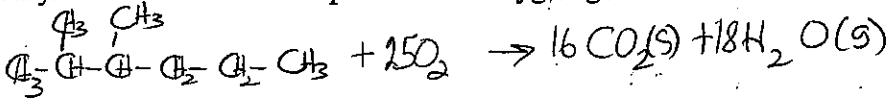
combustion

pentane



3. 2,3-dimethyl hexane burns in the presence of oxygen gas.

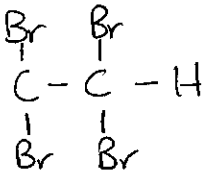
combustion



4. $H-C\equiv C-H + 2\,Br_2 \xrightarrow{cat}$

addition

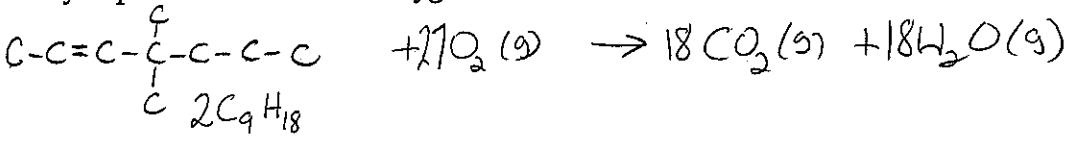
ethyne



1,1,2,2-tetrabromoethane

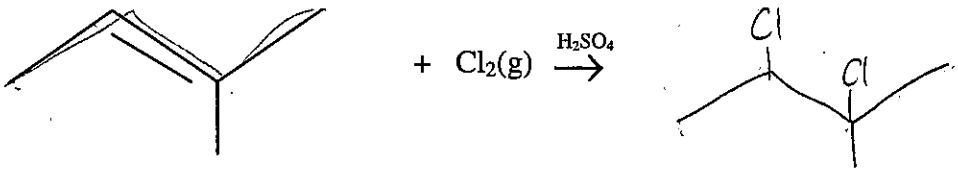
5. 4,4-dimethylhept-2-ene reacts with oxygen.

combustion



6.

addition



3-methylbut-2-ene

2,3-dichloro-2-methylbutane

7. $CH_3-CH_2-CH_2-CH_3 + O_{2(g)} \rightarrow$

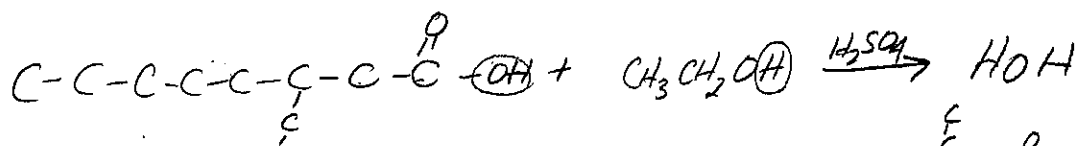
combustion

butane

C_4H_{10}

8. 3-ethyloctanoic acid reacts with ethanol.

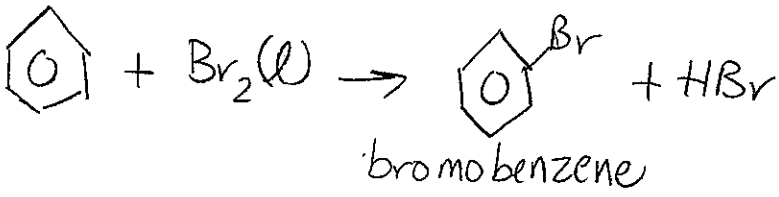
esterification



ethyl 3-ethyloctanoate

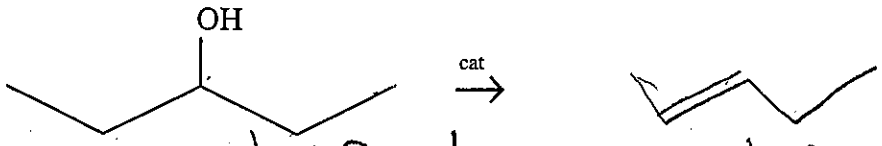
9. Benzene reacts with liquid bromine.

substitution



bromobenzene

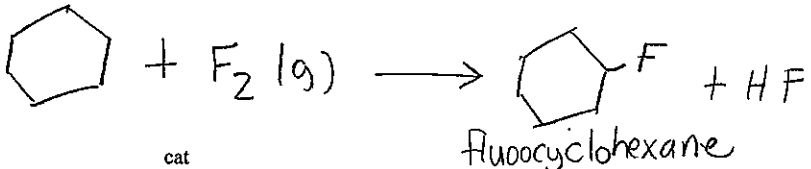
10.



elimination pentan-3-ol pent-2-ene + HOH

11. Cyclohexane reacts with fluorine gas.

substitution

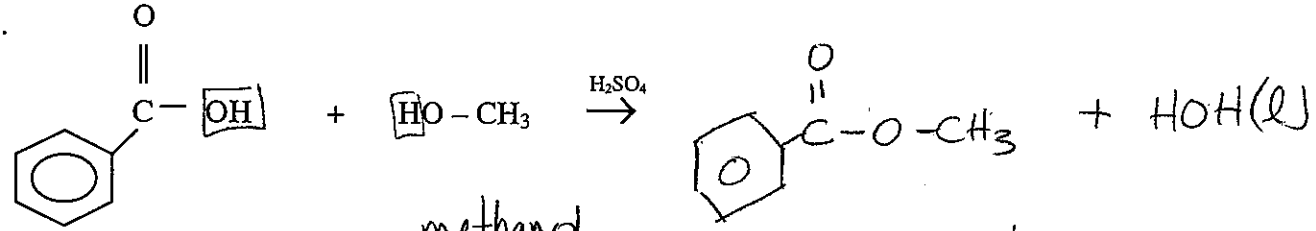


fluorocyclohexane

12.

addition pent-1-ene 1-chloropentane

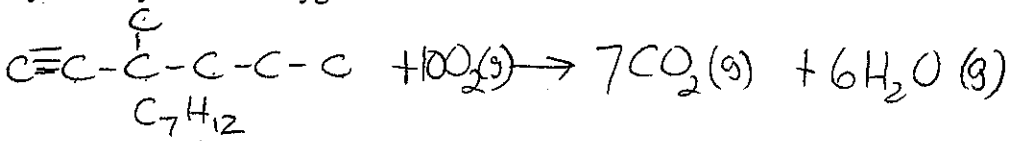
13.



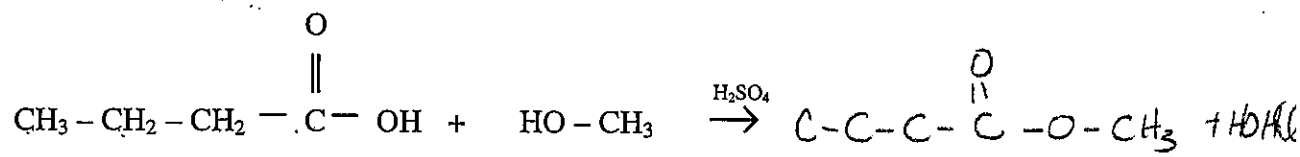
esterification benzoic acid methanol methyl benzoate

14. 3-methylhex-1-yne + oxygen →

combustion



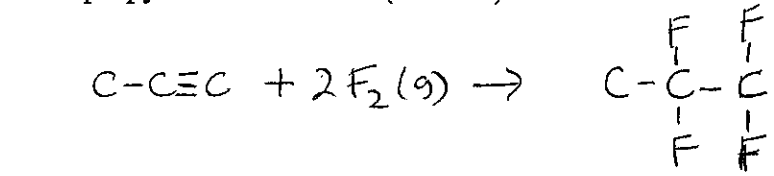
15.



esterification butanoic acid methanol methyl butanoate

16. propyne + fluorine (2 moles) →

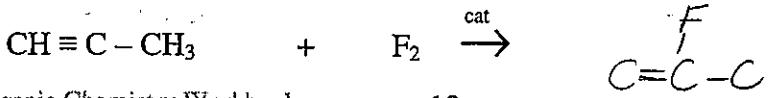
addition



1,1,2,2-tetrafluoropropane

17.

addition

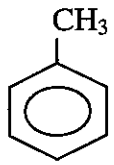


1,2-difluoropropene

18. fluoroethane + hydroxide ion $\xrightarrow{cat}$ C=C + HOH(l) + F^{1-}(aq)

elimination — C-C (F) — OH^{1-} — ethene

19.



substitution — + I_2 $\xrightarrow{cat}$

+ HI

1-iodo-2-methyl benzene
could be 1,3 or 1,4 as well

20. ethanol + pentanoic acid $\xrightarrow{H_2SO_4}$ HOH +

esterification — C-C-O-C(=O)-C-C-C-C
ethyl pentanoate

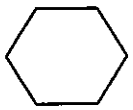
21. $CH_3-\underset{\underset{OH}{|}}{CH}-CH_2-CH_2-CH_2-CH_3$ $\xrightarrow{cat}$ HOH + $CH_2=CH-CH_2-CH_2-CH_2-CH_3$
hex-1-ene

elimination — or $CH_3-CH=CH-CH_2-CH_2-CH_3$
hex-2-ene

22. propene + hydrogen $\xrightarrow{cat}$

addition — H-C(H)(H)-C(H)=C(H)-H — H-C(H)(H)-C(H)(H)-C(H)(H)-H propane

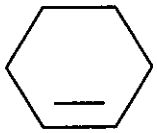
23.



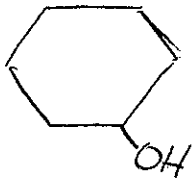
$+9O_2(g) \rightarrow 6CO_2(s) + 6H_2O(g)$

combustion — cyclohexane
C_6H_{12}

24.



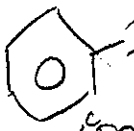
+ H – OH $\xrightarrow{cat}$



addition — cyclohexene — cyclohexanol

25. benzene + iodine $\xrightarrow{cat}$

substitution



+ HI

iodobenzene

26. butanoic acid + ethanol $\xrightarrow{H_2SO_4}$

esterification — C-C-C-C(=O)-O-H + C-C-OH → HOH + C-C-C-C(=O)-O-C-C
ethyl butanoate

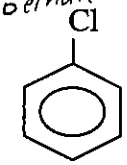
27. $C_{30}H_{62}$ + H_2 $\xrightarrow{cat}$ $C_{10}H_{22}$ + $C_{20}H_{42}$

cracking

28. chloroethane + fluorine $\xrightarrow{cat}$ CH_2CH_3 (1-chloro-1-fluroethan) or CH_2CH_2F (1-chloro-2-fluoroethan) + HF

Substitution

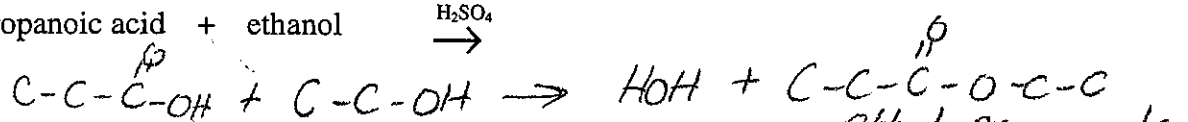
29.

Substitution + $Cl_2(aq)$ $\xrightarrow{cat}$  + HCl

30. propane + oxygen →

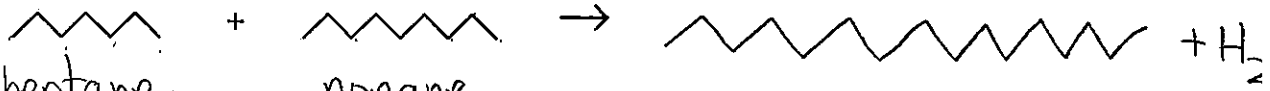
Combustion $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$

31. propanoic acid + ethanol $\xrightarrow{H_2SO_4}$

esterification 

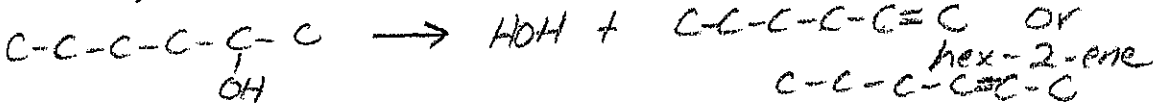
ethyl propanoate

32.



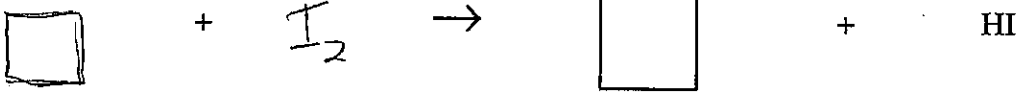
(reforming?) heptane nonane + H_2

33. hexan-2-ol $\xrightarrow{cat}$

elimination 

hex-1-ene or hex-2-ene

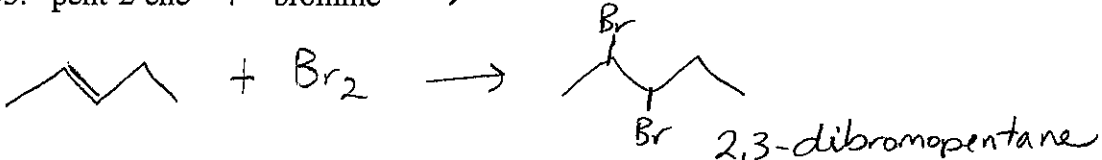
34.



Substitution + I_2 $\xrightarrow{cat}$ + HI

cyclobutane iodocyclobutane

35. pent-2-ene + bromine $\xrightarrow{cat}$

addition 

2,3-dibromopentane

36. C_7H_{16} + C_5H_{12} $\xrightarrow{cat}$  + H_2

(reforming?)

$\xrightarrow{cat}$

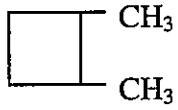
37. $C_{19}H_{40}$ + H_2 → decane + nonane

Cracking

Organic Chemistry Review

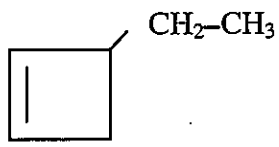
1. Name the following compounds:

a)



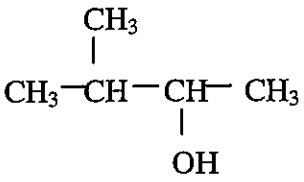
1,2-dimethylcyclobutane

b)



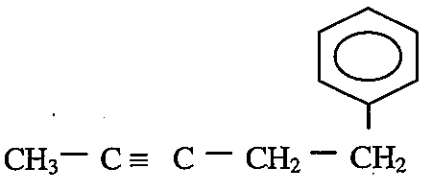
3-ethylcyclobutene

c)



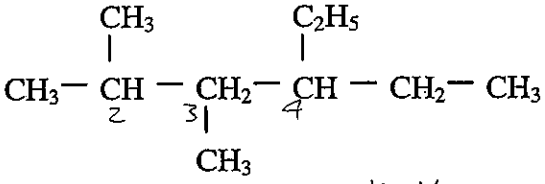
3-methylbutan-2-ol

d)



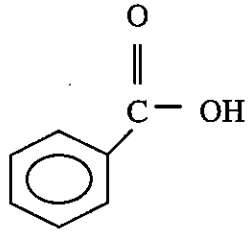
5-phenylpent-2-ene

e)



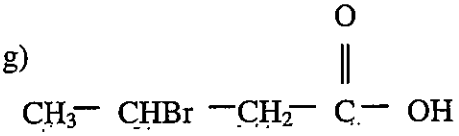
4-ethyl- 2,3-dimethylhexane

f)



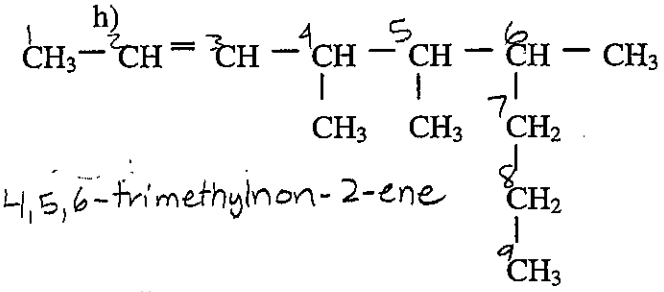
benzoic acid

g)



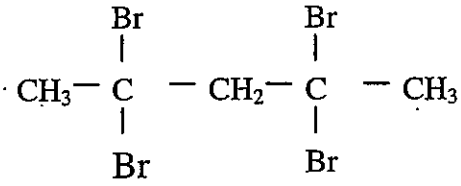
3-bromobutanoic acid

h)



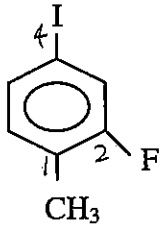
4,5,6-trimethylnon-2-ene

i)



2,2,4,4- tetrabromopentane

j)



2-fluoro-4-iodo-1-methylbenzene

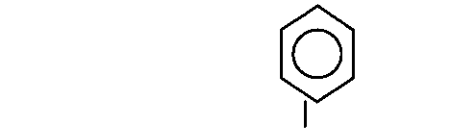
k) $CH_3-CH_2-CH_2-CH_2-C(=O)-OH$

pentanoic acid

l)

cyclohexene

m)

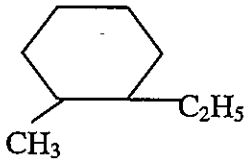


2-phenylpentane

n) $CH_3-CH_2-CH_2-CH_3$

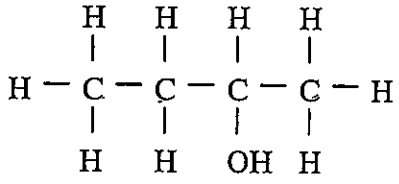
butane

o)



1-ethyl-2-methylcyclohexane

p)

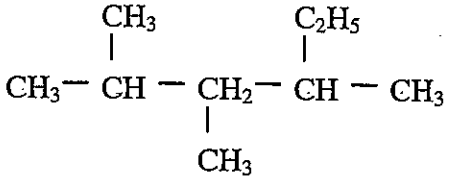


butan-2-ol

q) $CH_3-C\equiv C-CH(CH_3)-CH(CH_3)-CH_3$

4,5-dimethylhex-2-ene

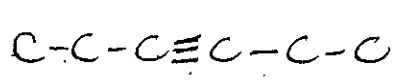
r)



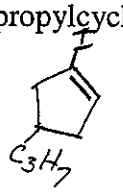
2-ethyl-3,4-dimethylpentane

2. Draw the structure for the following compounds:

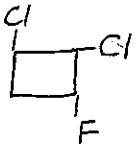
a) hex-3-yne



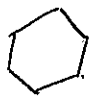
b) 1-iodo-4-propylcyclopentene



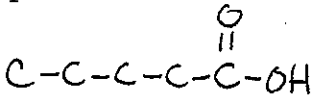
c) 1,2-dichloro-3-fluorocyclobutane



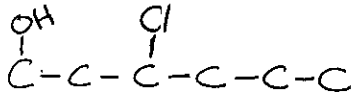
d) hexane



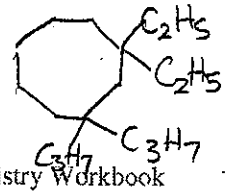
e) pentanoic acid



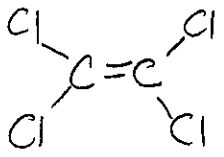
f) 3-chlorohexan-1-ol



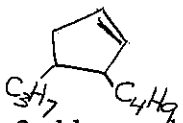
g) 1,1-diethyl-3,3-dipropylcyclooctane



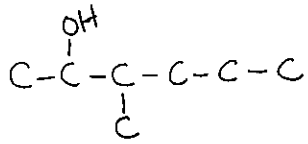
h) tetrachloroethene



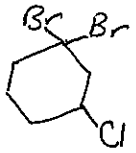
i) 3-butyl-4-propylcyclopentene



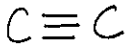
j) 3-methylhexan-2-ol



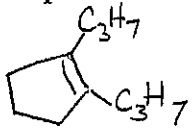
k) 1,1-dibromo-3-chlorocyclohexane



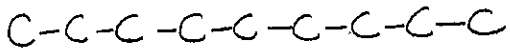
l) ethyne



m) 1,2-dipropylcyclopentene

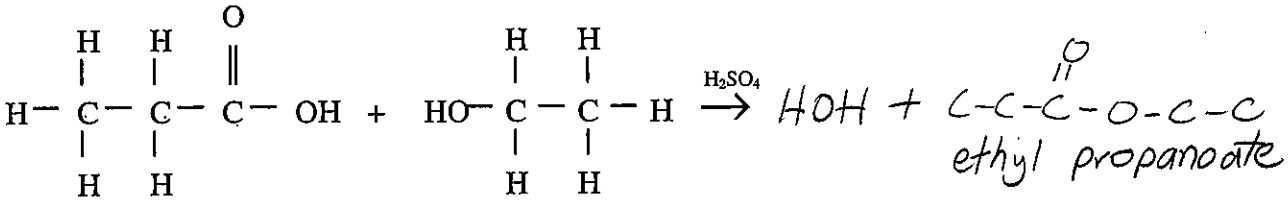


n) nonane



3. Complete each of the following reactions, name the organic reactant(s) and/or product(s), **and** give the reaction type.

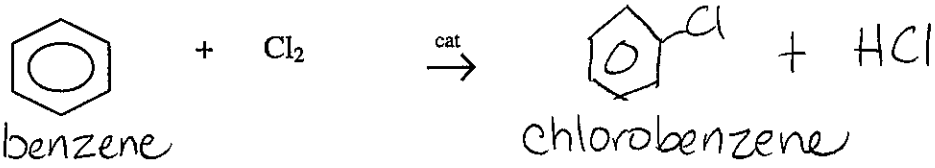
a)



esterification

propanoic acid ethanol ethyl propanoate

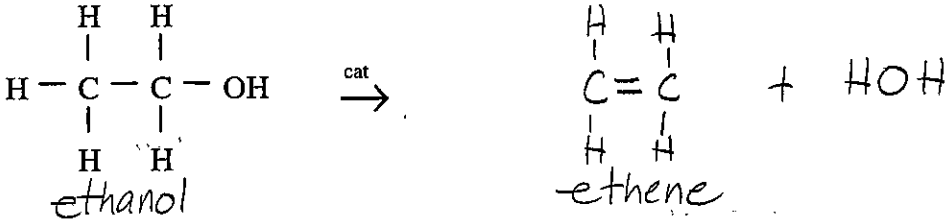
b)



substitution

benzene chlorobenzene

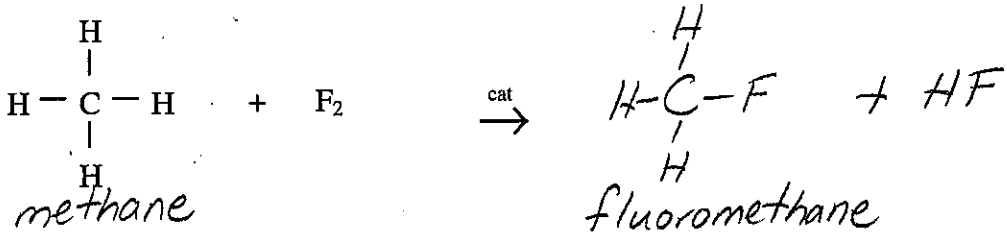
c)



elimination

ethanol ethene

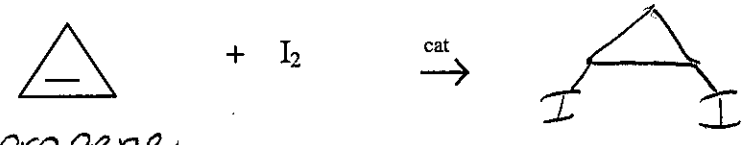
d)



substitution

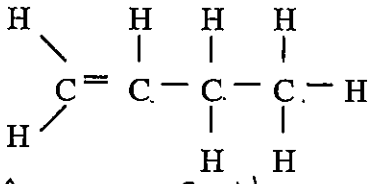
methane fluoromethane

e)

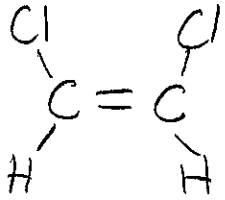


addition

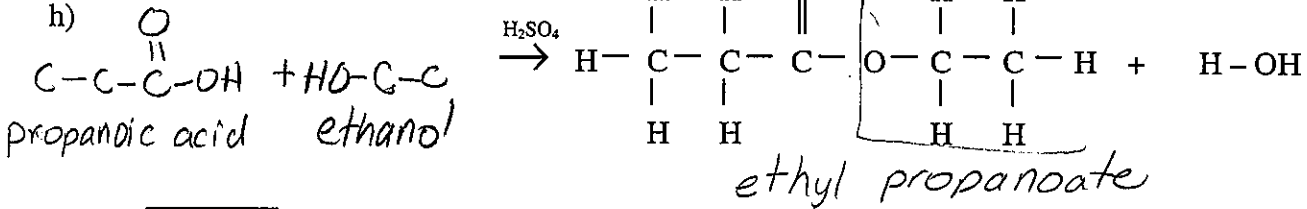
propene 1,2-diiodopropane

f)  $+6O_{2(g)} \rightarrow 4CO_{2(g)} + 4H_2O_{(g)}$

combustion C_4H_8

g) $H-C\equiv C-H + 1\,Cl_2 \xrightarrow{\text{acid}}$  1,2-dichloroethene

addition

h) 

propanoic acid ethanol

ethyl propanoate

i)  $+6O_{2(g)} \rightarrow 4CO_{2(g)} + 4H_2O_{(g)}$

combustion C_4H_8

6. Make a chart to list the organic compounds that are polar and nonpolar.

polar	nonpolar
- alcohols	- alkanes, alkenes, alkynes
- carboxylic acids	- benzene
- some organic halides	
- esters	

7. You have 4 clear colourless solutions all with the same number of carbons: an alkane, an alkene, a carboxylic acid and an alcohol. Design a procedure you could use to correctly label all four solutions.

30-C1.1s – design a procedure to identify types of organic compounds

① Test with litmus paper - the solution that turns blue litmus red is the acid.

② Check the other 3 for solubility with water. The one that is soluble in water is the alcohol.

③ Now test the alkane & alkene with bromine water the one that reacts with bromine to become colorless is the alkene.