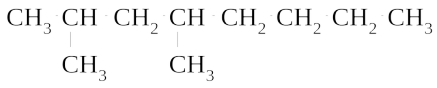
ORGANIC CHEMISTRY - - Revision Problems

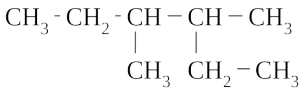
Alkanes

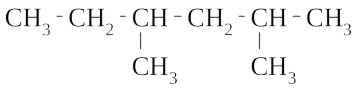
1. Name the following alkanes:

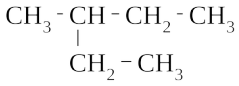
a) C_3H_8

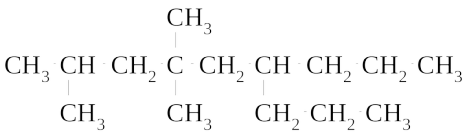
b) $CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$

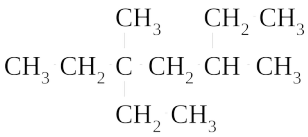
c) 

d) 

e) 

f) 

g) 

h) 

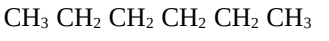
i) $(CH_3)_2CHCH_2CH(CH_3)_2$

j) $CH_3C(CH_3)_2CH(CH_2CH_3)CH_2CH_3$

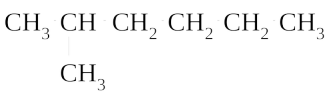
2. Give the structural formulae of the following

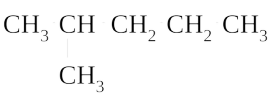
a) hexane
b) 3-methylpentane
c) 4-ethyl-2-methylheptane
d) 2,4-dimethyl-4-propyloctane
e) methylpropane
f) ethylpentane

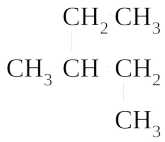
3. Which of the following substances make up a group of structural isomers?

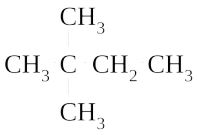
A 

B 

C 

D 

E 

F 

4. Give the structural formulae and names of <u>five</u> structural isomers with the molecular formula of C_8H_{18}.

5. Write balanced equations for the following reactions.

a) 1 mole of bromine is reacted with 1 mole of methane in the presence of UV light.
b) 1 mole of fluorine is shaken with 1 mole of propane in the presence of sunlight.
c) 1 mole of chlorine is mixed with 1 mole of pentane and the mixture is placed in a dark cupboard.
d) Methane is shaken with an excess of iodine, in the presence of UV light.
e) Chlorine gas (in excess) is mixed with butane and the mixture is exposed to UV light for several hours.
f) Bromine and ethane are mixed in a 1:1 mole ratio. The mixture is then exposed to UV light for several hours.
g) Decane is burnt in air.

6. Give the structural formula of an example of each of the following:

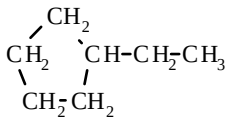
a) an aliphatic hydrocarbon

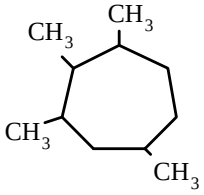
b) a straight chain alkane

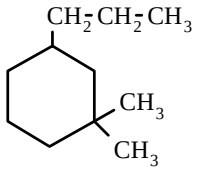
c) a branched chain hydrocarbon

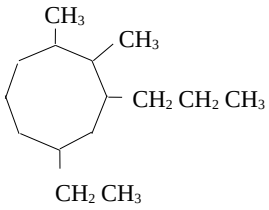
d) an alicyclic alkane

7. Name the following compounds:

a) 

b) 

c) 

d) 

8. Give the structural formulae of the following:

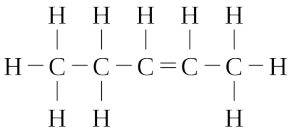
a) methylcyclohexane

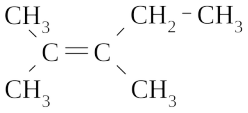
b) 3-ethyl-1,1-dimethylcyclopentane

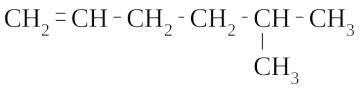
Alkenes

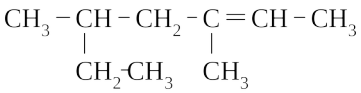
9. Draw electron dot diagrams of the following: a) ethane b) propene

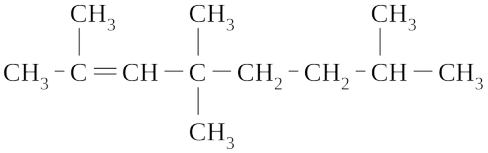
10. Name the following substances:

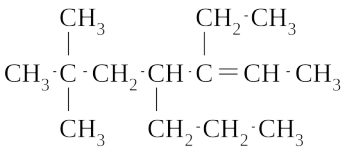
a) 

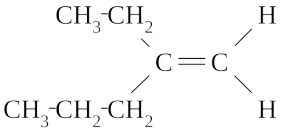
b) 

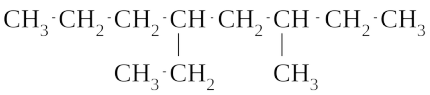
c) 

d) 

e) 

f) 

g) 

h) 

11. Draw the structural formulae of the following:

a) 2,3-dimethylnon-4-ene

b) methylpropene

c) 3-ethyl-2,4-dimethylpent-2-ene

12. There are many structural isomers with the molecular formula of C_6H_{12}

a) Give the structural formulae and names of three isomers (of C_6H_{12}) which are alkenes.

b) Give the structural formulae and names of two isomers (of C_6H_{12}) which are cycloalkanes.

13. Give the structural formulae and names of the geometrical isomers of

a) 1,2-dichloroethene b) 1-chloro-2-fluoroethene c) but-2-ene

d) 1-bromopropene e) pent-2-ene

14. Which of the following substances exhibit geometrical isomerism?

a) propane b) propene c) 1,2-difluoroethene

d) 1,2-dichloroethane e) 1,1-dichloroethene f) 1-chloro-2-bromoethene

g) 1,1-dibromo-2,2-difluroethene h) methylpropene i) 2-bromobut-2-ene

j) 2-methylbut-2-ene k) 1,2-dibromo-1,2-dichloroethene l) hex-3-ene

15. Write equations for the following reactions. Show the formulae of the organic compounds as structural formulae.

a) Ethene is reacted with chlorine, in the absence of UV light

b) Propene is mixed with chlorine and allowed to react for a very short time.

c) But-1-ene is mixed with hydrogen in the presence of a catalyst.

d) A mixture of ethene and bromine (in excess) are allowed to react in the presence of UV light for several hours.

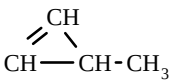
e) Ethane is mixed with an excess of fluorine and the mixture is exposed to ultraviolet light for several hours.

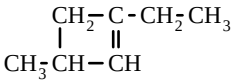
f) Iodine and pent-2-ene are mixed in a 1:1 mole ratio and allowed to react.

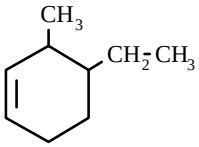
g) 2-methylbut-2-ene is reacted with fluorine in the absence of UV light.

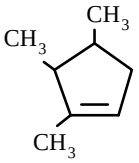
h) Hex-1-ene is burnt in air.

16. Give the names of the following compounds:

a) 

b) 

c) 

d) 

17. Draw the structural formulae of the following compounds:

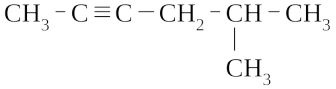
a) 3-methylcyclohexene b) 1,2,3-trimethylcyclopentene

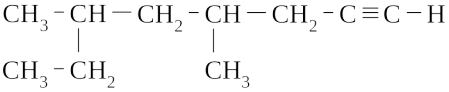
c) 1-ethyl-3-propylcycloheptane d) 4,4-dimethylcyclopentene

<u>Alkynes</u>

18. Give the names of the following:

a) $H - C \equiv C - CH_3$ b) $CH_3 - CH_2 - C \equiv C - CH_3$

c) 

d) 

19. Give the structural formulae of the following compounds:

a) dec-3-yne b) 4-ethyl-4,5-dimethylhex-2-yne

20. There are many structural isomers with the molecular formula of C_5H_8

a) Give the structural formulae and names of three isomers (of C_5H_8) which are alkynes.

b) Give the structural formulae and names of two isomers (of C_5H_8) which are cycloalkenes.

c) Give the structural formulae of two isomers (of C_5H_8) which are dienes (i.e. contain two double bonds).

21. Identify by name and structural formula each of the following:

a) an alkyne other than but-1-yne which has only four carbon atoms.

b) an alkane other than butane which has only four carbon atoms.

c) an unsaturated aliphatic hydrocarbon with a formula of C_6H_{12}.

d) a saturated hydrocarbon with a formula of C_4H_8.

e) an alicyclic hydrocarbon with a formula of C_4H_6

22. Write equations for the following reactions. Give structural formulae for the organic compounds. Identify each reaction as an addition reaction or a substitution reaction.

a) 1 mole of ethyne is reacted with 1 mole of bromine.

b) 1 mole of propyne is reacted with 2 mole of chlorine.

c) but-1-yne is reacted with an excess of fluorine in the absence of UV light.

d) propyne is added to an excess of bromine and the mixture is allowed to react for several hours in the presence of UV light.

e) the hydrogenation (reaction with hydrogen) of methylbutyne.

f) the reaction of 1 mole of ethane with 1 mole of chlorine in the presence of UV light

g) the reaction of ethene with bromine in the absence of UV light.

h) the preparation of chloromethane (CH_3Cl)

i) the preparation of 1,2-difluoropropane

j) the preparation of 2,3-dichlorobut-2-ene

k) the combustion of oct-1-yne

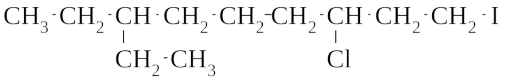
23. Draw <u>four</u> structural isomers of aromatic compounds with the formula C_9H_{12}. Name these isomers.

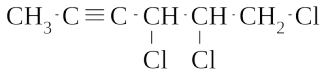
<u>Halogen substituted alkanes</u>

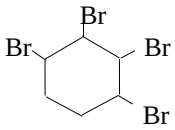
24. Name the following compounds:

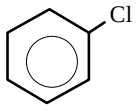
a) $CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - F$

b) $CH_2 = CH - CH_2 - CH_2 - Br$

c) 

d) 

e) 

f) 

25. Draw the structural formulae of the following compounds:

a) 1,2-dibromobutane

b) 3-chloro-2-methylpent-1-ene

c) trans-2,3-difluorobut-2-ene

d) cis-1,2-dichloropropene

26. Give the structural formulae and names of three structural isomers of the formula C_4H_7Cl . Include in your answer an aliphatic compound and an alicyclic compound.

27. Give the structural formulae and names of the geometrical isomers of

a) $C_2H_2Br_2$

b) C_4H_8

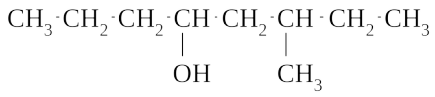
28. Give the structural formulae and names of the structural isomers of the formula $C_2H_2Br_2$.

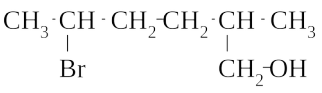
Alcohols

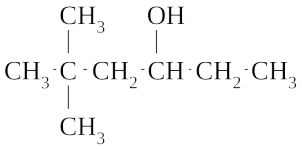
29. Give the names of the following compounds:

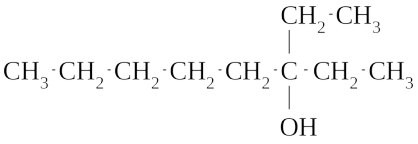
a) $CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2\,OH$

b) $HO - CH_2 - CH_2 - CH_2 - CH_2 - OH$

c) 

d) 

e) 

f) 

30. Identify each of the alcohols in question 29. as a “primary”, “secondary” or “tertiary” alcohol.

31. Give the structural formulae of the following compounds:

a) pentan-2-ol

b) trimethylbutan-2-ol

c) 2-methylcyclohexanol

d) 2,2-dichlorohexane-1,7-diol

e) sodium methoxide

f) butan-2-oxide ion

32. Methanol is very soluble in water because hydrogen bonds can form between the water molecules and the methanol molecules. Draw a diagram, using structural formulae, which shows how methanol molecules can hydrogen bond to water molecules.

33. Ethanol is a liquid at room temperature whereas ethane is a gas. Explain this observation.

34. Write equations, using structural formulae, for the following reactions:

a) sodium is added to water

b) sodium is added to ethanol

c) sodium is added to propan-2-ol

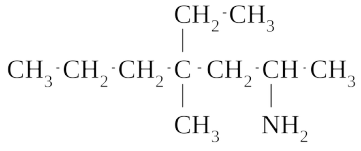
35. Give the structural formulae and names of a primary alcohol, a secondary alcohol and a tertiary alcohol with the following formulae:

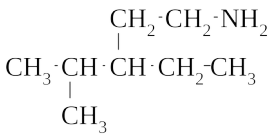
a) $C_4H_{10}O$

b) $C_6H_{14}O$

Amines

36. Name the following compounds:

a) 

b) 

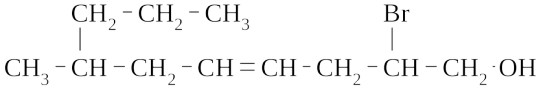
37. Give the structural formulae of the following substances:

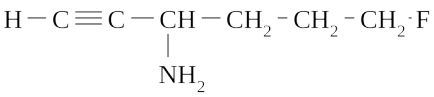
a) 2,4,4-trimethylhexan-2-amine

b) 3-amino-2-methylbutan-1-ol

38. Give an equation, using structural formulae, for the reaction between propan-2-amine and hydrochloric acid.

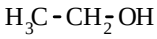
39. Identify and name the functional groups in the following compounds:

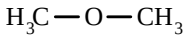
a) 

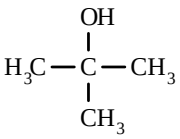
b) 

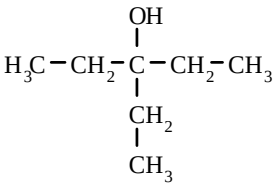
TEE Questions

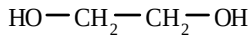
40. Which one of the following is a secondary alcohol?

A 

B 

C 

D 

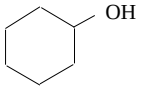
E 

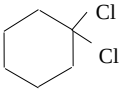
41. When an organic compound was treated with chlorine in the presence of ultraviolet light, a major reaction product was chlorocyclohexane. Which one of the following was the original organic compound?

A benzene 

B cyclohexane 

C cyclohexene 

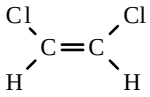
D cyclohexanol 

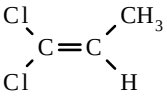
E 1,1-dichlorocyclohexane 

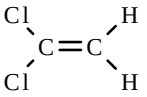
42. How many compounds are possible with formula $C_2F_4Cl_2$?

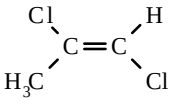
A 1 B 2 C 3 D 4 E 6

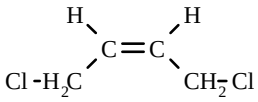
43. Which one of the following is a trans isomer?

A 

B 

C 

D 

E 

44. Draw structural formulae and give the names of all the isomers of molecular formula C_3H_5Cl.

45. An amine may be regarded as an alkyl-substituted ammonia. Butylamine (butan-1-amine, $CH_3CH_2CH_2CH_2NH_2$) is a liquid with a low boiling point and a strong ammonia-like fishy smell.

a) When a sample of butylamine is shaken with excess 0.1 mol L^{-1} hydrochloric acid the resulting solution has no odour. What has happened to the butylamine molecules?

b) Why was the odour lost?

c) When a little 0.1 mol L^{-1} sodium hydroxide is shaken with the resulting mixture the strong fishy stink returns. Why is this?

d) Why was **excess** dilute hydrochloric acid needed to get rid of the odour, but only a **little** sodium hydroxide solution needed to bring it back?

46. A compound has the formula C_6H_{12}. Which one of the following could it be?

A A straight chain alkane B A branched chain alkane C An alkene with one double bond
D An alkyne with one triple bond E An aromatic hydrocarbon

47. Write equations for any reactions that occur in the following procedures. In each case describe in full what you would observe, including any colours, odours, precipitates (give the colour), gases evolved (give the colour or describe as colourless). If a reaction occurs but the change is not visible, you should state this.

a) Pent-1-ene is shaken with a little bromine water.

b) A small piece of sodium is added to ethanol.

c) A piece of sodium metal is added to methanol

48. Identify by name or formula an example of each of the following.

a) A tertiary alcohol

b) A secondary alcohol with five carbon atoms

c) An alkane other than heptane whose molecule contains exactly seven carbon atoms.

d) A tertiary alcohol containing five carbon atoms.

e) A substance, other than water, which is a liquid at room temperature and pressure and which has hydrogen bonding between its molecules.

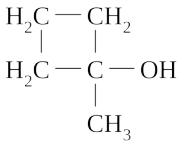
49. Briefly explain each of the following

Statement	Explanation
There are two isomers of 1,2-dichloroethene, but there is only one 1,2-dichloroethane	
There are two isomers of 1,2-dichloroethene, but there is only one 1,1-dichloroethene	

50. How many structural isomers are there of formula $C_3H_6Cl_2$?

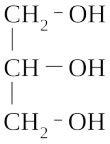
A 1 B 2 C 3 D 4 E 5

51. Which of the following are tertiary alcohols?

I 

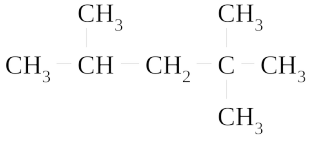
II $(CH_3)_3COH$

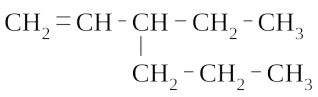
III $CH_3CH_2CH_2OH$

IV 

A I and II only B I, II and IV only C II and IV only
D II, III and IV only E All four alcohols

52. Write the systematic (IUPAC) name of each of the following:

a) 

b) 

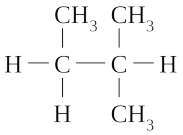
53. Give a chemical test which would distinguish between cyclohexane and cyclohexene. State the observations you would expect to make, and give the equation for any reaction.

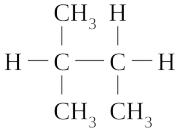
54. Write structural formulae and systematic (IUPAC) names for all isomers of molecular formula $C_2H_2Cl_2$.

55. Draw the structures of the following species, representing **all** the valence shell electron pairs as either **:** or as -

a) trichloromethane (chloroform) b) chloroethane c) trans-1,2-dibromoethene

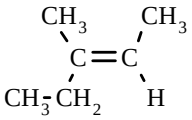
56. In which one of the following can geometric (*cis/trans*) isomerism occur?

A 

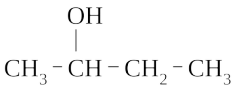
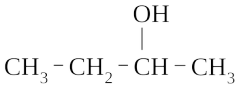
B 

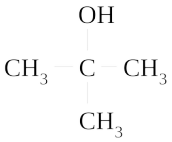
C $(CH_3)_2C = CHCH_3$

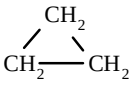
D $CH_3CH_2CH=CHCH_3$

E 

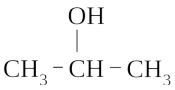
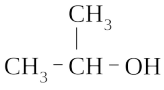
57. Which of the following is a pair of isomers?

A  and 

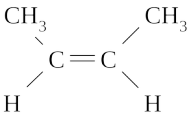
B  and $CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - OH$

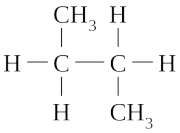
C $CH_3 - CH_2 - CH_3$ and 

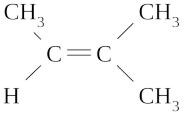
D $CH_3 - CH_2 - OH$ and $CH_3 - O - CH_3$

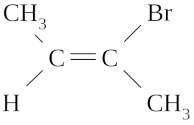
E  and 

58. Which of the compounds labelled P to S can have geometrical (*cis/trans*) isomers?

P 

Q 

R 

S 

A P only B P and S only C P, Q, R and S
D P, Q and S only E P, R and S only

59. Which of the following formulae could represent a cycloalkane?

A C_2H_4 B C_5H_{12} C C_4H_8 D C_3H_8 E C_4H_{10}

<u>Miscellaneous multiple-choice questions</u>

60. Which one of the following molecules can exhibit geometrical isomerism?

A $C_2H_5 - CH = CH - CH_3$ B $CH_2 = CH - CH_2Br$ C $CH_2Br - CH_2Br$
D $CH_3 - CH = C(CH_3)_2$ E $BrCH = CBr_2$

61. Which one of the following compounds does NOT exhibit geometrical isomerism (i.e. form <u>cis</u> and <u>trans</u> isomers)?

A $CH_3\,CH_2\,CH = CH\,CH_2\,CH_3$ B $Br_2\,C = CH\,Br$
C $CH_3\,CH = CH\,Br$ D $CH_3\,CH = CH\,CH_2\,CH_3$

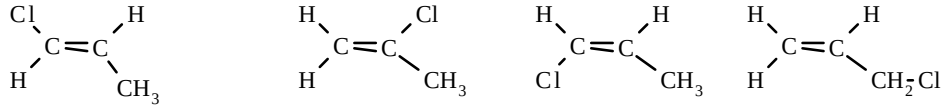
62. Which one of the following compounds has a dipole moment?

A CCl_4 B CH_3Br C CO_2 D $CH_2 = CH_2$ E BF_3

63 In which one of the following does geometrical isomerism exist?

A $CH_2 = CH - CH_2Cl$ B $(CH_3)_2C = CH - CH_3$ C $CH_3 - CH_2 - CH = CHCl$
D $ClCH_2 - CH_2Cl$ E $ClCH_2 - CH_2 - CH = CCl_2$

64. Consider the following structures:

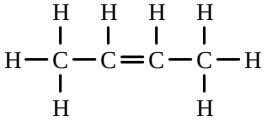


(1) (2) (3) (4)

Which are isomers?

A (1) and (3) only B (1), (2) and (3) only C (2), (3) and (4) only
D (1) and (2) only E (1), (2), (3) and (4)

65. Which of the following statements are true about the compound represented by the formula below?



I it decolourises bromine water II it is soluble in water
III it undergoes addition reaction with hydrogen chloride IV its systematic name is *trans* but- 2-ene

A I only B I and III only C I, III and IV only
D I, II, III and IV E II and III only

66. An isomer of a given chemical compound is another compound which has

A the same molecular weight but a different chemical composition
B the same empirical formula but a different molecular formula
C the same molecular weight but is radioactive
D the same molecular formula but different molecular weight
E the same molecular formula but different properties

67. For the substances C(graphite), N_2, C_3H_8 and C_2H_5OH, which of the following correctly represents them in order of increasing boiling point?

A N_2, C_3H_8, C_2H_5OH, C B N_2, C, C_3H_8, C_2H_5OH C N_2, C, C_2H_5OH, C_3H_8
D C, N_2, C_3H_8, C_2H_5OH E C_3H_8, N_2, C_2H_5OH, C

68. If an equal mass of each of the following is burned in excess oxygen which will give the greatest mass of CO_2?

A CH_4 B CH_3OH C C_2H_2 D CH_3CH_2OH E CH_3COOH

69. For which of the following compounds would you expect hydrogen bonding to play a significant role in determining the boiling point?

H_2O, C_2H_6, CH_3Br, C_2H_5OH, CH_3NH_2

A H_2O only B H_2O, CH_3Br and C_2H_5OH only
C H_2O and CH_3NH_2 only D H_2O, C_2H_5OH and CH_3NH_2 only
E all of them

70. Which one of the following best describes the molecular shape, polarity of bonds and molecular polarity in a CCl_4 molecule?

	molecular shape	polarity of bonds	molecular polarity
A	tetrahedral	polar covalent	non-polar
B	square planar	polar covalent	non-polar
C	tetrahedral	ionic	polar
D	square planar	ionic	polar
E	tetrahedral	non-polar covalent	non-polar

71. Which of the following equations represent an addition reaction?

I $CH_3 - CH = CH_2 + Br_2 \rightarrow CH_3 - CHBr - CH_2Br$ II $CH_2 = CH_2 + H_2 \rightarrow CH_3 - CH_3$
III $CH_3 - CH_3 + Br_2 \rightarrow CH_3 - CH_2Br + HBr$ IV $C_6H_6 + Br_2 \rightarrow C_6H_5Br + HBr$

A I and II only B III and IV only C I, II and IV only
D I only E IV only

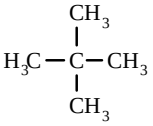
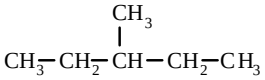
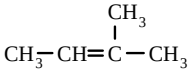
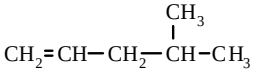
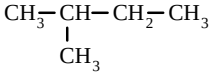
72. Which one of the following compounds does not exhibit geometrical isomerism?

A $CHCl = CHCl$ B $CH_3CH = CHCH_3$ C $CH_3CH = CCl_2$
D $CH_3CH = CHCl$ E $CH_3ClC = CClCH_3$

73. Which one of the following molecules has a zero dipole moment?

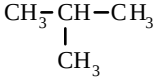
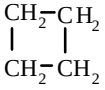
A $Cl_3C - CCl_3$ B $(CH_3)_3CH$ C $CHCl_3$
D $HO - CH_2 - CH_2 - OH$ E NH_3

74. Which of the following are isomeric with pentane?

I 
II 
III 
IV 
V 

A I, II and V B I, III and V C I and V D II only E II and IV

75. Which of the following substances would you expect to have the highest boiling point?

A  B  C $CH_3 - CH_2 - CH_2 - CH_3$

D $CH_3 - CH_2 - O - CH_2 - CH_3$ E $CH_3 - CH_2 - CH_2 - CH_2OH$

76. Which of the following compounds is unsaturated?

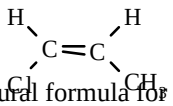
A pentane B *cis*-but-2-ene C dichloromethane D ethanol E ethanamine

77. Which of the following formulae can represent two substances which are *cis* and *trans* geometric isomers?

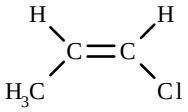
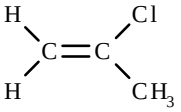
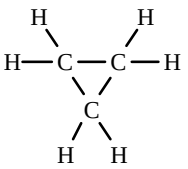
A C_4H_{10} B C_3H_6 C CH_2ClCH_2Cl D $CHClCHCl$ E CH_2CCl_2

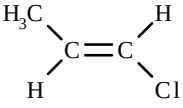
78. Which of the following molecules is planar?

A NH_3 B C_2H_4 C C_2H_6 D C_3H_6 E PCl_3

79. The structural formula for *cis*-1-chloropropene is 

Which, if any, of the following is the correct structural formula for the *trans* isomer of this molecule?

A  B  C 

D  E None of the above is the *trans* isomer.

80. Which of the following statements best explain the stability of benzene?

A Cyclo hydrocarbons are more stable that linear hydrocarbons.
B The benzene ring structure contains three double bonds.
C Benzene is an unsaturated hydrocarbon.
D Six delocalised electrons are present in the ring structure of benzene.
E The benzene ring is planar.

81. In which of the following substances are the intermolecular forces the greatest?

A Ice B Solid hydrogen sulfide C Solid ammonia
D Solid ethanol E Solid methane

82. Which one of the following compounds readily undergoes addition reaction?

A ethyne B ethane C benzene D bromoethane E ethanol

83. Which of the following reactions are substitution reactions?

I $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$ II $HC{\equiv}CH + HCl \rightarrow CH_2{=}CHCl$
III $CH_2{=}CH_2 + Br_2 \rightarrow CH_2Br\text{-}CH_2Br$ IV $C_6H_6 + Br_2 \rightarrow C_6H_5Br + HBr$

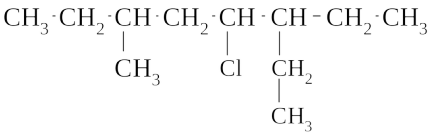
A I and II B II and IV C II and III D I only E I and IV

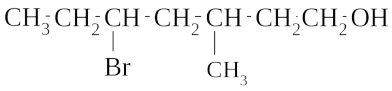
84. Which of the following substances is a tertiary alcohol?

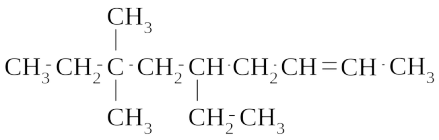
A $CH_3CH_2CH_2OH$ B $CH_2(OH)CH(OH)CH_2OH$ C $CH_3CH_2CH(OH)CH_2CH_3$
D $CH_3CH(OH)CH_3$ E $CH_3C(CH_3)_2OH$

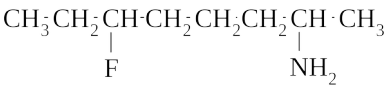
Miscellaneous short-answer questions

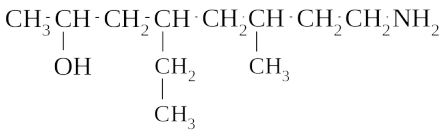
85. Name the following compounds:

a) 

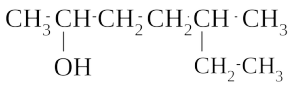
b) 

c) 

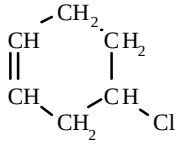
d) 

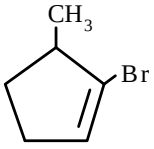
e) 

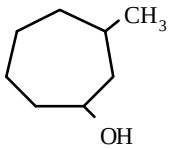
f) 

g) 

h) C_6H_5Cl

i) 

j) 

k) 

86. Give the structural formulae of the following

a) 2-chloropentan-1-amine b) 2,3-dimethylbut-2-ene c) 4-bromo-2-methylhexan-2-ol
d) cyclohexanamine e) 3-methylcyclopentanol f) 3-ethyl-4-methylpent-1-yne
g) 1,2-dichlorobenzene h) methanol i) ethyne
j) 1,1,2-trimethylheptan-1-amine

87. Give the structural formulae, and names of **three** structural isomers with the following molecular formulae:

a) C_5H_{12} b) C_4H_8 c) C_5H_8 d) C_4H_9Cl e) C_4H_9OH

88. Give the structural formulae and names of three structural isomers of 1,1-dibromocyclopentane.

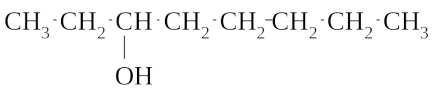
89 Sketch the structural formulae of the following:

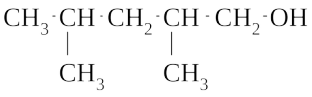
a) trans-1,2-dibromoethene
b) cis-1,2-dichloroethene
c) cisbut-2-ene
d) trans-1-chlorobut-1-ene
e) trans-1-chloroprop-1-ene
f) cis-2-bromobut-2-ene

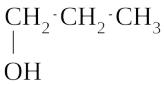
90. Write an equation for each of the following reactions:

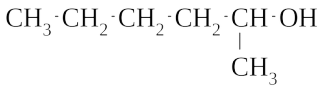
a) methane is reacted with excess chlorine in the presence of U.V. light.
b) ethene is reacted with hydrogen gas, in the presence of a catalyst.
c) propene is reacted with hydrogen bromide gas.
d) butyne is burnt.
e) the combustion of ethanol
f) methanamine is reacted with hydrochloric acid
g) sodium is added to propanol
h) propan-1-amine is reacted with nitric acid
i) sodium is added to methanol

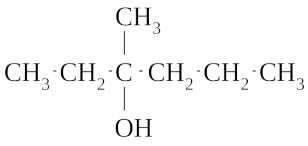
91. Name the following alcohols, and identify each as a primary, secondary or tertiary alcohol.

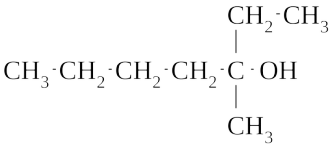
a) 

b) 

c) 

d) 

e) 

f) 

92 The questions below refer to the following organic compound:

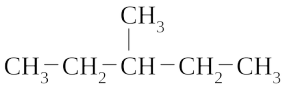
a) What is the correct IUPAC name for the compound?
b) Give the structural formula of the product formed when the compound reacts with chlorine, in the absence of ultraviolet light.
c) Give the balanced equation for the complete combustion of the organic compound.
d) Give the structural formulae of a pair of cis-trans isomers that have the same molecular formula as the organic compound.

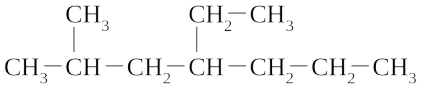
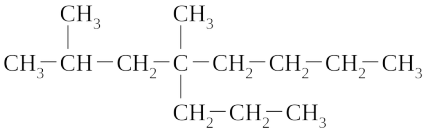
93. Draw the structural formula and name each of the following:

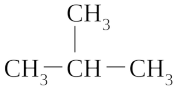
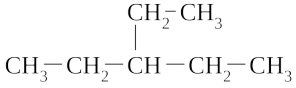
a) an alkyne containing three carbon atoms per molecule
b) a cyclic alkene containing six carbon atoms per molecule
c) an aromatic hydrocarbon containing seven carbon atoms per molecule
d) an amine containing seven hydrogen atoms per molecule

Answers:

1. a) propane b) decane c) 2,4-dimethyloctane
   d) 3,4-dimethylhexane e) 2,4-dimethylhexane f) 3-methylpentane
   g) 2,4,4-trimethyl-6-propylnonane h) 3-ethyl-3,5-dimethylheptane i) 2,4-dimethylpentane
   j) 3-ethyl-2,2-dimethylpentane

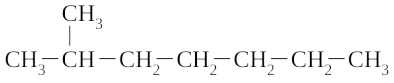
2. a) $CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$ b) 

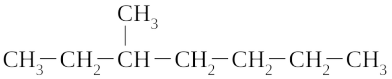
   c)  d) 

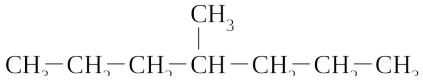
   e)  f) 

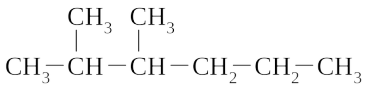
3. A, D, E, F

4. $CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$ octane

   
   2-methylheptane

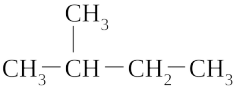
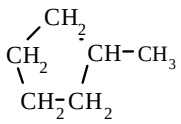
   
   3-methylheptane

   
   4-methylheptane

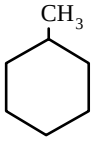
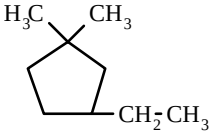
   
   2,3-dimethyhexane

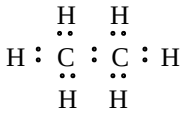
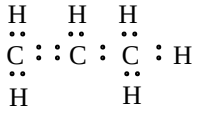
   also
   2,2-dimethylhexane, 2,4-dimethylhexane, 2,5-dimethylhexane, 3,3-dimethylhexane, 3,4-dimethylhexane, 2,2,3-trimethylpentane, 2,2,4-trimethylpentane, 2,3,3-trimethylpentane, 2,3,4-trimethylpentane, 3-ethyl-2-methylpentane, 3-ethyl-3-methylpentane, tetramethylbutane

5. a) $CH_4 + Br_2 \rightarrow CH_3Br + HBr$
   b) $CH_3 - CH_2 - CH_3 + F_2 \rightarrow CH_3 - CH_2 - CH_2F + HF$
   c) no reaction
   d) $CH_4 + 4\ I_2 \rightarrow CI_4 + 4HI$
   e) $CH_3 - CH_2 - CH_2 - CH_3 + 10\ Cl_2 \rightarrow CCl_3 - CCl_2 - CCl_2 - CCl_3 + 10\ HCl$
   f) $CH_3 - CH_3 + Br_2 \rightarrow CH_3 - CH_2Br + HBr$
   g) $2\ C_{10}H_{22} + 31\ O_2 \rightarrow 20\ CO_2 + 22\ H_2O$

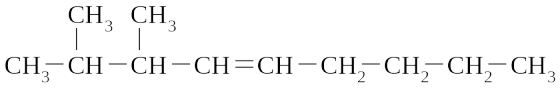
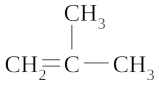
6. a) $CH_3 - CH_3$ b) $CH_3 - CH_2 - CH_2 - CH_3$ c)  d) 

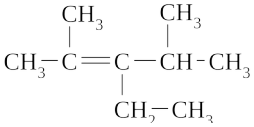
7. a) ethylcyclopentane b) 1,2,3,5-tetramethylcycloheptane
   c) 1,1-dimethyl-3-propylcyclohexane d) 5-ethyl-1,2-dimethyl-3-propylcyclooctane

8 a)  b) 

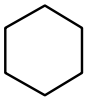
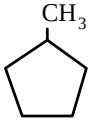
9. a)  b) 

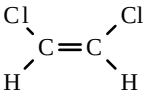
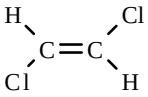
10. a) pent-2-ene b) 3-methylpent-2-ene c) 5-methylhex-1-ene
d) 3,5-dimethylhept-2-ene e) 2,4,4,7-tetramethyloct-2-ene
f) 3-ethyl-6,6-dimethyl-4-propylhept-2-ene g) 2-ethylpent-1-ene h) 5-ethyl-3-methyloctane

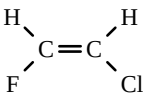
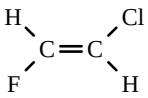
11. a)  b) 

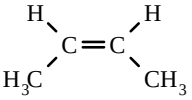
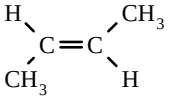
c) 

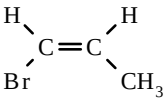
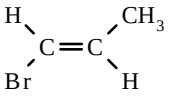
12. a) $CH_2 = CH - CH_2 - CH_2 - CH_2 - CH_3$ hex-1-ene $CH_3 - CH = CH - CH_2 - CH_2 - CH_3$ hex-2-ene
$CH_3 - CH_2 - CH = CH - CH_2 - CH_3$ hex-3-ene etc

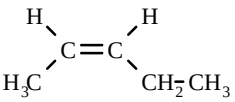
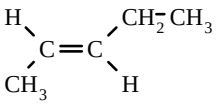
b)  cyclohexane  methylcyclopentane etc

13 a) cis-1,2-dichloroethene  trans-1,2-dichloroethene 

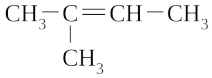
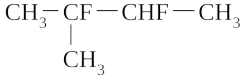
b) cis-1-chloro-2-fluoroethene  trans-1-chloro-2-fluoroethene 

c) cis-but-2-ene  trans-but-2-ene 

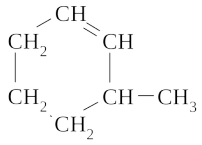
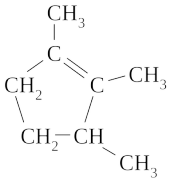
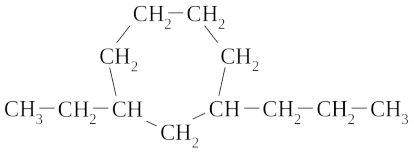
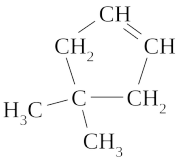
d) cis-1-bromopropene  trans-1-bromopropene 

e) cis-pent-2-ene  trans-pent-2-ene 

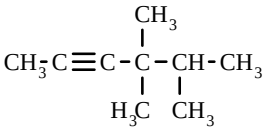
14. c) 1,2-difluoroethene f) 1-chloro-2-bromoethene i) 2-bromobut-2-ene
k) 1,2-dibromo-1,2-dichloroethene l) hex-3-ene

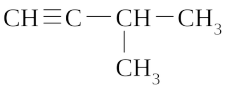
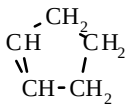
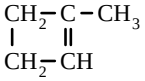
15. a) $CH_2 = CH_2 + Cl_2 \rightarrow CH_2Cl - CH_2Cl$
b) $CH_2 = CH - CH_3 + Cl_2 \rightarrow CH_2Cl - CHCl - CH_3$
c) $CH_2 = CH - CH_2 - CH_3 + H_2 \rightarrow CH_3 - CH_2 - CH_2 - CH_3$
d) $CH_2 = CH_2 + 5\ Br_2 \rightarrow CBr_3 - CBr_3 + 4HBr$
e) $CH_3 - CH_3 + 6\ F_2 \rightarrow CF_3 - CF_3 + 6HF$
f) $CH_3 - CH = CH - CH_2 - CH_3 + I_2 \rightarrow CH_3 - CHI - CHI - CH_2 - CH_3$
g)  $+ F_2 \rightarrow$ 
h) $C_6H_{12} + 9\ O_2 \rightarrow 6CO_2 + 6H_2O$

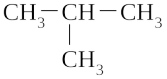
16. a) 3-methylcyclopropene b) 1-ethyl-3-methylcyclobutene
c) 4-ethyl-3-methylcyclohexene d) 2,3,4-trimethylcyclopentene

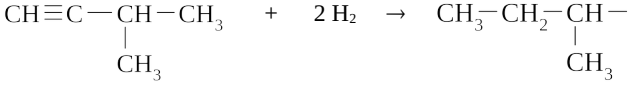
17 a) 
b) 
c) 
d) 

18. a) propyne b) pent-2-yne c) 5-methylhex-2-yne d) 4-6-dimethyloct-1-yne

19 a) $CH_3CH_2C\equiv C-CH_2CH_2CH_2CH_2CH_2CH_3$ b) 

20. a) $CH \equiv C - CH_2 - CH_2 - CH_3$ pent-1-yne $CH_3 - C \equiv C - CH_2 - CH_3$ pent-2-yne
 3-methylbut-1-yne etc
b)
cyclopentene  1-methylcyclobutene 
c) $CH_2 = CH - CH = CH - CH_3$ $CH_2 = CH - CH_2 - CH = CH_2$ etc

21. a) but-2-yne $CH_3 - C \equiv C - CH_3$
b) methylpropane  or cyclobutane or methylcyclopropane
c) hex-1-ene, hex-2-ene, hex-3-ene, 2-methylpent-1-ene etc
d) cyclobutane or methylcyclopropane
e) cyclobutene or methylcyclopropene

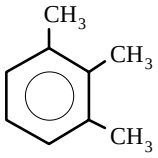
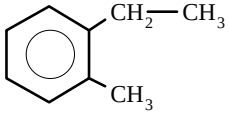
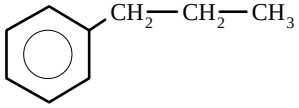
22. a) $CH \equiv CH + Br_2 \rightarrow CHBr = CHBr$ addition reaction
b) $CH \equiv C - CH_3 + 2Cl_2 \rightarrow CHCl_2 - CCl_2 - CH_3$ addition reactions
c) $CH \equiv C - CH_2 - CH_3 + 2F_2 \rightarrow CHF_2 - CF_2 - CH_2 - CH_3$ addition reaction
d) $CH \equiv C - CH_3 + 6\,Br_2 \rightarrow CBr_3 - CBr_2 - CBr_3 + 4HBr$ addition & substitution
e)  addition

f) $CH_3 - CH_3 + Cl_2 \rightarrow CH_2Cl - CH_3 + HCl$ substitution
g) $CH_2 = CH_2 + Br_2 \rightarrow CH_2Br - CH_2Br$ addition
h) $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$ (in presence of UV light) substitution

22. i) $CH_2 = CH - CH_3 + F_2 \rightarrow CH_2F - CHF - CH_3$ addition

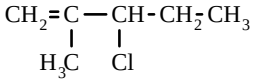
j) $CH_3 - C \equiv C - CH_3 + Cl_2 \rightarrow CH_3 - CCl = CCl - CH_3$ addition

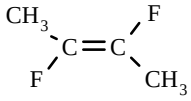
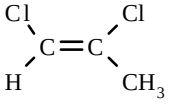
k) $2C_8H_{14} + 23\,O_2 \rightarrow 16\,CO_2 + 14H_2O$

23. 1,2,3-trimethylbenzene  1-ethyl-2-methylbenzene  propylbenzene  etc

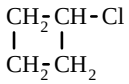
24. a) 1-fluoropentane b) 4-bromobut-1-ene c) 7-ethyl-3-chloro-1-iodononane

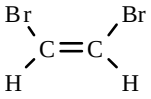
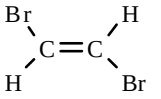
d) 4,5,6-trichlorohex-2-yne e) 1,2,3,4-tetrabromocyclohexane f) chlorobenzene

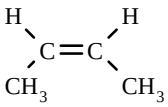
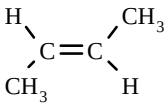
25 a) $BrCH_2 - CHBr - CH_2 - CH_3$ b) 

c)  d) 

26. $CH_2 = CH - CH_2 - CH_2Cl$ 4-chlorobut-1-ene $CH_3 - CH = CH - CH_2Cl$ 4-chlorobut-2-ene etc

 chlorocyclobutane etc

27 a) cis-1,2-dibromoethene  trans-1,2-dibromoethene 

b) cis-but-2-ene  trans-but-2-ene 

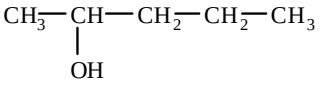
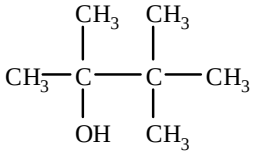
28. $CHBr = CHBr$ 1,2-bibromoethene $CBr_2 = CH_2$ 1,1-dibromoethene

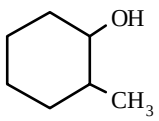
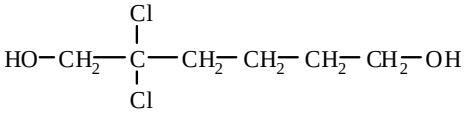
29. a) hexan-1-ol b) butane-1,4-diol c) 6-methyloctan-4-ol

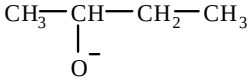
d) 5-bromo-2-methylhexan-1-ol e) 5,5-dimethylhexan-3-ol f) 3-ethyloctan-3-ol

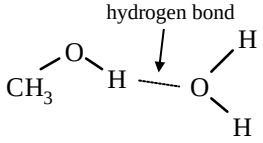
30. a) primary alcohol b) primary alcohol c) secondary alcohol

d) primary alcohol e) secondary alcohol f) tertiary alcohol

31 a)  b) 

c)  d) 

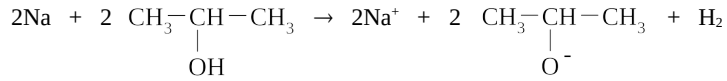
e) $CH_3O^-\ Na^+$ f) 

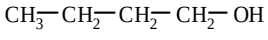
32. 

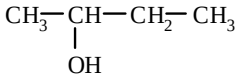
33. The bonds between ethanol molecules are hydrogen bonds, but between ethane molecules there are only dispersion forces. Hydrogen bonds are stronger than dispersion forces, for molecules of similar size. Thus, ethanol is a liquid which has stronger bonds between molecules compared to the forces between molecules in a gas.

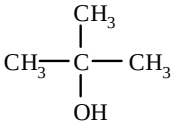
34. a) $2Na + 2H_2O \rightarrow 2Na^+ + 2\,OH^- + H_2$

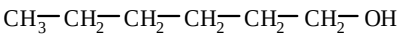
b) $2Na + 2CH_3\text{-}CH_2OH \rightarrow 2Na^+ + 2\,CH_3\text{-}CH_2O^- + H_2$

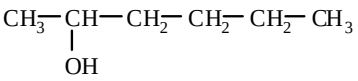
c) 

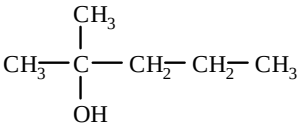
35. a) butan-1-ol (primary) 

butan-2-ol (secondary) 

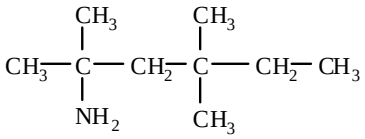
methylpropan-2-ol (tertiary) 

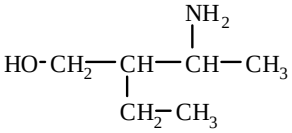
b) hexan-1-ol (primary) 

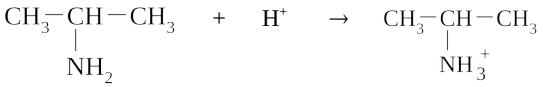
hexan-2-ol (secondary) 

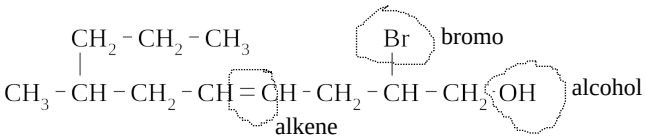
2-methylpentan-2-ol (tertiary) 

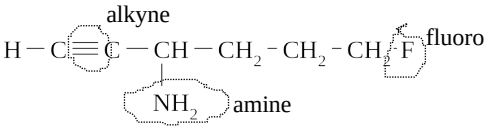
36. a) 4-ethyl-4-methylheptan-2-amine b) 3-ethyl-4-methylpentan-1-amine

37 a) 

b) 

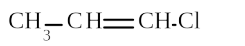
38. 

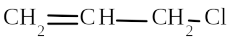
39. a) 

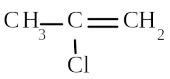
b) 

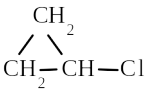
40. C 41. B 42. B 43. D

44.

 1-chloropropene (cis- and trans- isomers)

 3-chloropropene

 2-chloropropene

 chlorocyclopropane

45. a) The butylamine molecules accept hydrogen ions from the hydrochloric acid, to form an ionic compound

$CH_3CH_2CH_2CH_2NH_2 + H^+ \rightarrow CH_3CH_2CH_2CH_2NH_3^+$

b) Ionic compound are not very volatile, and so rarely have a smell. But butylamine is volatile (because low boiling point indicates weak forces between butylamine molecules)

c) When NaOH is added, the 'amine ion' reacts with hydroxide ions to form butylamine again:

$CH_3CH_2CH_2CH_2NH_3^+ + OH^- \rightarrow CH_3CH_2CH_2CH_2NH_2 + H_2O$

d) Only a **few molecules** of butylamine are required to produce enough smell to be detected. So, a large amount of HCl was required to react with nearly all the amine molecule to get rid of the stink. However, only a small amount of NaOH was required to reform a **few molecules** of the amine to cause th smell again.

46. C

47. a) $CH_3CH_2CH_2CH = CH_2 + Br_2 \rightarrow CH_3CH_2CH_2CHBr - CH_2Br$

Orange colour of bromine layer becomes colourless.

b) $2CH_3CH_2OH + 2Na \rightarrow 2CH_3CH_2O^-Na^+ + H_2$

Grey solid disappears and colourless gas evolved

c) $2CH_3OH + 2Na \rightarrow 2CH_3O^-Na^+ + H_2$

Grey solid disappears and colourless gas evolved

48. a) 2-methylpropan-2-ol b) pentan-2-ol c) 2-methylhexane

d) 2-methylbutan-2-ol e) methanol, ethanol

49.

Statement	Explanation
There are two isomers of 1,2-dichloroethene, but there is only one 1,2-dichloroethane	The two isomers of 1,2-dichloroethene are the cis and trans isomers that form because the double bonded carbons cannot rotate around the double bond. However, with 1,2-dichloroethane, the carbons are bonded with a single bond and so rotation can occur around this bond and so geometrical isomers do not form.
There are two isomers of 1,2-dichloroethene, but there is only one 1,1-dichloroethene	The two isomers of 1,2-dichloroethene are the cis and trans isomers that form because on each double bonded carbon there are two different groups of atoms. But with 1,1-dichloroethene, on each carbon there are two identical atoms. When this occurs, geometrical isomers do not exist, and so there is only one isomer of 1,1-dichloroethene.

50. D

51. A

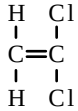
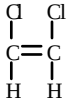
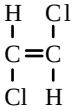
52. a) 2,2,4-trimethylpentane b) 3-ethylhex-1-ene

53. Test - add an aqueous solution of bromine to each, and shake

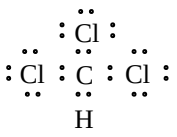
Observation - with cyclohexene - the orange colour will disappear, but with cyclohexane -the orange colour will remain

Equation $C_6H_8 + Br_2 \rightarrow C_6H_8Br_2$

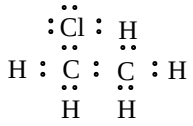
54. 1,1-dichloroethene cis-1,2-dichloroethene trans-1,2-dichloroethene

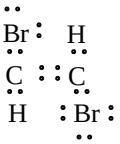
55. a)



b)



c)



56. D 57. D 58. B 59. C

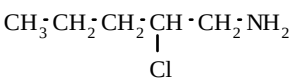
60. A 61 B 62 B 63 C 64 E

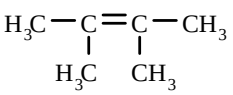
65 B 66 E 67 A 68 C 69 D

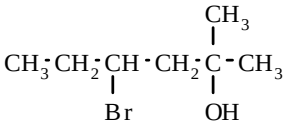
70	A	71	A	72	C	73	A	74	C
75	E	76	B	77	D	78	B	79	D
80	D	81	A	82	A	83	E	84	E

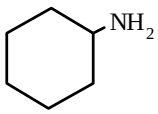
85. a) 4-chloro-3-ethyl-6-methyloctane
b) 5-bromo-3-methylheptan-1-ol
c) 5-ethyl-7,7-dimethylnon-2-ene
d) 6-fluorooctan-2-amine
e) 8-amino-4-ethyl-6-methyloctan-2-ol
f) 3-chloro-5-methylhex-1-yne
g) 5-methylheptan-2-ol
h) chlorobenzene
i) 4-chlorocyclohexene
j) 2-bromo-3-methylcyclopentene
k) 3-methylcycloheptanol

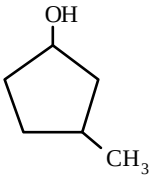
86.

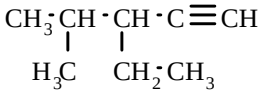
a) 

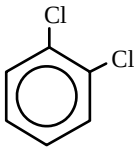
b) 

c) 

d) 

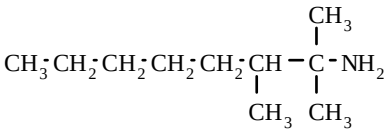
e) 

f) 

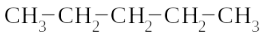
g) 

h) CH_3OH

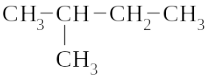
i) $CH \equiv CH$

j) 

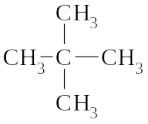
87. a)



pentane

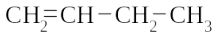


methylbutane

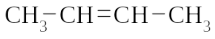


dimethylpropane

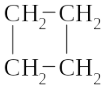
b)



but-1-ene

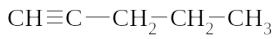


but-2-ene

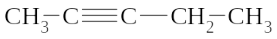


cyclobutane

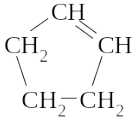
c)



pent-1-yne



pent-2-yne

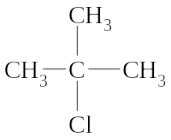


cyclopentene

d)

1-chlorobutane

2-chlorobutane

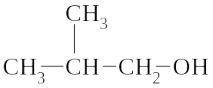


2-chloromethylpropane

87. e)

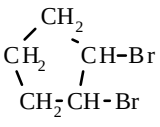
butan-1-ol

butan-2-ol

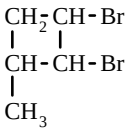


methylpropan-1-ol

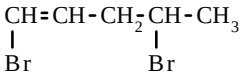
88. 1,1-dibromocyclopentane has an empirical formula of $C_5H_8Br_2$, so, we are looking for isomers of $C_5H_8Br_2$. There are many isomers, three typical ones are:



1,2-dibromocyclopentane

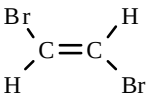


1,2-dibromo-3-methylcyclobutane

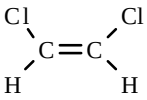


1,4-dibromopent-1-ene

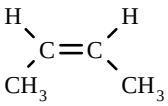
89 a)



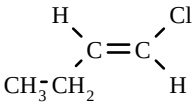
b)



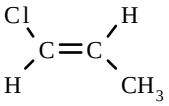
c)



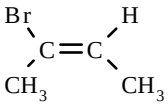
d)



e)



f)



90. a) $CH_4 + 4Cl_2 \rightarrow CCl_4 + 4HCl$

b) $CH_2 = CH_2 + H_2 \rightarrow CH_3 - CH_3$

c) $CH_3\,CH = CH_2 + HBr \rightarrow CH_3\,CH_2\,CH_2\,Br$ or $CH_3\,CH(Br)\,CH_3$

d) $2C_4H_6 + 11\,O_2 \rightarrow 8CO_2 + 6H_2O$

e) $CH_3\,CH_2OH + 3\,O_2 \rightarrow 2CO_2 + 3H_2O$

f) $CH_3\,NH_2 + H^+ + Cl^- \rightarrow CH_3\,NH_3^+ + Cl^-$

g) $2\,CH_3\,CH_2\,CH_2OH + 2Na \rightarrow 2\,CH_3\,CH_2\,CH_2O^- + 2Na^+ + H_2$

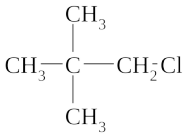
h) $CH_3\,CH_2\,CH_2\,NH_2 + H^+ \rightarrow CH_3\,CH_2\,CH_2\,NH_3^+$

i) $2CH_3OH + 2Na \rightarrow 2CH_3O^- + H_2 + 2Na^+$

91. a) octan-3-ol secondary alcohol
b) 2,4-dimethylpentan-1-ol primary alcohol
c) propan-1-ol primary alcohol
d) hexan-2-ol secondary alcohol
e) 3-methylhexan-3-ol tertiary alcohol
f) 3-methylheptan-3-ol tertiary alcohol

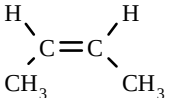
92. a) methylpropene

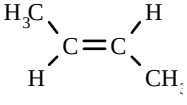
b)



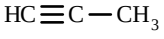
c) $C_4H_8 + 6\,O_2 \rightarrow 4CO_2 + 4H_2O$

d)





93. a) propyne



b) 4-methylcyclopentene