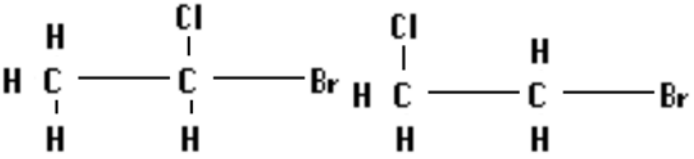
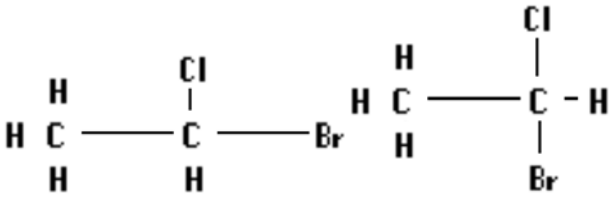
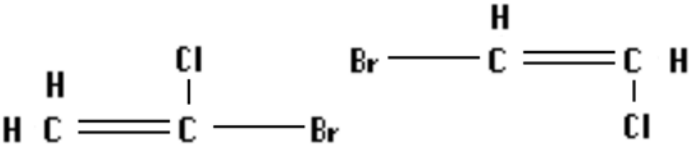
1972
What types of isomerism are possible among the molecules that can be obtained by substituting a chlorine atom and a bromine atom for two of the hydrogen atoms in each of the following?
(a) Ethane, C_2H_6
(b) Ethene, C_2H_4
Show structures to illustrate each of the types of isomerism you name for each of these compounds.
Answer:
(a) positional (structural) isomers



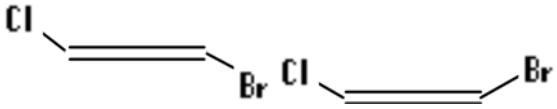
optical isomer:



(b) positional (structural) isormers

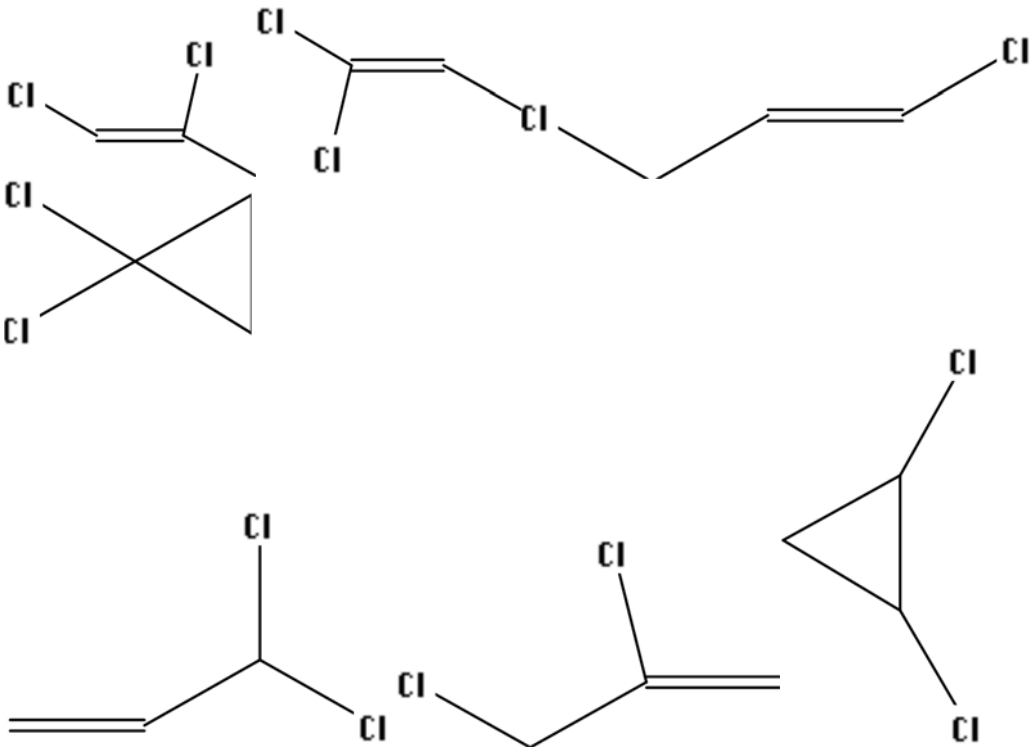


cis - trans isomers



1974 D
Briefly discuss the following statement:
"The functional group concept is important in organizing the information of organic chemistry."
Support your discussion by giving two chemical equations to illustrate the application of this concept for each of two functional groups.
Answer:
Rationale on scoring:
Discussion of functionality (structural feature reacting as a unit; reactivity relatively independent of the rest of molecule) - 2 points
Correct identification of functional groups - 2 points
Equations illustrating reactivity - 3 points

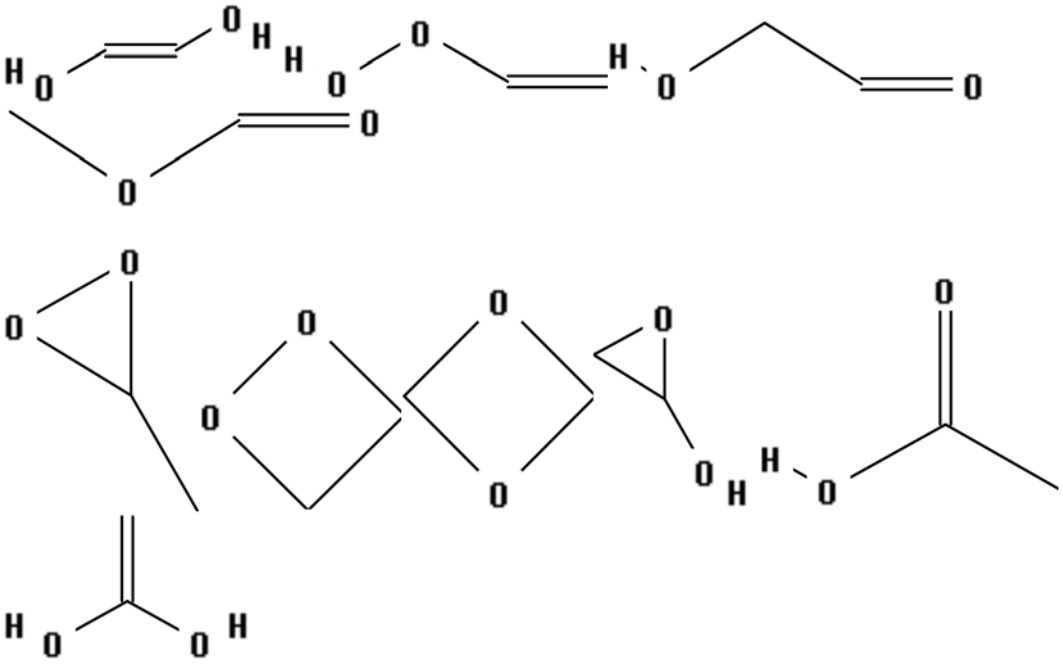
1975 D
Draw structural formulas for seven different isomers of $C_3H_4Cl_2$.
Answer:



1977 D

Write structural formulas for two stable isomers X and Y that have the molecular formula $C_2H_4O_2$. Select a physical property and a chemical property that would distinguish between the two isomers in the laboratory. Explain.

Answer:



Correct distinguishing physical property: solubility, odor, boiling point, pH of aqueous solution, etc.

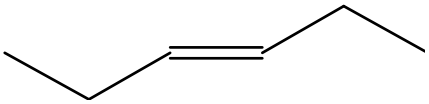
Correct distinguishing chemical property: type of reaction, acid or reducing property, conductivity, or pH of solution, etc.

1978 D

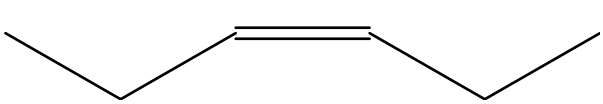
Dehydration of 3-hexanol yields a mixture of four isomers each with the molecular formula C_6H_{12}. Draw structures of the four isomers and name each of them.

Answer:

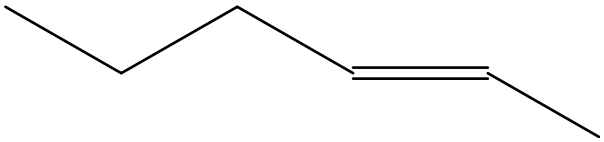
trans-3-hexene



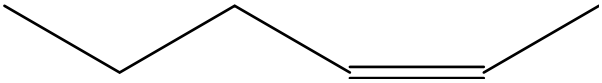
cis-3-hexene



trans-2-hexene



cis-2-hexene



1981 D

Assume that you have two different gases that you know are not cyclic (i.e. not ring) compounds, each with the following elementary analysis: C = 85.7%, H = 14.3%. Each gas has a molecular weight of 56.1.

(a) What is the molecular formula for the compounds?

(b) Draw the structural formulas for the four possible noncyclic isomers with this molecular formula.

(c) In the presence of an appropriate catalyst, both gases add hydrogen. The hydrogenated products are identical, their molecular weight is 58. Which of the structures you drew to answer (b) can definitely be eliminated on the basis of this additional information?

Answer:

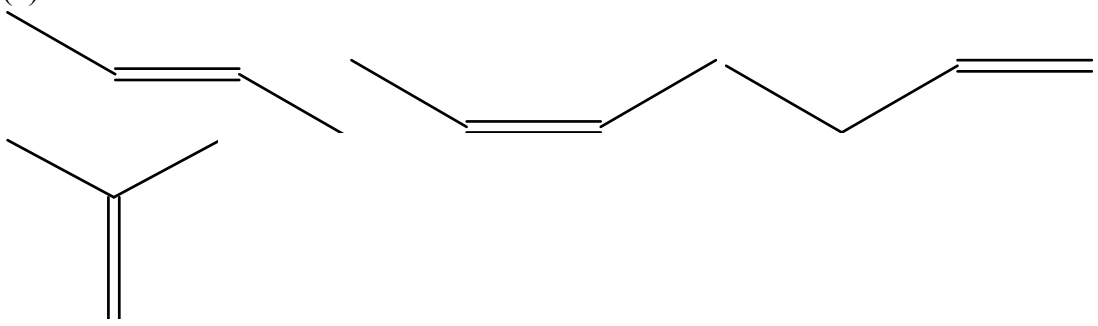
(a)

$$\frac{56\text{g}}{1\text{ mol cmpd}} \times \frac{0.857\text{ g C}}{1\text{g cmpd}} \times \frac{1\text{ mol C}}{12\text{ g C}} = \frac{4\text{ mol C}}{1\text{ mol cmpd}}$$

$$\frac{56\text{g}}{1\text{ mol cmpd}} \times \frac{0.143\text{ g H}}{1\text{g cmpd}} \times \frac{1\text{ mol H}}{1.01\text{ g H}} = \frac{8\text{ mol H}}{1\text{ mol cmpd}}$$

molecular formula: C_4H_8

(b)



(c) The last formula in Part (b) can be eliminated (2-methyl-1-propene).

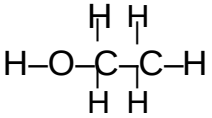
1998 D

Answer each of the following using appropriate chemical principles.

(c) Dimethyl ether, $H_3C\text{-}O\text{-}CH_3$, is not very soluble in water. Draw a structural isomer of dimethyl ether that is much more soluble in water and explain the basis of its increased water solubility.

In each case, justify your choice.

Answer



(c) The O-H bond in ethyl alcohol is very polar and will allow the molecule to be attracted to and dissolve in the polar water.

2002 B

Consider the hydrocarbon pentane, C_5H_{12} (molar mass 72.15 g).

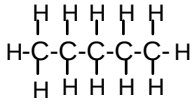
(a) Write the balanced equation for the combustion of pentane to yield carbon dioxide and water.

(b) What volume of dry carbon dioxide, measured at 25˚C and 785 mm Hg, will result from the complete combustion of 2.50 g of pentane?

(c) The complete combustion of 5.00 g of pentane releases 243 kJ of heat. On the basis of this information, calculate the value of ΔH for the complete combustion of one mole of pentane.

(d) Under identical conditions, a sample of an unknown gas effuses into a vacuum at twice the rate that a sample of pentane gas effuses. Calculate the molar mass of the unknown gas.

(e) The structural formula of one isomer of pentane is shown below. Draw the structural formulas for the other two isomers of pentane. Be sure to include all atoms of hydrogen and carbon in your structures.



Answer:

(a) $C_5H_{12} + 8\ O_2 \rightarrow 5\ CO_2 + 6\ H_2O$

(b) 2.50 g $C_5H_{12} \times$ $\times$ = 0.173 mol CO_2

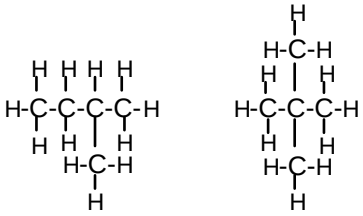
V = = =

4.10 L

(c) $\times$ = -3510 kJ/mol

(d) = ; = ; M_2 = 18.0

(e)



2003 D (repeated in bonding)

Compound Name	Compound Formula	ΔH°_{vap} (kJ mol^{-1})

Propane	$CH_3CH_2CH_3$	19.0
Propanone	CH_3COCH_3	32.0
1-propanol	$CH_3CH_2CH_2OH$	47.3

Using the information in the table above, answer the following questions about organic compounds.

(a) For propanone,

(i) draw the complete structural formula (showing all atoms and bonds);

(ii) predict the approximate carbon-to-carbon-to-carbon bond angle.

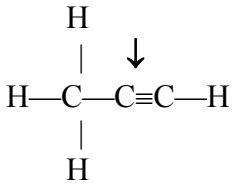
(b) For each pair of compounds below, explain why they do not have the same value for their standard heat of vaporization, ΔH°_{vap}. (You must include specific information about <u>both</u> compounds in each pair.)

(i) Propane and propanone

(ii) Propanone and 1-propanol

(c) Draw the complete structural formula for an isomer of the molecule you drew in, part (a) (i).

(d) Given the structural formula for propyne below,

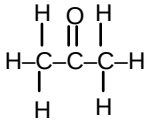


(i) indicate the hybridization of the carbon atom indicated by the arrow in the structure above;

(ii) indicate the total number of sigma (σ) bands and the total number of pi (π) bonds in the molecule

Answer:

(a) (i)



(ii) 120˚

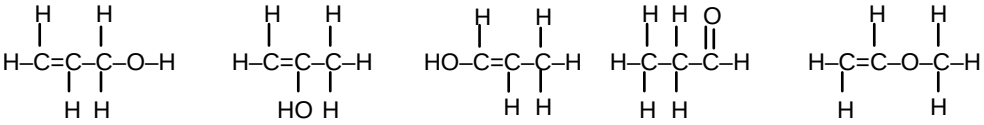
(b) (i) propane, 26 electrons, molar mass = 44

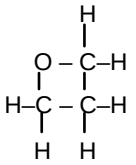
propanone, 32 electrons, molar mass = 58

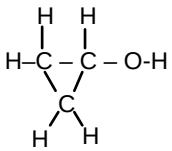
higher # electrons means larger van der Waal forces, larger molar mass means a slower molecule, the oxygen creates a polar molecule and dipol–dipole interactions

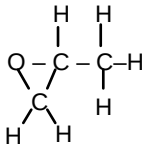
(ii) 1-propanol has an –OH which creates a site for hydrogen bonding with other –OH on adjacent molecules increasing intermolecular forces that must be overcome in order to vaporize the liquid.

(c)









(d) (i) *sp*

(ii) 6 sigma, 2 pi