AP® Chemistry
2003 Sample Student Responses

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8A1

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

8. 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.

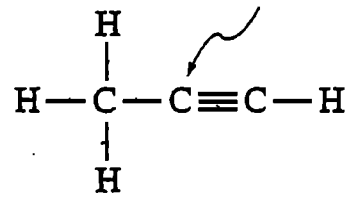
(b) For each pair of compounds below, explain why they do not have the same value for their standard heat of vaporization, ΔH°_{vap}. (You must include specific information about <u>both</u> compounds in each pair.)

(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).

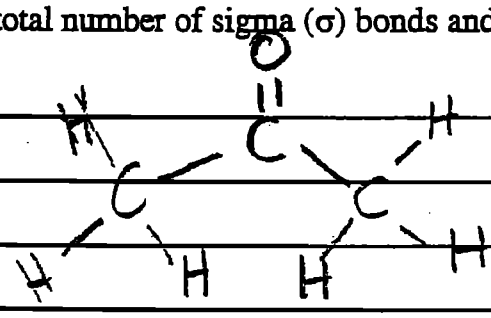
(d) Given the structural formula for propyne below,



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

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

a) i)



ii) The bond angle between  will be approximately 120° (sp^2 hybridization)

b) i) propane is a non polar compound bearing only London dispersion forces. Propanone, however, has polar bonds

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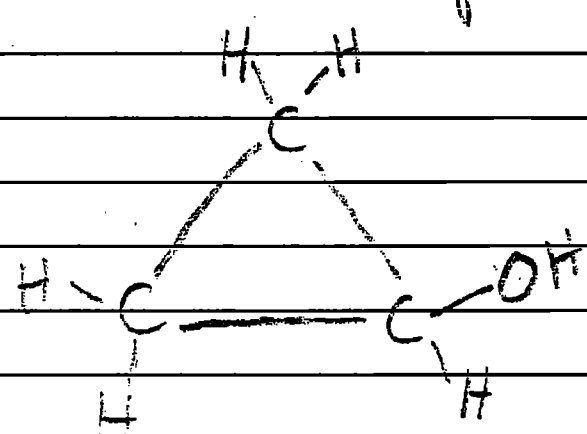
which induce dipoles, increasing bonding between molecules. This requires propanone to be heated more strongly to match its vapor pressure to that of the air above it.

ii) While propanone is a polar compound with dipole-dipole interactive forces, 1-propanol is also polar, but can engage in hydrogen bonding at one end, which strengthens intermolecular forces and raise the heat of vap.

c)



cyclopropanol

d) i) linear (sp) hybridization

ii) 6 σ bonds and 2 π bonds

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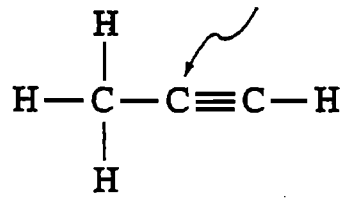
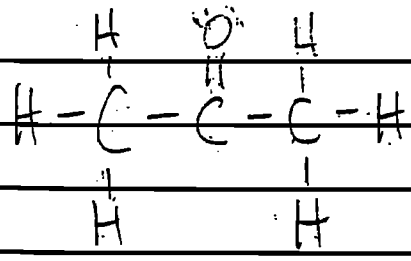


(i) indicate the hybridization of the carbon atom indicated by the arrow in the structure above; sp linear

(ii) indicate the total number of sigma (σ) bonds and the total number of pi (π) bonds in the molecule. 6 sigma 2π

a) i)



ii) The carbon to carbon bond angle is the same as the bond angle for a trigonal planar configuration. This should be 120°.

b) i) The heat of vaporization is higher for propanone than propane because of the O in propanone. The double bond takes more energy to break. Propane does not have any

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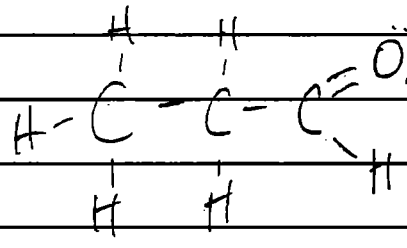
double bonds and therefore has the lower heat of vaporization.

ii) Although propanone has a double bond between carbon and oxygen, 1-propanol has a stronger type of bond that increases the heat of vaporization. This is the hydrogen bonding between the O-H. The hydrogen bond is difficult to break and requires more heat.

c)



d) i) The carbon atom is linear so it has sp hybridization.

ii) Each single bond is also a sigma bond and a triple bond has one sigma and two pi bonds. Therefore, there are 6 sigma bonds and 2 pi bonds.

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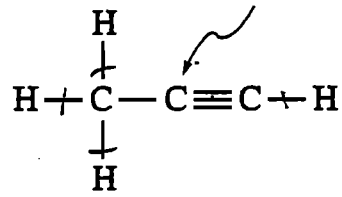
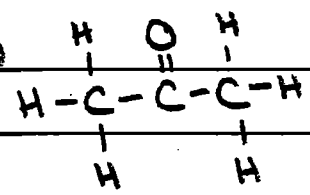


(i) indicate the hybridization of the carbon atom indicated by the arrow in the structure above;

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

(A)(i)



(ii) 120°

(B) (i) propane has a lower ΔH°_{vap} than propanone bc it lacks the extra atom of O that is double bonded to a C. Double bonds are harder to break apart than single bonds – they are shorter + stronger propane has only single bonds propanone has a double bond.

8C2

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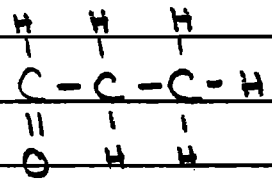
(B) (ii) 1-propanol has a high bp than propanone bc it has stronger H-bonds that are more difficult to break up. Propanone's O is not bonded to an H → it simply has dispersion forces

(C)



(D) - (i) sp

(ii) $\sigma = 5$

$\pi = 2$