Name _______________ Section No. __________ Marks _____/33

CHEMISTRY 230: ORGANIC CHEMISTRY CLASS TEST NO. 1 –Answer Key

Note: students generally showed very poor linguistic skills, frequently misusing technical terms and even writing such garbled English as to make the sense impossible to decipher.

1) Explain the meaning of the term *polar covalent bond*, giving an example of a polar covalent bond and a non-polar one. (3)

A polar bond[1] is a bond between two atoms of different electronegativity[2]. It is associated with a dipole moment since the atoms have opposite charges. An example of a polar bond is the O-H bond, and of a non-polar one, any bond between like atoms, such as Cl-Cl.

Give an example of a molecule which is non-polar even though its bonds are polar. Explain why it is non-polar. (2)

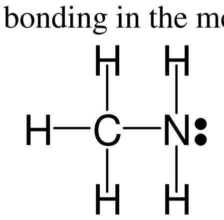
The carbon tetrafluoride molecule is non-polar even though the C-F bond is highly polar. In the molecule these bonds are arranged symmetrically around the carbon atom so that their vector sum is zero.

2) The boiling points of two chlorides are 1465°C and 12°C respectively. What can you say about the bonding in these chlorides? (2)

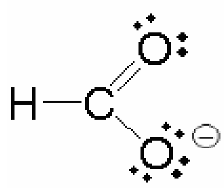
The one with the higher boiling point is ionic and the one with the lower boiling point is molecular covalent[3]

3) This question involves the bonding in molecules and the acid strength of organic compounds.

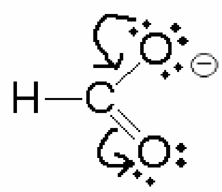
a) Draw a Lewis structure to illustrate the bonding in the methanamine molecule, CH_3NH_2. (1)



b) Draw a Lewis structure to illustrate the bonding in the methanoate ion, $CHCOO^-$. (1)



c) The methanoate ion is *resonance stabilised.* Give a second structure showing the other main resonance structure of this ion. Place curly arrows on this structure to show the electron shifts necessary to change it back into the first one. (2)



d) How does resonance stabilization make methanoic acid a stronger acid than ethanol, CH_3CH_2OH. (2)

Resonance stabilisation makes methanoic acid stronger than methanol by delocalising the charge over the conjugate base, the methanoate ion and so stabilising it. No such stabilisation can occur with the conjugate base of ethanol, the ethoxide ion, CH3CH2O-, since only one stable Lewis structure can be drawn.

e) Rank the following molecules in order of decreasing acid strength, strongest first: (2)

CH_3CH_3, CH_3NH_2, CH_3OH, CHCH, CH_2CH_2

$CH_3OH > CH_3NH_2 > CHCH > CH_2CH_2 > CH_3CH_3$

f) The pK_a of ethanol is about 15. What does this tell you about its acid strength? (1)

Ethanol is a very weak acid.

g) What can you conclude about the acid strength of the protonated form of ethanol, $CH_3CH_2O^+H_2$? (1)

It will be stronger than ethanol.[4]

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[1] Many students confused the term "bond" with "molecule". Obviously this shows a lack of understanding and loses marks. Confusing "atom" with "element" and "molecule" with "compound" are also common errors.

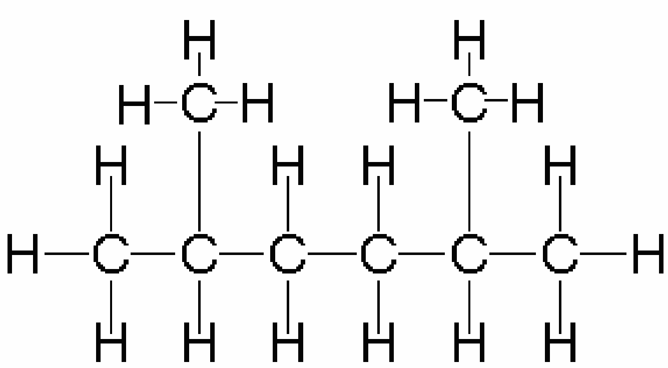
[2] The term "electronegativity" can only be applied to atoms and elements, never to molecules or bonds.

[3] The strength of the bonding has nothing to do with the boiling point in molecular compounds since boiling leaves the molecules intact.

[4] In fact, it is a strong acid.

4) This question concerns the IUPAC nomenclature and structures for various organic compounds. (One mark for each answer.)

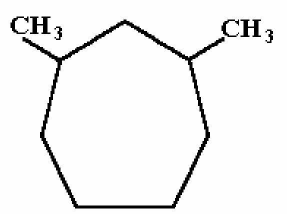
a) $CH_3CH(CH_3)CH_2CH_2CH(CH_3)CH_3$
Give the Kekulé formula. (1)



Give the IUPAC name. (1)

2,5-dimethylhexane

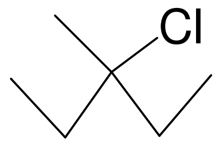
b)



Give the IUPAC name. (1)

1,3-dimethylcycloheptane

c)



Give the IUPAC name. (1)

3-chloro-3-methylpentane

Give the condensed formula. (1)

$CH_3CH_2CCl(CH_3)CH_2CH_3$

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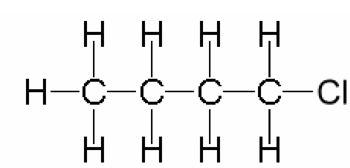
d) Explain why the name 2-ethylpropane is not possible under IUPAC. (2)

"Propane" implies that the longest chain has 3 carbon atoms, but drawing the structure shows that it has 4. Hence the name should be based on "butane", not propane.

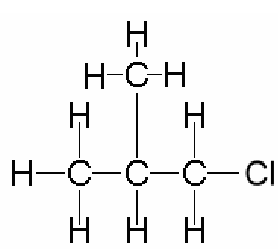
Suggest the correct name for this compound. (1)

2-methylbutane

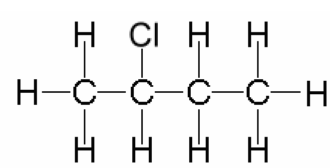
e) Draw Kekulé structures for 3 *isomers* of formula C_4H_9Cl and give the IUPAC name of each one. (6)



1-chlorobutane



1-chloro-2-methylpropane



2-chlorobutane[5]

5) The following questions involve theories of bonding.

a) What is the principle difference between the Valence Bond approach to chemical bonding and the Molecular Orbital approach? (2)

In the Valence Bond approach the electrons in the molecule are assumed to occupy orbitals very like those they occupied in the isolated atoms before bonding occurred. In the molecular orbital approach the electrons in the molecule are assumed to occupy new, molecular, orbitals.

[5] There is also one other isomer, 2-chloro-2-methylpropane