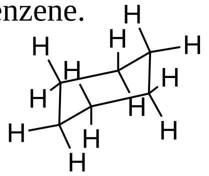
TEST QUESTIONS WITH MULTIPLE CHOICE ANSWERS (ONLY ONE CORRECT)
(Answer by encircling **only one** of the four offered answers under A, B, C or D)

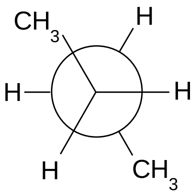
1. The name of the given compound is:
   A. 1,2,3,4,5,6-hexahydrobenzene.
   B. cyclohexanone.
   C. dodecahexane.
   D. cyclohexane.



2. Hybride orbitals can be obtained with “mixing” of:
   A. one *s* and one *p* orbital with an angle between of 120°.
   B. one *s* and one *p* orbital with an angle between of 180°.
   C. two *s* and two *p* orbitals and they are oriented towards the vertices of a tetrahedrone.
   D. three *s* and three *p* orbitals and they are oriented towards the vertices of an octahedron.

3. Mark the answer with all electrophiles.
   A. H^+, $^+NO_2$, BF_3, CN^-
   B. BF_3, $AlCl_3$, H^+
   C. F^-, Cl^-, Br^-, I^-
   D. RNH_2, R_2NH, R_3N

4. The formula representing the compound in the picture is:
   A. a perspective stereoformula.
   B. a Sawhorse projection formula.
   C. a sceletal stereoformula.
   D. a Newman projection formula.



5. Which compound has π electrons?
   A. Ethanol.
   B. Cyclopropane.
   C. Cyclobutanol.
   D. Toluene.

6. Wurtz synthesis is a reaction between:
   A. alkyl halogenide and sodium.
   B. Grignard reagent and bromine.
   C. alkene and hydrogen.
   D. acid and alcohol.

7. Which of the following reactions give alkenes as products?
   A. Hydrogenation, hydratation.
   B. Dehydrogenation, halogenation.
   C. Dehalogenation, elimination of water.
   D. Hydrohalogenation, hydratation.

8. $K_2Cr_2O_7$ is:
   A. an electron donor.
   B. an electron acceptor.
   C. a reduction reagent.
   D. a nucleofile.

9. Teflon is:
   A. tetrafluoroethene.
   B. polytetrafluoroethene.
   C. polyvinyl fluoride.
   D. tetrafluoroethylene monomer.

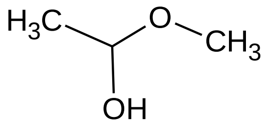
10. How many condensed rings are there in one ethyl formate molecule?
    A. 1 B. 2 C. 3 D. 4

11. Mark which compound is aromatic!
    A. Acetone.
    B. Diethyl ether.
    C. Toluene.
    D. Formaldehyde.

12. Ethylene glycole is:
    A. ethylene alcohol.
    B. ethene-1,2-diol.
    C. ethane-1,2-diol.
    D. propane-1,2,3-triol.

13. Mark the answer where all compounds contain carbonyl group.
    A. Aldehydes, ketones, alcohols.
    B. Esters, ethers.
    C. Alkyl halides, carboxylic acids.
    D. Amides, esters, acyl halides.

14. The given compound is:
    A. an alcohol.
    B. a hemiacetal.
    C. an acetal.
    D. an ester.



15. The active component of the medicine aspirin is an ester of:
    A. benzyl alcohol and acetic acid.
    B. *o*-hydroxybenzoic acid and acetic acid.
    C. ethanol and acetic acid.
    D. aspartame diol and acetic acid.

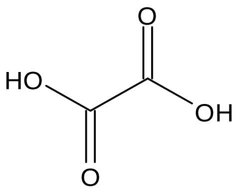
PROBLEMS

(Put the calculations and the answer to the problem at the designated place)

(M(C) = 12 g/mol; M(H) = 1 g/mol; M(O) = 16 g/mol; M(N) = 14 g/mol)

1. Oxalic acid is the simplest dicarboxylic acid with a molecular formula $H_2C_2O_4$. It is a white crystalline substance that is soluble in water and is a stronger acid than acetic acid and its conjugated base (oxalate, $C_2O_4^{2-}$) forms salts and complexes with different metals.

A. Draw the structural formula of oxalic acid and its IUPAC name.



Задача 1. А. ОДГОВОР: Етандиска киселина (1 p.)

B. One sample of industrial oxalic acid with unknown purity was analyzed by an acid-base titration with a standard solution of NaOH (c = 0.1122 mol/dm^3).
A sample of technical oxalic acid with a mass of 0.1305 g was dissolved in 50 cm^3 of distilled water, phenolphthalein was added as an indicator, and 23.5 cm^3 of the standard solution of NaOH were used for the titration.
Calculate the mass fraction of oxalic acid in the sample of the technical oxalic acid!

$c(\mathrm{NaOH}) = 0{,}1122\ \mathrm{mol/dm^3}$
$m_{\text{техничка}}(H_2C_2O_4) = 0{,}1305$ g
$V(\mathrm{NaOH}) = 23{,}5\ \mathrm{cm^3} = 0{,}0235\ \mathrm{dm^3}$
$M(H_2C_2O_4) = 90$ g/mol

$H_2C_2O_4(aq) + 2NaOH(aq) \rightarrow Na_2C_2O_4(aq) + 2H_2O(l)$ (1 p.)

$n(H_2C_2O_4) : n(\mathrm{NaOH}) = 1 : 2$
$n(H_2C_2O_4) = 1/2 \cdot n(\mathrm{NaOH})$ (1 p.)

$$\frac{m(H_2C_2O_4)}{M(H_2C_2O_4)} = \frac{c(\mathrm{NaOH}) \cdot V(\mathrm{NaOH})}{2}$$

$$m(H_2C_2O_4) = \frac{c(\mathrm{NaOH}) \cdot V(\mathrm{NaOH}) \cdot M(H_2C_2O_4)}{2}$$

$$m(H_2C_2O_4) = \frac{0{,}1122\frac{\mathrm{mol}}{\mathrm{dm^3}} \cdot\ 0{,}0235\ \mathrm{dm^3}\ \cdot 90\ \mathrm{g/mol}}{2}$$

$$m(H_2C_2O_4) = 0{,}1186\ \mathrm{g}$$

$$w(H_2C_2O_4) = \frac{m(H_2C_2O_4)}{m_{\text{техничка}}(H_2C_2O_4)} \cdot 100\ \%$$

$$w(H_2C_2O_4) = \frac{0{,}1186\ \mathrm{g}}{0{,}1305\ \mathrm{g}} \cdot 100\ \% = 90{,}88\ \%$$ (2 p.)

ANSWER: $w(H_2C_2O_4) = 90{,}88\ \%$ (4 p.)

C. Oxalic acid is a reduction agent that takes part in redox reactions with oxidation agents, such as $KMnO_4$ according to the given equation. If for a titration of a sample with a mass of 0.5010 g from the same technical oxalic acid, a volume of 19.3 cm^3 of the standard solution of $KMnO_4$ with concentration of 0.1055 mol/dm^3 were used, calculate the mass fraction of oxalic acid in the sample using also this analysis with redox titration!

$2KMnO_4 + 3H_2SO_4 + 5H_2C_2O_4 \rightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 10CO_2$

$m_{\text{техничка}}(H_2C_2O_4) = 0{,}5010$ g
$V(KMnO_4) = 19{,}3\ cm^3 = 0{,}0193\ dm^3$
$c(KMnO_4) = 0{,}1055\ mol/dm^3$
$w(H_2C_2O_4) = ?$
$n(H_2C_2O_4) : n(KMnO_4) = 5 : 2$
$n(H_2C_2O_4) = 5/2 \cdot n(KMnO_4)$ (1 p.)

$$\frac{m(H_2C_2O_4)}{M(H_2C_2O_4)} = \frac{5 \cdot c(KMnO_4) \cdot V(KMnO_4)}{2}$$

$$m(H_2C_2O_4) = \frac{5 \cdot c(KMnO_4) \cdot V(KMnO_4) \cdot M(H_2C_2O_4)}{2}$$

$$m(H_2C_2O_4) = \frac{5 \cdot 0{,}1055 \frac{mol}{dm^3} \cdot 0{,}0193 dm^3 \cdot 90 \frac{g}{mol}}{2}$$

$m(H_2C_2O_4)=0{,}4581$ g

$$w(H_2C_2O_4) = \frac{m(H_2C_2O_4)}{m_{\text{техничка}}(H_2C_2O_4)} \cdot 100\%$$

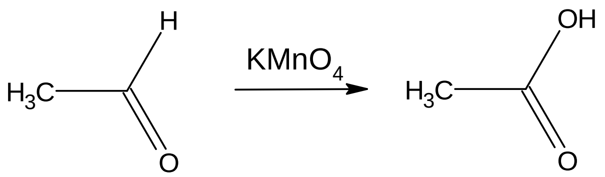
$$w(H_2C_2O_4) = \frac{0{,}4581\ g}{0{,}5010\ g} \cdot 100\% = 91{,}44\ \%$$ (2 p.)

ANSWER: $w(H_2C_2O_4) = 91{,}44$ % (3 p.)

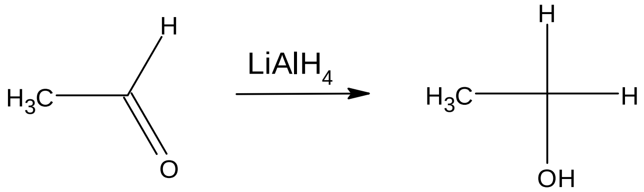
2. If you have only ethanol as a starting compound, explain how can you obtain ethyl acetate from it if you have the usual reagent available: H_2SO_4, HNO_3, NaOH, Br_2, $KMnO_4$, $LiAlH_4$ etc.

A. Write down the equations of the reactions that should be carried out to obtain ethyl acetate from ethanol. Write the names of all reactants and products. (3 p.)

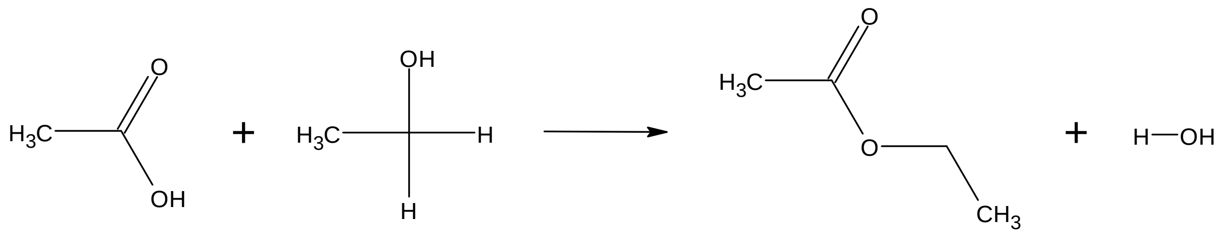
SOLUTION:



Ethanal, CH_3CHO acetaldehyde — Ethanoic (acetic) acid, CH_3COOH (1 p.)



Ethanal, CH_3CHO — Ethanol, CH_3CH_2OH (1 p.)



CH_3COOH Ethanoic (acetic) acid | CH_3CH_2OH Ethanol | $CH_3COOCH_2CH_3$ Ethyl ethanoate (Ethyl acetate) | H_2O Water (1 p.)

B. What is the maximum mass of ethyl acetate that can be obtained theoretically if we have 1 L solution of ethanol (the density of this solution is 0.868 g/cm^3) in which the mass fraction of ethanal is 40 %.

SOLUTION:

$V_{p\text{-}p}$ = 1 L = 1 dm^3 = 1000 cm^3
$\rho_{p\text{-}p}$ = 0,868 g/cm^3
$w(C_4H_8O_2)$ = 40 % = 0,40

$m_{p\text{-}p} = V_{p\text{-}p} \cdot \rho_{p\text{-}p}$
$m_{p\text{-}p}$ = 1000 cm^3 · 0,868 g/cm^3
$m_{p\text{-}p}$ = 868 g

$$w(C_2H_4O) = \frac{m(C_2H_4O)}{m_{p-p}}$$

$m(C_2H_4O) = w(C_2H_4O) \cdot m_{p\text{-}p}$
$m(C_2H_4O)$ = 0,40 · 868 g = 347,2 g

$$n(C_2H_4O) = \frac{m(C_2H_4O)}{M(C_2H_4O)} = \frac{347{,}2\ \text{g}}{44\frac{\text{g}}{\text{mol}}} = 7{,}89\ \text{mol}$$ (2 p.)

Half of the whole quantity of ethanol is oxidized to acetic acid, half is reduced to ethanol
=> $n(C_2H_5OH) = n(CH_3COOH) = 1/2 \cdot n(C_2H_4O)/2$

n(ethyl acetate) = $n(C_2H_5OH) = n(CH_3COOH)$ = = $1/2 \cdot n(C_2H_4O)/2$

m(ethyl acetate) = 1/2·n(етанал) · M(ethyl acetate) $M(C_4H_8O_2)$=88 g/mol
m(ethyl acetate) = 3,945 mol · 88 g/mol = 347,16 g

(2 p.)

ANSWER: 347,2 g (4 p.)