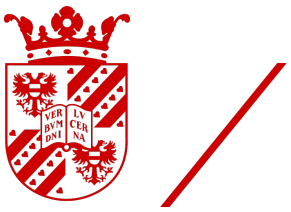


university of groningen

Materials and Molecules

Tentam during COVID-19
03/04/2020

Tim Lankhuizen

Question 1 ***[10 points]***
(6 points for correct structures, taking into account the requirement. 2 points for names. 2 points for following extra instructions)

Read the instructions below carefully

Draw 8 neutral chemical structures (STICK) with the molecular formula of $C_8H_{12}O_2$ that adhere to the octet rule. (WARNING: there are over 10000 possible structures, so having the same structures as fellow students will be highly suspicious and checked!)

The following minimal requirements need to be met (having structures that meet more requirements at once is fine)

- at least one structure should contain a carbon-carbon double bond
- at least one structure should contain a carboxylic acid group
- at least one structure should contain an aldehyde group
- at least one structure should contain an alcohol group
- at least one structure should contain an least one chiral center

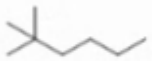
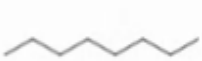
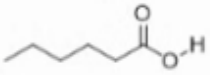
Indicate the structures selected to meet the above requirements and provide a name for these selected structures!
Furthermore make sure to adhere to the following extra instructions:

- indicate cis and trans when appropriate
- indicate all chiral carbones with a *
- indicate when two of the structures drawn are geometric isomers
- indicate when two of the structures drawn are enantiomers
- if you drew two enamtiomers indicate R and S
- indicate when drawn structures are diastereomers

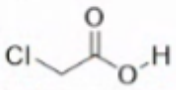
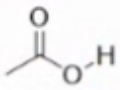
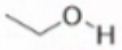
Question 2
[Total points: 16] , (4 points each)

Below a series (A-D) of four(4) chemical structures is provided. Each series is ordered based on a specific chemical or physical property. Please explain the specific property for each series (A-D) based on the provided structures. Make sure you also mention in your own words the underlying main physical and/or chemical concept(a) related to this property. Compounds are numbered to be able to refer to them in the text.

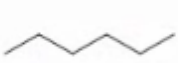
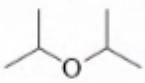
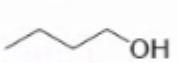
A)

	1	2	3	4
				
Boiling point	106.8 °C	125.6 °C	175.8 °C	223 °C

B)

	1	2	3	4	5
	Br-H				
pK_a	-8.7	2.9	4.8	15.9	60

C)

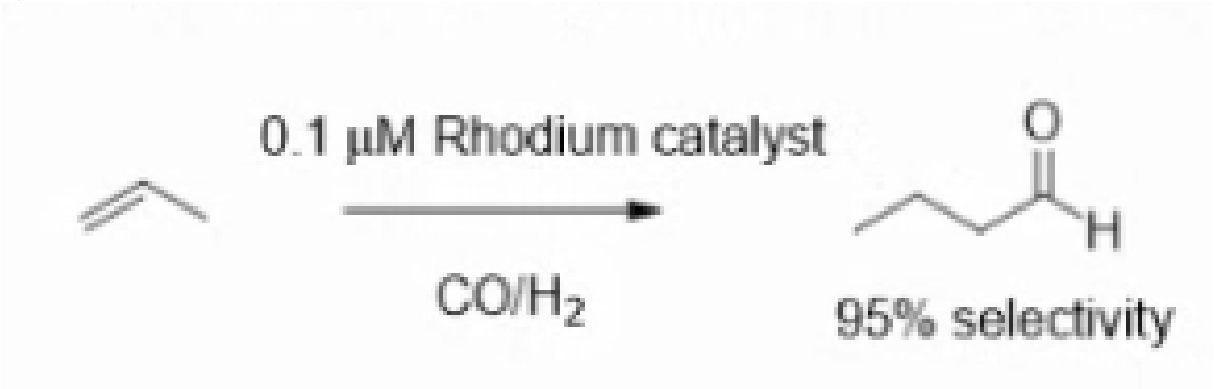
	1	2	3	4
				
Solubility in water	9.5 mg/L	0.2 g/100 mL	0.8 g/100 mL	8 g/100mL

D)

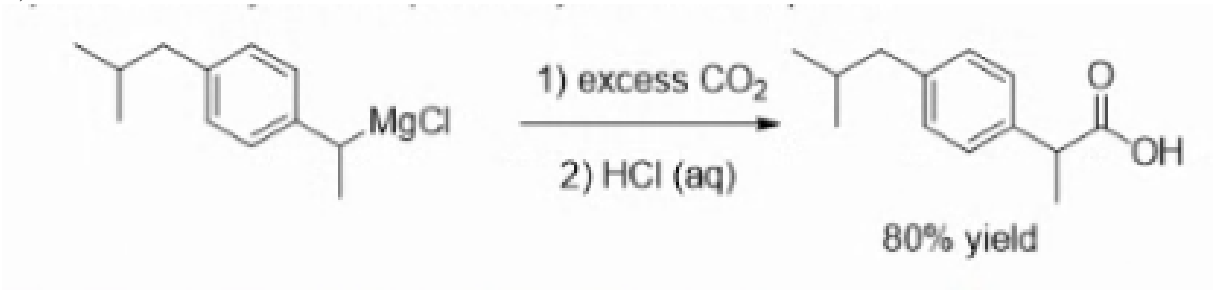
	1	2	3	4
				
ΔH_c Heat of combustion (KJ/mol)	-2720.50 ± 0.40	-2717.6 ± 0.96	-2709.9 ± 0.86	-2706.6 ± 0.96

Question 3
[Total points: 4]
Consider the two chemical processes (a and b) for the provided reaction equations below. Discuss these two processes based on environmental impact taking into account what you expect regarding the absolute amount and type of waste generated. in your answer, please take into account all aspects provided in the reaction equations as well as the setting in which these processes are operated.

a) Rhodium catalyzed hydroformylation to crease a major chemical intermediate



b) Final carboxylation step in the synthesis of Ibuprofen



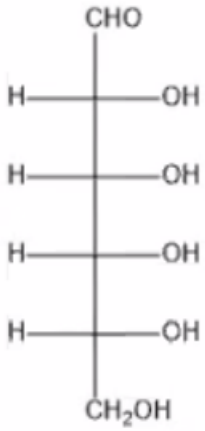
Question 4
[Total points: 10]
Draw a trimmer using the structures provided below. Please follow the instructions (read all the instructions before you begin).

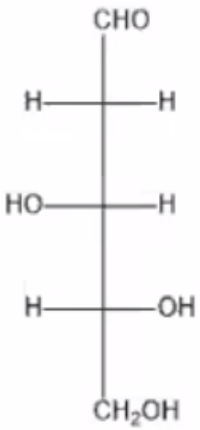
A. Convert the two Fisher projections below to Haworth projections:

- Pentose in an alpha-furanose form
- Hexose in an beta-pyranose form (make two copies)

B. Connect the Haworth's projections with the correct chemical bond(s).

- Use the two hexoses and connect them with a beta/1.4 bond
- Connect the pentose in alpha/1.6 direction on the non-reducing end of the hexose-dimer you made in step 1

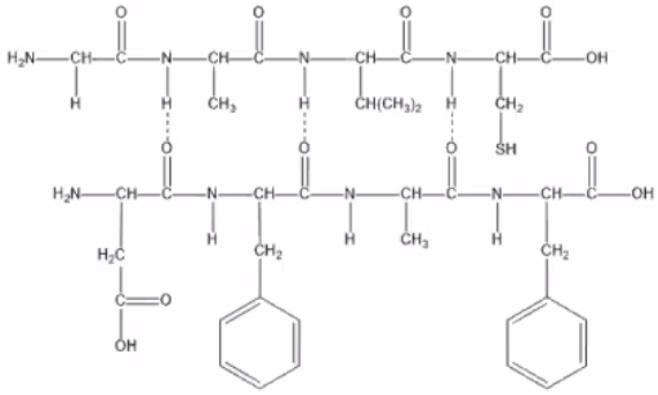




Question 5
[Total points: 6]

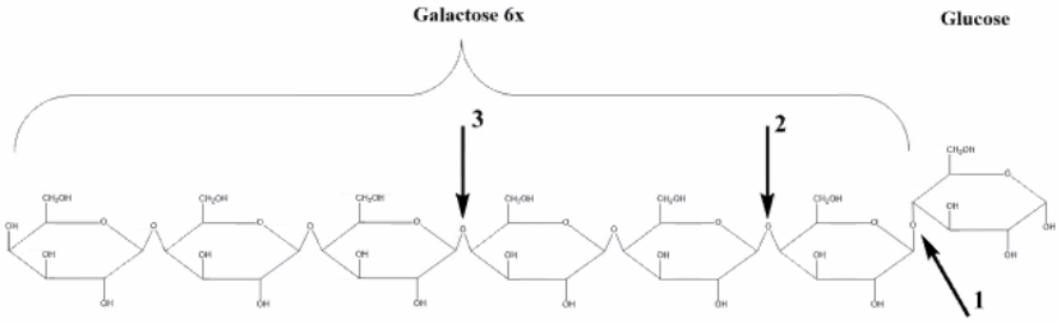
A. Name all specific type(s) of chemical bond(s) and interaction(s) in the figure given below. Please describe in detail the structure provided below. Make sure you include in your answer key types of bonds/interactions and chemical groups.

B. The compound is stable at 50 degrees Celsius. Describe what happens to the structure of the compound if the temperature is raised to 70 degrees Celsius.



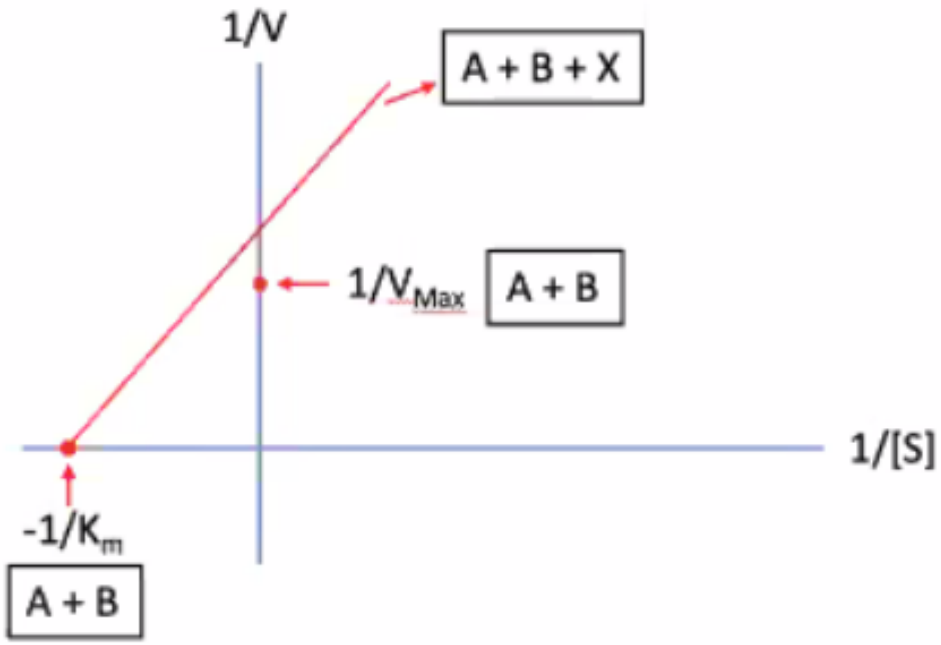
Question 6
[Total points: 6]

Arrows in the figure below indicate three cleavage sites of the enzyme(s) that are cleaved in the following order 1 → 2 → 3. Derive the chemical name (based on the key characteristics) of the enzyme(s) that can cleave the position of number 3. Explain your answer.



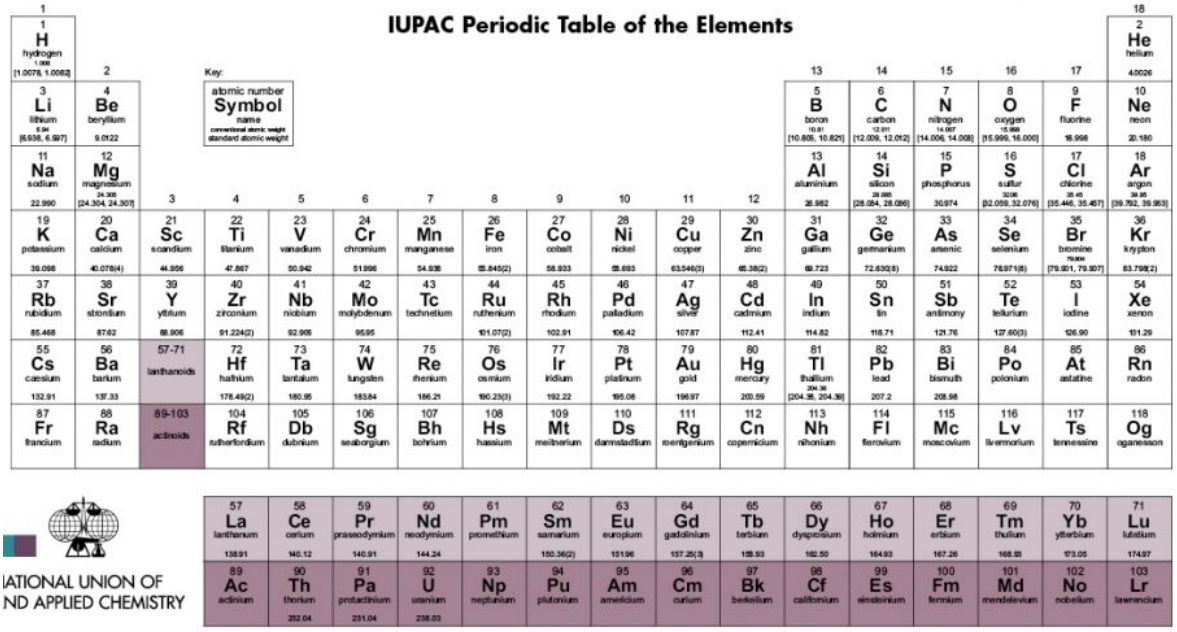
Question 7
[Total points: 8]

Compound **A** and **B** produce compound **F**. Following the reaction equation $\mathbf{A} + \mathbf{B} \rightarrow \mathbf{F}$. When compound **X** is introduced to this reaction, the reaction changes as described in the figure below (red line). Following the reaction equation $\mathbf{A} + \mathbf{B} + \mathbf{X} \rightarrow \mathbf{F}$.
A. Describe the effect **X** has on the reaction $\mathbf{A} + \mathbf{B} + \mathbf{X} \rightarrow \mathbf{F}$ compared to $\mathbf{A} + \mathbf{B} \rightarrow \mathbf{F}$. Include $V_{max}, V_m and V$ in your answer.
B. Explain what kind of molecule is **X** and what are its chemical characteristics.



Question 8
[Total points: 7]

Explain in your own words, also providing examples , how the periodic table can be used to predict which type of chemical bonds are formed when atoms of elements in the periodic table are brought together in a material. Explain in your own words, also providing examples, why chemical bonds are fundamental factor for determining the properties, like mechanical and electrical ones, of (solid state) materials.



Question 9
[Total points: 8]

Explain in your own words, using both Energy and stress arguments, why materials with the highest ultimate tensile strength can be totally useless for applications in construction in which these materials are tensile loaded. Explain why the above description also directly implies that materials with ionic, covenant and metallic bonding have distinctly different mechanical behaviour.

Question 10
[Total points: 9]

Explain in your own words, including essential factors like number of free charge carriers and the charge carrier mobility, why the temperature dependency of the electrical conductivity is so much different for metals and intrinsic semiconductors. in a similar way explain why in the range from zero Kelvin to room temperature dependence of the electrical conductivity is so much different for pure silicon and silicon that is doped (significantly) with phosphorous atoms.

Question 11
[Total points: 6]

Explain the most efficient shapes for resisting bending and torsion and then explain why these shapes can affect the selection of the best, i.e. lowest weight or costs, material for applications when materials are loaded in bending or torsion.