

Name of school:	
Subject:	<i>3D World of Chemistry</i>
Class:	Third grade
School year:	2023/2024
Annual hourly fund:	35






ANNUAL CURRICULUM PLAN

Month	Teaching unit	Unit title	Estimated number of hours	Educational outcomes	Intersubject topics
September	Introduction	Basics of Working in <i>ChemSketch</i> Software	2	<ul style="list-style-type: none"> to use the tools available in the <i>ChemSketch</i> program to draw the desired molecules of organic compounds to display the structure of molecules of organic compounds in three dimensions using the <i>3D Viewer</i> option to use tools for marking parts of a molecule or the whole 	1. Application of information and communication technologies in the teaching process

		Revision and systematization of teaching		<p>molecule, tools for rotating molecules and moving molecules in 2D and 3D.</p> <ul style="list-style-type: none">● to draw a hydrocarbon chain using the options <i>DrawNormal</i>, <i>DrawContinuous</i>, <i>DrawChains</i>● to delete parts of the molecule structure or the entire molecule using the <i>Delete</i> option● to draw a double and triple bond in a compound● to add alkyl groups to the existing compound and change the types of atoms in the structure of the molecule● to cancel changes made in the program● to optimize the structure of the molecule● to draw the structures of anions and cations using the charge generation tool● practice the use of learned tools in the <i>ChemSketch</i> program on the given examples	
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		contents		<ul style="list-style-type: none"> • use an example from everyday life to check if educational outcomes are achieved. 	
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Content

- The *DrawNormal* tool is the default tool when the program is started. With this tool active, you can easily draw normal or branched chains and replace the drawn atoms with other atoms from the Periodic Table of Elements.
- The *DrawContinuous* tool is very convenient for "*sprouting*" new atoms. Note that with this tool active, you can draw bonds from the selected atom only.
- Drawing double and triple bonds – by pointing to the last drawn bond (you will see a rectangle around the bond), and then clicking it to make a double bond. By clicking one more time we can draw a triple bond.
- Canceling actions - This will cancel the last action performed and reset the workspace to exactly what it was before your last change.
- Deleting individual atoms - With the *Delete* tool () active, click the atom you want to delete from the structure.
- Changing atoms - To replace an atom with a new element whose button is not displayed on the Atoms toolbar
- Drawing bond between two atoms - When either *DrawNormal* () or *DrawContinuous* () tool is selected, dragging from one atom to another draws a single bond between them.
- "*Cleaning*" structure – to "*clean*" the drawn structure by standardizing all the bond lengths and angles.
- Editing atom labels - The *Edit Atom Label* tool () allows you to substitute terminal atoms with shorthand abbreviations.
- Rotating structural fragments
- Drawing chains - Using the *DrawChains* tool () , you can easily draw chains of any length simply by dragging.
- Setting charges and defining anions and cations
- Cleaning workspace - If you want to clean the workspace in order to draw your structures from scratch

Recommendations for achieving educational outcomes

Give students a few more examples to practice all the learned options of working in *ChemSketch*.

Month	Teaching unit	Unit title	Estimated number of hours	Educational outcomes	Intersubject topics
October	Hydrocarbons	Alkanes and Cycloalkanes	3	<ul style="list-style-type: none">● to draw different examples of alkane and cycloalkane molecules and present them with a structural, condensed structural formula and with skeletal formula.● to generate name of previously drawn alkane and cycloalkane molecules in the <i>ChemSketch</i> program● to determine the molecular formula of previously drawn alkane and cycloalkane molecules in the <i>ChemSketch</i> program	<ol style="list-style-type: none">1. Application of information and communication technologies in the teaching process2. Examples of alkanes and cycloalkanes in everyday life

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| | | | | <ul style="list-style-type: none">● to improve the representation of the structure of molecules (adjustment of bond length and interbond angles) using the <i>Clean Structure</i> option● to draw structural isomers of alkanes and cycloalkanes● to show the structures of alkanes and cycloalkanes in three dimensions● to rotate alkane and cycloalkane molecules in two and three dimensions● to change the way of displaying the structures of alkane and cycloalkane molecules in three dimensions● to move alkane and cycloalkane molecules in 3D and 2D● to determine bond lengths and bond angles in alkane and cycloalkane molecules● to optimize the structures of alkane and cycloalkane molecules | |
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		Revision and systematization of teaching contents		<ul style="list-style-type: none"> ● to rotate the molecular structure in three dimensions in order to visually represent the Newman projection formulas of different alkanes ● to save on the computer the two-dimensional and three-dimensional structure of the desired alkane or cycloalkane molecule ● practice the use of learned tools in the <i>ChemSketch</i> program on given examples ● use an example from everyday life to check if educational outcomes are achieved. 	
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Content

Draw the 5-ethyl-2,2-dimethylheptane molecule.

- generate its name in the program and determine the molecular formula of that molecule,
- display it with skeletal formula, structural and condensed structural formula,
- display the structure of the molecule in three dimensions in different ways,
- determine the lengths of the selected bonds and specific bond angles,

- optimize the molecule,
- rotate and move it in two and three dimensions,
- save the 2D and 3D structure to the computer,
- draw the structure of cycloalkane and generate a name for that molecule, determine the molecular formula, transfer to three dimensions, save both the 2D and 3D structure of the molecule.

Recommendations for achieving educational outcomes

Give students a few more examples to practice all the learned options of working in *ChemSketch*.

Give them a task to search the Internet for examples of alkanes and cycloalkanes in everyday life and to show their structures in 2D and 3D.

Month	Teaching unit	Unit title	Estimated number of hours	Educational outcomes	Intersubject topics
October - November	Hydrocarbons	Alkenes and Alkynes	2	<ul style="list-style-type: none"> ● to draw different examples of alkenes and alkynes molecules and present them with a structural, condensed structural formula and with skeletal formula. ● to generate name of previously drawn alkene and alkyne 	1. Application of information and communication technologies in the teaching process 2. Examples of alkenes and alkynes in everyday life

				<p>molecules in the <i>ChemSketch</i> program</p> <ul style="list-style-type: none">● to determine the molecular formula of previously drawn alkene and alkyne molecules in the <i>ChemSketch</i> program● to improve the representation of the structure of molecules (adjustment of bond length and interbond angles) using the <i>Clean Structure</i> option● to draw structural isomers of alkenes and alkynes● to show the structures of alkenes and alkynes in three dimensions● to rotate alkene and alkyne molecules in two and three dimensions● to change the way of displaying the structures of alkene and alkyne molecules in three dimensions● to move alkene and alkyne molecules in 3D and 2D	
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| | | | | <ul style="list-style-type: none"> ● to determine bond lengths and bond angles in alkene and alkyne molecules ● to optimize the structures of alkene and alkynemolecules ● to save on the computer the two-dimensional and three-dimensional structure of the desired alkene or alkyne molecule | |
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Content

Draw the eten molecule.

- generate its name in the program and determine the molecular formula of that molecule,
- display it with skeletal formula, structural and condensed structural formula,
- display the structure of the molecule in three dimensions in different ways,
- determine the lengths of the selected bonds and specific bond angles,
- optimize the molecule,
- rotate and move it in two and three dimensions,
- save the 2D and 3D structure to the computer,
- Draw the structure of alkynes and generate a name for that molecule, determine the molecular formula, transfer to three dimensions, save both the 2D and 3D structure of the molecule.

Recommendations for achieving educational outcomes

Give students a few more examples to practice all the learned options of working in *ChemSketch*.

Give them a task to search over the Internet for examples of alkenes and alkynes in everyday life and to show their structures in 2D and 3D.



Month	Teaching unit	Unit title	Estimated number of hours	Educational outcomes	Intersubject topics
December	Arenes	Arenes -alkyl, alkenyl, alkynyl substituted benzene derivatives	2	<ul style="list-style-type: none">● to draw different examples of arene molecules and present them with a structural, condensed structural formula and with skeletal formula.● to generate name of previously drawn arene molecules in the <i>ChemSketch</i> program● to determine the molecular formula of previously drawn arene molecules in the <i>ChemSketch</i> program● to improve the representation of the structure of molecules (adjustment of bond length and	<p>1.Application of information and communication technologies in the teaching process.</p> <p>2.Examples of arenes in everyday life.</p>

				<p>interbond angles) using the <i>Clean Structure</i> option</p> <ul style="list-style-type: none">● to draw structural isomers of arenes● to show the structures of arenes in three dimensions● to rotate arene molecules in two and three dimensions● to change the way of displaying the structures of molecules in three dimensions● to move arene molecules in 3D and 2D● to determine bond lengths and bond angles● to optimize the structures of arene molecules● to save on the computer the two-dimensional and three-dimensional structure of the desired arene molecule● practice the use of learned tools in the ChemSketch program on given examples	
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		Revision and systematization of teaching contents		<ul style="list-style-type: none"> ● use an example from everyday life to check if educational outcomes are achieved. 	
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Content

Draw the formula of the methyl benzene or any example of arenes.

- generate the name in the program and determine the molecular formula of that molecule,
- show it with skeletal formula, structural and condensed structural formula,
- show the structure of the molecule in three dimensions in different ways,
- determine the lengths of the selected bonds and specific bond angles,
- optimize the molecule,
- rotate and move it in two and three dimensions,
- save the 2D and 3D structure to the computer,
- determine the molecular formula, switch to three dimensions.

Recommendations for achieving educational outcomes

Give students a few more examples to practice all the learned options of working in *ChemSketch*.

Students use opportunities to draw examples of the structure of benzene, the production of toluene, styrene, the Friedel-Craftz synthesis.

Give them a task to search the Internet for examples of arenes in everyday life and to show their structures in 2D and 3D.

Month	Teaching unit	Unit title	Estimated number of hours	Educational outcomes	Intersubject topics
December - January	Lewis structures	3D visualization of Lewis structural formulas	2	<ul style="list-style-type: none">● to visualize atoms, molecules or ions with Lewis symbols● to explain the spatial arrangement of particles in elementary substances and molecules of chemical compounds by applying VSEPR theory● to calculate the bond angle between two atoms in drawn molecules.	<ol style="list-style-type: none">1. Application of information and communication technologies in the teaching process.

		Revision and systematization of teaching contents		<ul style="list-style-type: none"> ● To visualize drawn molecules or ions in a 3D model ● To name organic and inorganic compounds using the <i>ChemSketch</i> program. ● To use ready-made complex ion templates found in <i>ChemSketch</i>. ● To apply VSEPR theory when determining the spatial shape of molecules or ions. ● practice the use of learned tools in the <i>ChemSketch</i> program on given examples ● use an example from everyday life to check if educational outcomes are achieved. 	
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Content

Apply the rules to draw Lewis structural formulas.

- Use *ChemSketch* when drawing Lewis structural formulas.
- Apply VSEPR theory to visualize molecules or ions in 3D.

- Apply the 3D visualization function in *ChemSketch* to display molecules or ions.
- Calculate the binding angle between atoms in a molecule or ion.
- Covalent bond: Lewis structures, single, double, triple bond length and bond strength, valence, spatial shape of molecules, polarity of molecules.
- Use ready-made complex ion templates found in *ChemSketch*.

Recommendations for achieving educational outcomes

To present Lewis structures in the processing of teaching content use examples that are most commonly used: water molecules, ammonia molecules, methane molecules, sulfate anion.

Month	Teaching unit	Unit title	Estimated number of hours	Educational outcomes	Intersubject topics
February	Chirality Optical Activity	Chiral Compounds Chiral compounds structure and properties - optical activity		<ul style="list-style-type: none"> ● to describe the concept of chirality, optical activity, enantiomers ● to determine the chirality compound according to its structural formula ● to draw structural and skeletal formulas of various chiral compounds 	<ul style="list-style-type: none"> ● Chiral compounds and their impact to everyday life - drugs and medicines ● Chiral compounds in the nature -

				<ul style="list-style-type: none">● to generate the names of drawn compounds in <i>ChemSketch</i>● to generate molecular formulas of compounds● to optimize the formulas using the <i>Clean Structure</i> function in the <i>ChemSketch</i> program● to draw the optical isomers of the compounds formed● to mark the chirality center in the structure of compound● to display structure of chiral compounds in three dimensions● to observe structures of compounds from different angles● to rotate and move the drawn structure in 2D and 3D● to determine bond lengths and bond angles of different chiral compounds● to save the created 2D and 3D structures to the computer● practice the use of learned tools in the <i>ChemSketch</i> program on given examples	<p>amino acids, carbohydrates, enzyme catalysis</p> <ul style="list-style-type: none">● biochemistry - the metabolic pathways of biomolecules
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		Revision and systematization of teaching contents		<ul style="list-style-type: none">● use an example from everyday life to check if educational outcomes are achieved.	
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Content

Draw the lactic acid formula following the given instructions. Specify:

- compound name,
- molecular formula,
- create a complete and simplified molecular formula,
- optimize formula with *Clean Structure*,
- mark the chiral carbon atom,
- create a 3D model,
- create previews from different angles,
- determine the bond length between the first and second carbon atoms,
- determine the bond angle between the first and second carbon atoms.

Recommendations for achieving educational outcomes

Give students some more examples to practice all the learned options of working in *ChemSketch*.

Give them a task to search over the Internet for information on the occurrence of chiral compounds in nature, their relationship to the metabolism of basic substances and their use in everyday life. Search for information on proteinogenic amino acids.

Month	Teaching unit	Unit title	Estimated number of hours	Educational outcomes	Intersubject topics
March	Organic compounds composed of oxygen and nitrogen	Alcohols	2	<ul style="list-style-type: none">to draw different examples of alcohol molecules and present them with a structural, condensed structural formula and with skeletal formula.to generate name of previously drawn alcohol molecules in the <i>ChemSketch</i> programto determine the molecular formula of previously drawn alcohol molecules in the <i>ChemSketch</i> program	<ol style="list-style-type: none">Application of information and communication technologies in the teaching process.Examples of alcohols in everyday life.

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| | | | | <ul style="list-style-type: none">● to optimize the representation of the structure of molecules (adjustment of bond length and interbond angles) using the <i>Clean Structure</i> option● to draw structural isomers of alcohol● to show the structures of alcohol in three dimensions● to rotate alcohol molecules in two and three dimensions● to change the way of displaying the structures of molecules in three dimensions● to move alcohol molecules in 3D and 2D● to optimize the structures of alcohol molecules● to save on the computer the two-dimensional and three-dimensional structure of the desired alcohol molecule● practice the use of learned tools in the <i>ChemSketch</i> program on given examples | |
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		Revision and systematization of teaching contents		<ul style="list-style-type: none">● use an example from everyday life to check if educational outcomes are achieved.	
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Content

Draw the formula of the alcohol hexan-2-ol.

- generate the name in the program and determine the molecular formula of that molecule,

- show it with skeletal formula, structural and condensed structural formula,
- show the structure of the molecule in three dimensions in different ways,
- determine the lengths of the selected links and specific link angles,
- optimize the molecule,
- rotate and move it in two and three dimensions,
- save the 2D and 3D structure to the computer,
- determine the molecular formula, switch to three dimensions, save both the 2D and 3D structure of the molecule.

Recommendations for achieving educational outcomes

- Give students a few more examples to practice all the learned options of working in *ChemSketch*.
- Give them a task to search over the Internet for examples of alcohols in everyday life and to show their structures in 2D and 3D.

Month	Teaching unit	Unit title	Estimated number of hours	Educational outcomes	Intersubject topics
March-April	Organic oxygen compounds	Aldehydes and ketones	2	<ul style="list-style-type: none"> ● to draw different examples of acyclic and cyclic aldehydes and ketones ● to show the structure of aldehydes and ketones with 	1. Examples of aldehydes and ketones in everyday life.

				<p>molecular, structural, condensed structural formulas and hyphens,</p> <ul style="list-style-type: none">● to name aldehydes and ketones according to the IUPAC nomenclature or generate the name in the <i>ChemSketch</i> program,● to determine the molecular formula of previously drawn aldehydes and ketones in the <i>ChemSketch</i> program● to display 3D models of aldehyde and ketone molecules drawn in 2D using <i>ChemSketch</i> and rotate them,● to improve the display of the structure of aldehydes and ketones using the <i>Clean Structure</i> function,● to save the two-dimensional and three-dimensional structure of aldehydes and ketones on the computer,● to improve digital skills by using a web browser to find other	
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		Revision and systematization of teaching contents		<p>examples of aldehydes and ketones.</p> <ul style="list-style-type: none"> ● practice the use of learned tools in the <i>ChemSketch</i> program on given examples ● use an example from everyday life to check if educational outcomes are achieved. 	
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Content

Draw the methanal, ethanal, propanal and propanone structure.

Draw phenyl ethanal structure.

Draw cyclopentane-1,3-dione structure.

- generate names in *ChemSketch* and determine the molecular formula,
- display drawn molecules with skeletal, structural, and condensed structural formula,
- display structures in three dimensions,

- rotate molecules in two and three dimensions,
- save structures to the computer.

Recommendations for achieving educational outcomes

Give examples to practice (3,7-dimethylocta-2,6-dienal, 5-methylheptane-2,4-dione).

Tell students to find examples of aldehydes and ketones to draw, generate names and molecular formulas in *ChemSketch*.

Month	Teaching unit	Unit title	Estimated number of hours	Educational outcomes	Intersubject topics
May	Biomolecules	Carbohydrates	2	<ul style="list-style-type: none"> ● to draw different examples of carbohydrate molecules and show their structure using Fisher's and Haworth's formulas ● to generate the carbohydrate name in <i>ChemSketch</i> ● to describe the chemical properties of different carbohydrates 	1. Application of information and communication technologies in the teaching process

		Revision and systematization of teaching contents		<ul style="list-style-type: none"> ● to draw the “D” and “L” structures of different monosaccharides ● to save on the computer the structures of molecules of different carbohydrates ● practice the use of learned tools in the <i>ChemSketch</i> program on given examples ● use an example from everyday life to check if educational outcomes are achieved. 	
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Content

Draw the glucose molecule.

- draw Fischer formula of glucose,
- draw Haworth formula of glucose,
- write formulas of glucose derivatives,
- find differences between “L” and “D” optical isomers.

Recommendations for achieving educational outcomes

Give students a few more examples to practice *ChemSketch*.

Give them a task to search carbohydrates in everyday life and discuss their importance.

Month	Teaching unit	Unit title	Estimated number of hours	Educational outcomes	Intersubject topics
May- June	Transition metals	Coordination compounds	2	<ul style="list-style-type: none">● to draw different examples of coordination ions and compounds and show them with a structural formula.● to show the structures of coordination compounds in 2D● to display 3D models of coordination compounds drawn in 2D using the program option <i>3D Viewer</i>● to determine the coordination number and geometry of coordination compounds	<ol style="list-style-type: none">1. Application of information and communication technologies in the teaching process.2. Examples of coordination compounds in everyday life.

				<ul style="list-style-type: none">● to determine possible geometric isomers of coordination compounds● to determine the coordination number and shape of the drawn coordination compound● to show the structure of coordination compounds in three dimensions● to rotate coordination structures in two and three dimensions● to change the three-dimensional display of the coordination ion structure● to move the structures of coordination compounds in 2D and 3D● to determine/correct bond lengths and bond angles in coordination ions● to optimize the structure of the coordination compound● to save on the computer the two-dimensional and three-dimensional structure of the	
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		Revision and systematization of teaching contents		<p>desired coordination ion or compound.</p> <ul style="list-style-type: none"> ● practice the use of learned tools in the <i>ChemSketch</i> program on given examples ● use an example from everyday life to check if educational outcomes are achieved. 	
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Content

Draw selected structures representing the most common coordination numbers and geometric shapes of complex compounds.

- determine the coordination number in the structures shown,
- recognize complex compounds presented,
- determine possible geometric isomers of selected complex compounds,
- create a 3D model of selected structures,

- display the selected stereo-bonded structure,
- determination of the charge of the central metal atom in selected structures.

Recommendations for achieving educational outcomes

Give students a few more examples to practice all the learned options of working in *ChemSketch*, find examples and draw and write the coordination number, structure and possible isomers of the selected examples.

Use examples of the most common coordinating numbers.

Month	Teaching unit	Unit title	Estimated number of hours	Educational outcomes	Intersubject topics
June	Drawing apparatuses	Rotary evaporator	2	<ul style="list-style-type: none"> • use pre-available templates in the <i>ChemSketch</i> program for drawing different apparatuses • arrange, rotate and move parts of the drawn apparatus • save the drawn apparatuses on the computer 	1. Application of information and communication technologies in the teaching process. 2. Examples of basic chemical apparatuses

		<p>Revision and systematization of teaching contents</p> <p>Analysis of student success at the end of the school year and final grading.</p>		<ul style="list-style-type: none"> practice the use of learned tools in the <i>ChemSketch</i> program on given examples 	<p>used in chemical technology.</p>
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Content

Draw a rotary evaporator scheme.

- insert pictures needed from Lab Kit Menu,
- label different parts of apparatus by using arrows,
- insert names of apparatus parts,
- if needed, rotate apparatus objects,
- if needed, move apparatus parts.
- save the picture of the apparatus.

Recommendations for achieving educational outcomes

Give students a few more examples to practice all the learned options of working in *ChemSketch*.

Create an alternative apparatus according to the original specification. Modification of the original flasks.