

CANNIZZARO PUZZLE

General informations	
1. Activity title	The Cannizzaro Puzzle
2. Date of the last tryout	2001
3. Author name	Catherine Filteau, Patrick Draper
4. College or university	Champlain Regional College (Saint-Lambert)
5. Author e-mail address	cfilteau@crc-lennox.qc.ca pdraper@crc-lennox.qc.ca
6. Science field	Organic chemistry
7. Student age	18-19 ans
8. Course title and number	Organic Chemistry I: 202-BFA-05
9. Time spent on the activity	10 hours (5 hours labs + 5 hours research and final report)

Activity description	
10. Activity summary	<p>This activity combines a written research and a laboratory experiment based on the Cannizzaro reaction. The experimental objective is to identify an unknown aldehyde by characterization of the two Cannizzaro products, an acid and an alcohol.</p> <p>Students work in pairs. Before the first laboratory period, the students research the Cannizzaro reaction, write a mechanism based on their knowledge of carbonyl chemistry and construct a flow diagram for isolation of the products. Over two laboratory periods the students perform the reaction on the aldehyde then isolate, purify and identify the products. The identification of the products is done by infrared spectroscopy and melting point determination. This information allows the students to determine the structure of the starting aldehyde. During the experimental part, each team keeps a laboratory notebook. After the second period, the students write a formal computer generated laboratory report which includes identification of their unknown aldehyde and discussion of research questions.</p>
11. Relevance and originality of the activity	<p>This project is one of three activities completed by science students in order to achieve the Integration of knowledge (objective 00UU).</p> <p>The experimental part of the activity combines a synthesis, separation, purification and identification. The students must take responsibility for designing the experimental procedure based on their understanding of basic laboratory techniques.</p> <p>Since the Cannizzaro reaction is not covered in class, the students have to use their knowledge of carbonyl compounds and apply it to this new reaction.</p>

Objectives and student program links		
12. Pedagogical objectives to be fulfilled or competencies to be developed		<p>These skills include:</p> <ul style="list-style-type: none"> - Keeping a laboratory notebook - Increased knowledge of laboratory safety through introduction of MSDS sheets (material safety data sheet) - Basic research skills by designing a experimental protocol and using different sources of information; internet, books, references - Scientific and problem-solving skills - Written communication skills and computer technology literacy through the preparation of a formal computer generated laboratory report - Team work for the experimental part and autonomous learning for some of the research component
13. Link between the activity and the student's program	a) General program objectives to be fulfilled	<p>Take a systematic approach to problem solving and reason logically</p> <p>Use appropriate data-processing technologies (in writing their formal laboratory report)</p> <p>Communicate effectively in writing Learn autonomously.</p> <p>Work as a member of a team</p> <p>Adopt attitudes that are useful for scientific work</p> <p>Apply what has been learned to new situations</p>
	b) Links with the course	<p>This project builds on laboratory skills (or techniques) previously learned in the lab. For example: liquid-liquid extraction principle, interpretation of infrared spectra, recrystallization techniques.</p> <p>This reaction, new to students, is based on reactivity of carbonyl compounds discussed in class</p>
	c) Links with other courses	<p>Some of the questions to be discussed in their formal laboratory report are biology and biochemistry related. They make the connection between biological oxidation/reduction reactions and the Cannizzaro reaction at the molecular level.</p>

Number of students and pedagogical supervision	
14. Approximative number of students in the classroom	46-50
15. Number of students required per team	2
16. Pedagogical supervision	The teachers act as resource persons for the pre-laboratory work and the research component of the project. During the laboratories, the teachers are present for help and security.

Description of the activity steps		
17. Description of the activity steps and time necessary for each step	a) Before	<p>The teachers set deadlines for each part and distribute the project description and requirements (Appendix E-1) to the students 2 weeks before the first laboratory period dedicated to this project.</p> <p>The teams then research the Cannizzaro reaction and mechanism and prepare a flow diagram for the isolation of the products. This part is to be submitted a few days before the first lab. The suggested time for this part is 2 hours.</p>
	b) During	<p>After submission of the pre-laboratory work, the students are given a brief procedure (1 page) for the reaction and isolation of the products.</p> <p>Two weeks of laboratory sessions (5 hrs total) are dedicated to the experimental part of the project. During the first period the reaction and isolation of the crude products is completed. At the beginning of the second session, each team is provided with basic purification information for the recrystallization. Identification of the products is also completed during this second period.</p>
	c) After	<p>Students have to complete a formal laboratory report (computer generated) including identification of their unknown and research questions. This completed report is due 10 days after the second laboratory session. The suggested time for this part is 3 hours.</p> <p>The teachers grade the students work according to an evaluation grid (Appendix P-3)</p>

Evaluation and required materials					
18. Evaluation suggestions	<p>This project counts for 15% of the final course mark as specified in the local science program description of objective (00UU).</p> <p>This 15% is divided into the following:</p> <ul style="list-style-type: none"> - Pre-laboratory report (2 marks) - Laboratory work and lab notebook (8 marks) - Laboratory report (4 marks) - Evaluation by other team member (1 mark). <p>A detailed evaluation description used by the teachers is given in Appendix P-3</p>				
19. Required materials	<p>A laboratory equipped for organic chemistry including: microscale (or regular) glassware, small separatory funnels, inorganic and organic reagents (especially 4-5 unknown aldehydes), melting point apparatus and IR spectrophotometer. (see Appendix P-4).</p> <p>The experiment can be adapted to available materials and can be done without an IR spectrophotometer.</p>				
20. Appendices	<table border="1" style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td style="width: 20%; vertical-align: top;">a) Teacher</td> <td> <p>Appendix P-1: Recrystallization conditions and melting point data</p> <p>Appendix P-2: List of possible starting aldehydes</p> <p>Appendix P-3: Evaluation grid</p> <p>Appendix P-4: List of materials</p> </td> </tr> <tr> <td style="vertical-align: top;">b) Students</td> <td> <p>Appendix E-1: Project description and requirements</p> <p>Appendix E-2: Laboratory protocol</p> <p>Appendix E-3: Recrystallization conditions</p> </td> </tr> </tbody> </table>	a) Teacher	<p>Appendix P-1: Recrystallization conditions and melting point data</p> <p>Appendix P-2: List of possible starting aldehydes</p> <p>Appendix P-3: Evaluation grid</p> <p>Appendix P-4: List of materials</p>	b) Students	<p>Appendix E-1: Project description and requirements</p> <p>Appendix E-2: Laboratory protocol</p> <p>Appendix E-3: Recrystallization conditions</p>
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Other suggestions and references	
21. Other ideas to explore	<p>For advanced students (and availability of equipment), an NMR spectrum (Nuclear Magnetic Resonance) of their products could be produced to help the identification. Given more time, the students could be asked to find an appropriate recrystallization solvent based on solubility data given in the Handbook of Chemistry and Physics.</p> <p>Le séchage de la phase organique (par du magnesium anhydre suivi d'une filtration) pourrait être effectuée par du papier filtre traité à la silicone.</p> <p>If an infrared spectrophotometer is unavailable, the melting point determination is sufficient for identification of the products.</p> <p>This project can be used as a laboratory test.</p> <p>The research questions can be changed each time the project is assigned and they can be adapted to provide links to other courses or objectives.</p>
22. References	<p>PAVIA, Donald L., Gary M. LAMPMAN, George S. KRIZ and Randall G. ENGEL (1999). Introduction to Organic Laboratory Techniques, 3rd edition, Montreal, Saunders College Publishing, 773 p.</p> <p>Robert Perkins, Chemistry Department, Kwantlen University College, 12 666 72nd avenue, Surrey B.C. V3W 2M8. Personal communications.</p> <p>McMURRY, John (1999). Organic Chemistry, 5th edition, Toronto, Brooks/Cole Thomson Learning, 1284 p.</p>