Socially-based Curriculum Unit: Extraction, Distillation and Combustion of Fossil Fuels

Unit Title: Extraction, Distillation and Combustion of Fossil Fuels

Time Frame: 5 days

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Developed for Course Name and Course Code: Science, Grade 11, College/University Preparation (SNC3M)

Strand(s) and Curriculum Learning Expectations Addressed:

Everyday Chemicals and Safe Practice Strand
CPV.01 · demonstrate an understanding of the properties, benefits, and hazards of everyday chemicals, and of the safe use of these products in the home, the workplace, and industry;
CPV.02 · investigate, through laboratory experiments and computer simulations, the chemical and physical properties of representative types of everyday chemicals, using appropriate equipment safely and accurately;
CPV.03 · evaluate the advantages and disadvantages of the use of common types of chemicals in everyday life, and analyse the environmental/economic impact of their use.

Desired Results

Unit Description:

In this unit, students will study fossil fuel extraction, distillation, storage and combustion. These topics will include the environmental impacts of the petroleum industry. The laboratory activities will involve a safe procedure involving approved chemicals. The distillation of a petroleum product is not a safe procedure therefore a safe substitution will be made to teach the distillation concepts. The laboratories include:

1. Demonstrating distillation using copper sulfate.
2. The production and incomplete combustion of a hydrocarbon.
3. Incomplete Combustion of Fossil Fuels Using Natural Gas or Propane (and a Bunsen burner).

Process marks will be awarded during the lab periods. A final report on the lab exercises, questions and a summative evaluation at the end of the five lessons will be used to evaluate the students understanding of fossil fuel extraction, distillation and combustion.

Enduring Understandings / Learning:

After these five lessons, students should recall:

1. How fossil fuels are formed, extracted and refined.
2. That environmental damage occurs at every stage: extraction (water injection), refining, transportation (example the spill in the Exonn Valdez) and combustion.
3. How to avoid incomplete combustion and excessive pollution (NOX, CO, SOX) by maintaining woodstoves, lawn mowers, automobiles and other machines that without maintenance would cause unnecessary pollution and incomplete combustion.
4. That lab safety involves proper eyewear (goggles), gloves (leather palms) and safe chemical handling and storage.

Assessment Tasks

Performance Tasks and Other Evidence That Will Demonstrate the Knowledge and Skills Acquired:

In this five day lesson plan there will be an opportunity to evaluate students in both a formative and summative manner. It will be up to the teacher to decide the frequency and length of these evaluations.

- Lesson 1: Using the cooperative learning strategy students will be able to evaluate themselves as to their knowledge of fossil fuels. (Formative)
- Lesson 2: Distillation of Copper Sulfate
  Students will form a hypothesis, graph and analyze questions for the distillation of copper sulfate. These tasks should be taken up in class and students should evaluate their own work. (Formative)
- Lesson 3: Combustion of a Hydrocarbon
  After the experiment of the combustion of a hydrocarbon the students should submit their hypotheses and analysis questions for evaluation. (Summative)
- Lesson 4: Incomplete Combustion of a Fossil Fuel
  In lesson 2 the students should have become familiar with clamps, stands and the precautions necessary for heating up a liquid. Once the liquid had cooled, it was returned to a proper storage area. Students also graphed the temperature versus time data. Students should now be evaluated on lab safety, proper use of equipment, the care with which they record data and their lab clean up. This is considered a performance task.
- Lesson 5: Students are to complete and evaluate their "Are You Ready?" sheets. This is a formative assessment. These questions will form the basis of a formal summative evaluation. This will take the form of a test.

Assessment Criteria:

- Lesson 1: Knowledge and Understanding
  The student demonstrates (limited, some, considerable or thorough) knowledge of facts and terms

regarding types of fossil fuels, conditions for their formation, extraction, distillation and the environmental impacts of their continues use.

- Lesson 2: Inquiry
  The student applies (few, some, most or all) of the skills and strategies for the formation of a hypothesis, interpretation of data (the warming curve) and analyzing questions pertaining to distillation.
- Lesson 3: Making Connections
  Student extends the analysis of hydrocarbon combustion in the lab to practical applications in everyday devices (example: lawnmowers) with (limited, moderate, considerable or high) degree of effectiveness.
- Lesson 4: Inquiry
  The student uses the tools, equipment and materials safely and correctly (seldom, with some supervision, minimal supervision, at all times) when studying the incomplete combustion of a hydrocarbon.
- Lesson 5: Communication and Making connections
  The student communicates information and ideas with (limited, moderate, considerable or high) degree of clarity. The student also assesses environmental and social impacts with (limited, moderate, considerable or high) amount of effectiveness.

Unit Planning Notes

Prior Learning Necessary:

- In grade 9, students were introduced to the classification of matter. This topic should be re-visited so that students will understand that a distillation involves changing a mixture into a pure substance.
- Students should also become familiar with the Kinetic Molecular Theory and latent heat (warming curves) to assist in their hypothesis.
- In grade 10, students learned how to write formulae, word equations, and chemical equations. Students should review double displacement reactions so that they can determine the reactants and products involved in the making of acetylene.

Preparation Notes:

- Apparatus required: Safety goggles, good work gloves, retort stands, clamps, wire mesh screens, thermometers (alcohol), cork borers, small diameter (3mm) glass tubing, two hole stoppers, flasks, test tubes, warming plates, and Bunsen burners.

- Learn how to cut and bend glass tubing. Practice inserting glass tubing and thermometers into the two holed rubber stoppers using cork borers.
- Learn about the chemicals before using them by checking out different resources including MSDS sheets; the chemicals used are Copper (II) Sulfate ($CuSO_4$), which should be 1 molar (1M) and Calcium carbide (Ca_2C), which needs to be in pebble form. Powdered calcium carbide does not work.

Learning Plan

Lesson 1

Students need prior knowledge of fossil fuel extraction and production before proceeding to lesson 1. Information on the fossil fuel extraction process and production of fossil fuels can be found on the internet.

Teachers should choose from ONE of the following to accomplish this:

a) Board notes on the formation, extraction, and transportation of fossil fuels. (Interactive Socratic Method). Finish with the cooperative game described below.
Total time: 76 minutes (including game)

b) Overhead notes on the formation, extraction, and transportation of fossil fuels leaving blank areas for the students to fill in to make it interactive. Finish with the cooperative game below.
Total time: 76 minutes (including game)

c) Download information from electronic sources and create ten work stations with different information from the websites at each station. Example:

Station one: Introduction to fossil fuels
Station two: Fossil Fuel formation
Station three: Combustion, drilling and refining.

Students are to write down the headings for each station and leave space below each heading (6 lines). Students can then begin at any station, like a bell ringer lab test. The students are to read the information provided at each station and make notes under the headings. The students have four minutes at each station. Time for this section: 40 Minutes.
Using a Socratic method proceed with a question answer period to make sure the students are comfortable understanding what they have written and are comfortable with common terms associated with fossil fuels. Time for this section: 10 minutes
Finish with the cooperative game described below.
Total time: 76 minutes (including game)

Students then go on to the cooperative activity game with fossil fuels. Start by pairing up the students and asking the pair of students to throw a ball back and forth between each other (underhand and lightly). Start by asking the students to answer a question about their school such as name ten good things about your school.

As the students throw the ball to their partner, they answer the question.
Once the students are comfortable with this exercise, ask a question about fossil fuels such as:

Name a fossil fuel
Answer: Methane, Ethane, Propane, Butane, Pentane, Hexane, Heptane, Octane, Nonane, Decane etc…
Describe conditions for formation of fossil fuels:
Answer: Pressure, low oxygen, dead organisms (in low oxygen environments), tetonic plate activity etc…
What types of bonding occur in hydrocarbons?
Answer: Alkane (single bond), alkene (double bond), alkynes (triple bond) and cyclic.
Name the combustion products when fossil fuels are burned.
Answer: Water, Carbon Dioxide, Carbon monoxide, SOx, and NOx.

Continue the cooperative activity game to help the students fully understand the information in this first lesson.
Total time: 15 minutes

Lesson 2: Distillation of Copper Sulfate

Purpose:

1. To demonstrate the separation of two substances by distillation. The purpose is to show how fossil fuels are distilled using Copper Sulfate solution as a safe alternative to actually using a fossil fuel.
2. Create a warming curve for the distillation of Copper Sulfate ($CuSO_4$) solution.

Theory:

Students should be introduced to the concept of the fractional distillation of fossil fuels.

1. The teacher should draw a diagram of a fractional distillation tower explaining how fractional distillation works using the diagram.
2. Revisit the classification of matter (Pure Substances, Mixture, compounds, elements…) to illustrate that fraction distillation changes a mixture into pure substances.
3. Review kinetic molecular theory to explain the shape of the warming curve (latent heat) created by heated a substance such as Copper Sulfate.

Hypothesis:

1. Knowing that the solution contains (copper ions, sulfate ions and water), the students should hypothesize what the distillate will look like and suggest the composition of the distillate. (Copper ions, sulfate ions, copper sulfate or water).
2. Sketch the warming curve for the distillation of Copper Sulfate solution. Will it be a straight line or will it be a saturation curve?

Lab: See Appendix A

1. Assemble the thermometer and distillation tubing in the cork using a cork borer and lubricant as a demonstration as to how students should assemble their own apparatus. The alternative is that you do the assembly.
2. Students should assemble their apparatus' according to the demonstration and conduct the lab as outlined in Appendix A.

Lesson 3: The Production and Incomplete Combustion of a Hydrocarbon

Purpose:

1. Demonstrate the production of a hydrocarbon using Calcium Carbide (Ca_2C).
2. Illustrate the incomplete combustion of a hydrocarbon.

Theory/Hypothesis:

Teachers need to develop the hypothesis with the student. Here are some teaching points for the hypothesis:

1. Reintroduce formula writing (example $Ca^{2+} + C^{4-} \rightarrow Ca_2C$)
2. Review hydrocarbon structure to make sure students are aware that hydrocarbons consist of only hydrogen and carbon (Not nitrogen or sulfur contaminates).
3. Discuss alkanes, alkenes and alkynes-the difference between them and that an alkyne is the hydrocarbon that is formed in this reaction.
4. Revisit Gr. 10 chemistry and double displacement reactions. The metals are the chemicals that exchange positions in the reaction.
5. Mention that hydrogen is a black, shiny metal at $-272.3^{o}C$, and can occupy that part of the periodic table.

Lab: See Appendix B.

Lesson 4: Incomplete Combustion of Fossil Fuels Using Natural Gas or Propane

Question of the day: What are the products of gasoline combustion found in car exhaust?

Purpose:

1. Demonstrate the incomplete combustion of fossil fuels.

Theory/Hypothesis:

The hypothesis will need to be developed with the teachers help using these teaching points:

1. With a good supply of oxygen, combustion will be complete, carbon oxides and water will form.

2. With incomplete combustion, expect the same products as the burning of acetylene (calcium carbide experiment)
3. Complete combustion is efficient.

Lab: See Appendix C.

If there is time after lesson 4 is complete the teacher could revisit lessons 1, 2 and 3. Ask the students questions or to help make a list on the blackboard some important terms for incomplete combustion, fossil fuels, distillation etc… (Example: Begin by asking the students to name 10 fossil fuels. Write the names down on the black board until the important fossil fuels are all named).

Lesson 5: Evaluation

Prepare a worksheet to test if the students are ready, called an 'Are You Ready?' sheet (see Appendix D). Students are to answer the questions for the first 15 minutes without their notebook. After 15 minutes the students can use their notebooks. The questions will be answered on the board and marks assigned for each question. This is a formative quiz.

For low- functioning students (3L/4L) the test is similar to the 'Are You Ready?' sheet. For more academic students several questions on the 'Are You Ready?' sheet might be the basis for a detailed test question.

A preferred way to mark the 'Are You Ready?' sheets is to purchase a '4x8' white board sheet. Cut it into 8 different pieces measuring 2' x 2'. Drill 4 holes on each piece so they could be hung in any directions. Hang the white boards on a row of nails at the top of your board. Student writing on these boards tends to be more legible.

Reviewing in pairs: One student performs the role of the teacher and the other student performs the role of the student to the 'teacher'. The 'teacher' has both the question and answers sheets and quizzes the student. The two students in the roles will reverse roles every four minutes.

An 'Are You Ready?' lesson will take 76 minutes.

- Writing the quiz: 25 minutes
- Putting answers on the white board: 15 minutes
- Taking up the answers: 20 minutes
- Review in pairs: 16 minutes

Appendices

Appendix A: Lab for Lesson 2 "Distillation of Copper Sulphate"
Appendix B: Lab for Lesson 3 "The Production and Incomplete Combustion of a Hydrocarbon"
Appendix C: Lab for Lesson 4 "Incomplete Combustion of Fossil Fuels Using Natural Gas or Propane"
Appendix D: Sample Evaluation

Other Possible Course Applications

This unit is also appropriate for S**NC 4M: Science, Grade 12, College/University Preparation.**

Strand: Organic Products in Everyday Life
OPV.01 · describe the properties, benefits, and hazards of representative everyday organic products, and the use of these products in personal daily life, industry, and agriculture;
OPV.02 · investigate the properties of everyday organic products, using appropriate laboratory procedures and equipment safely and accurately, and gathering and integrating information from print and electronic sources;
OPV.03 · analyse the impact on society and the environment of the use of organic products.