CLIMATE CHANGES

Chemistry 20

TEACHER'S RESOURCE

Inside education

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CLIMATE CHANGES

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FOSSIL FUELS AND CARBON DIOXIDE EMISSIONS

TO THE TEACHER

This lesson will help students make the connections between scientific calculations on fossil fuels and the STS issue of climate change. This exercise should be addressed after the basic introduction to gravimetric stoichiometry and students are practicing their skills. All students should be able to do the calculations and summary sections (#1-4)

Based on the outcome of the calculations completed by the students, methane (natural gas) is found to be the best fossil fuel choice as it relates to the production of carbon dioxide. This outcome should be discussed further with the class. Ideas from this discussion should be recorded for use in the brainstorming exercise (#5)

In perspectives brainstorming, ideas are organized and developed into one of five major sections (scientific, technological, economic, political, and ecological). This activity can be brief (five or ten minutes) or longer if you wish to make more connections. Students should be challenged to look at the issue of CO_2 emissions and their relationship to climate change from a variety of perspectives and appreciate each differing point of view (examples are provided in the key, page 6)

A decision-making exercise on energy efficiency completes the lesson and should help focus on how society can benefit from increasing efforts towards energy efficiency. Some examples of how this could be developed for each perspective are:

Scientific - Increasing energy efficiency reduces the rate of CO_2 emissions and research in this area could help explain the long and short term benefits.

Technological - New and emerging technological devices will improve energy efficiency. Using cars as an example, students can discuss new aerodynamic designs and high efficiency engines and drivetrains. Other areas of focus could include the increased use of renewables (wind and solar, for example) and fuel cell technology. Benefits are realized in the reduction of CO_2 (as well as air pollutants) from reduced fossil fuel consumption.

Ecological - The role of the consumer and the actions of the individual can be directly linked to impacts on the environment. Conserving water, using mass transit, driving slower, and using a more fuel-efficient car are just some of the many ways each individual can have a direct impact on the reduction of CO_2 emissions.

Economic - Energy efficiency is directly related to economic savings for all energy users. There are many very concrete examples of this from reduced costs of products that were manufactured using energy to savings at the fuel pump.

Political - All levels of government are affected by changes to public access to energy whether it be a shortage of supply, an increase in cost or the relevance of environmental impacts associated with energy use. Economic prosperity, rebates to citizens, reducing emissions to meet international agreements (for example, the Kyoto Accord), and global stability are all benefits furthered by energy efficiency.

Activities in this lesson can be adjusted to meet the time available to you and your class. As an "add in", lesson development is left up to the individual teacher and will be different for each class. Exercises can be discussed in class or assigned as written response questions. In addition, a page of extension activities is provided should teachers choose to further develop the lesson. These activities are also designed to help teachers integrate technology and careers into the classroom.

LESSON PLAN

Unit Two
Quantitative Relationships in Chemical Changes

Concept
Relationships between amounts of reactants can be used to study chemical reactions.

Objectives

A. Skills	B. Attitudes	C. STS Connections
- Analyzing data related to quantitative relationships in chemical changes. - Developing planning, collecting, organizing and communication skills.	- Develop a positive attitude toward mathematical and scientific process skills. - Develop an awareness of the relationship between chemical principles and application of chemistry.	- Making connections between scientific concepts and the STS issue of global climate change. - Developing critical thinking skills on STS issues.

Method
Students will:

- complete a series of gravimetric stoichiometry problems.
- participate in a perspectives brainstorming exercise.
- be able to make decisions on energy efficiency using a variety of perspectives.

Closure
Students should be able to connect scientific knowledge to STS perspectives and decision making.

Lesson Evaluation
Students are able to:

- use gravimetric stoichiometry to calculate carbon dioxide emissions.
- identify STS perspectives by completing a brainstorming activity.
- use STS perspectives in a decision-making activity.

MAKING THE LINK:
FOSSIL FUELS, CARBON DIOXIDE AND GLOBAL CLIMATE CHANGE

Understanding the connection between fossil fuel consumption and carbon dioxide emissions is essential for you to understand global climate change. As carbon dioxide is released into the air, consumers have a difficult time linking this to environmental impacts because the emissions are not visible to the naked eye. In addition, the consumer has the added difficulty of understanding the complexity of abstract concepts and issues related to climate change.

The following exercise will help you to connect the use of fossil fuels as an energy source to the emission of carbon dioxide, a greenhouse gas that contributes to climate change.

1. Calculate the mass of carbon dioxide produced from the combustion of 1.00 kg of methane.

$$CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_20_{(g)}$$

m=1.00 kg	m= ?
M=16.05 g/mol	M= 44.01 g/mol

$$n_{CH_4} = \frac{m}{M} = \frac{1.00 \text{ kg} \times 1000 \text{ g/kg}}{16.05 \text{ g/mol}} = 62.3 \text{ mol}$$

$$n_{CO_2} = n_{CH_4} \times \frac{1}{1} = 62.3 \text{ mol} \times \frac{1}{1} = 62.3 \text{ mol}$$

$$m_{CO_2} = nM = 62.3 \text{ mol} \times 44.01 \text{ g/mol} = 2.74 \times 10^3 \text{g} = 2.74 \text{ kg}$$

2. Gasoline consists of many hydrocarbons. Using octane $C_8H_{18(l)}$ to represent the composition of gasoline, calculate the mass of carbon dioxide produced when 1.00 kg of octane undergoes combustion.

$$2C_8H_{18(l)} + 25\ O_{2(g)} \longrightarrow 16\ CO_{2(g)} + 18\ H_20_{(g)}$$

m=1.00 kg	m= ?
M=114.26 g/mol	M= 44.01 g/mol

$$n_{C_8H_{18}} = \frac{m}{M} = \frac{1.00\ kg \times 1000\ g/kg}{114.26\ g/mol} = 8.75\ mol$$

$$n_{CO_2} = n_{C_8H_{18}} \times \frac{16}{2} = 8.75\ mol \times \frac{16}{2} = 70.0\ mol$$

$$m_{CO_2} = nM = 70.0\ mol \times 44.01\ g/mol = 3.08 \times 10^3 g = 3.08\ kg$$

3. Coal is a primary energy source used throughout the world. Using carbon solid to represent coal, calculate the mass of carbon dioxide produced when 1.00 kg of coal is burned.

$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$

m = 1.00 kg
M = 12.01 g/mol

m = ?
M = 44.01 g/mol

$$n_C = \frac{m}{M} = \frac{1.00 \text{ kg} \times 1000 \text{ g/kg}}{12.01 \text{ g/mol}} = 83.3 \text{ mol}$$

$$n_{CO_2} = n_C \times \frac{1}{1} = 83.3 \text{ mol} \times \frac{1}{1} = 83.3 \text{ mol}$$

$$m_{CO_2} = nM = 83.3 \text{ mol} \times 44.01 \text{ g/mol} = 3.66 \text{ kg}$$

4. **Summary of CO_2 emissions**

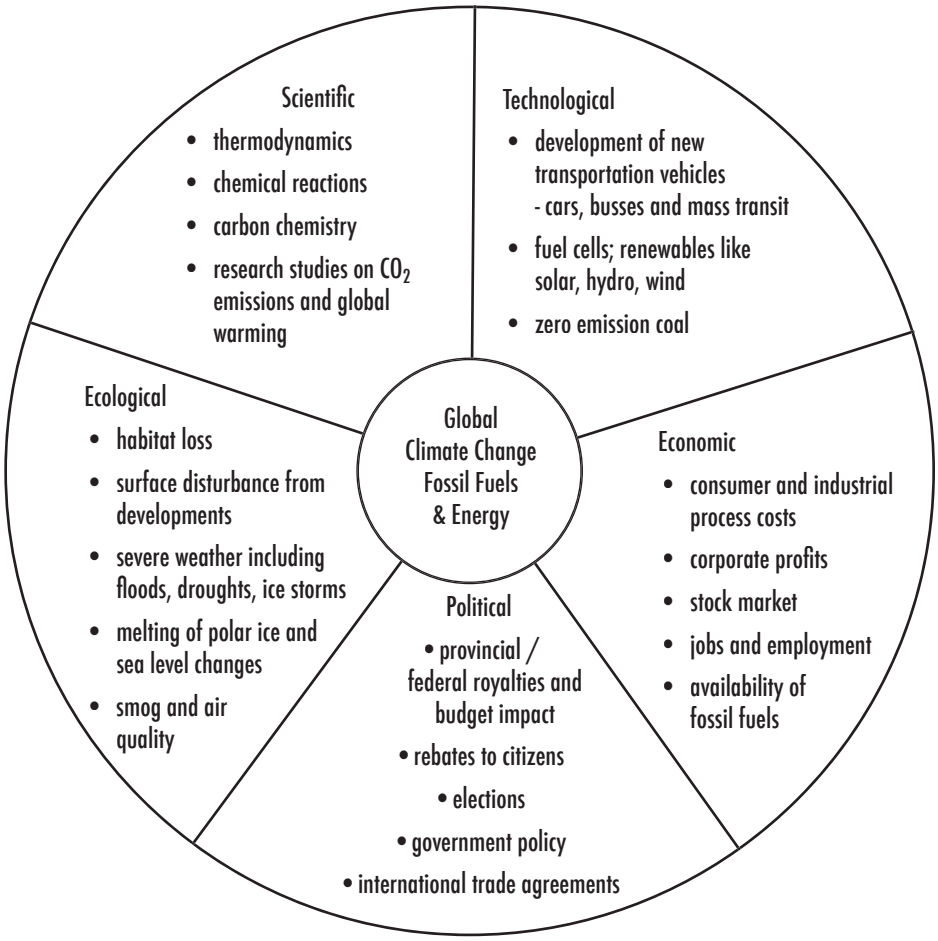
a. Combustion of 1.00 kg of methane produces 2.74 kg of CO_2.
Combustion of 1.00 kg of octane produces 3.08 kg of CO_2.
Combustion of 1.00 kg of $C_{(s)}$ produces 3.66 kg of CO_2.

b. Which fossil fuel produces the most CO_2/kg? $C_{(s)}$, Coal
Which fossil fuel produces the least CO_2/kg? $CH_{4(g)}$, Methane.

5. Identifying the issue: Perspectives brainstorming

Briefly describe how each perspective could be used to understand CO_2 emissions as an STS issue.

PERSPECTIVES WHEEL DIAGRAM



6. Decision-making: Energy efficiency makes sense!

Referencing each of the perspectives in the diagram above, describe how energy efficiency could benefit society.

EXTENSION ACTIVITIES

Use current print, library, audiovisual and technology-related resources to complete the following. (A list of Internet websites has been provided to assist students.)

A. Research Projects

a. Develop an essay on climate change and global warming by describing the role of each perspective on this STS issue.

b. Consider how industry develops energy resources. Explain, using diagrams and a written report, how each of the following energy technologies works.

- Hydroelectric dam
- Nuclear reactor
- Wind turbine
- The mining and extraction of crude oil from oil sands
- Internal combustion engine
- Coal-fired electricity generating plant
- Diesel-fuel driven electric generator
- Fuel cells
- Photo-voltaic panels (solar)

c. Take a position on recycling and energy conservation!

How would support for recycling and energy conservation programs in your community help to respond to the climate change issue? How could you get involved in recycling and energy conservation actions? How do choices that you make as a consumer affect recycling and energy conservation efforts?

B. Careers

Select one or more of the following career areas or occupations and answer the following:

a. Write a job description for people working in this area.

b. What post-secondary program(s) or training are required for this type of work?

c. Where can you go to obtain this post-secondary training or program?

d. List the high school graduation requirements and any additional courses that may help you to enter a post-secondary program and / or training.

Heavy equipment operator

Chemist

Office administrator

Computer technician

Management consultant

Engineer

Electrician

Sales and marketing

Instrumentation

Pipefitter

Other (choose your own)

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$$\_\_C_{(s)} + \_\_O_{2(g)} \longrightarrow$$

4. Summary of CO_2 emissions

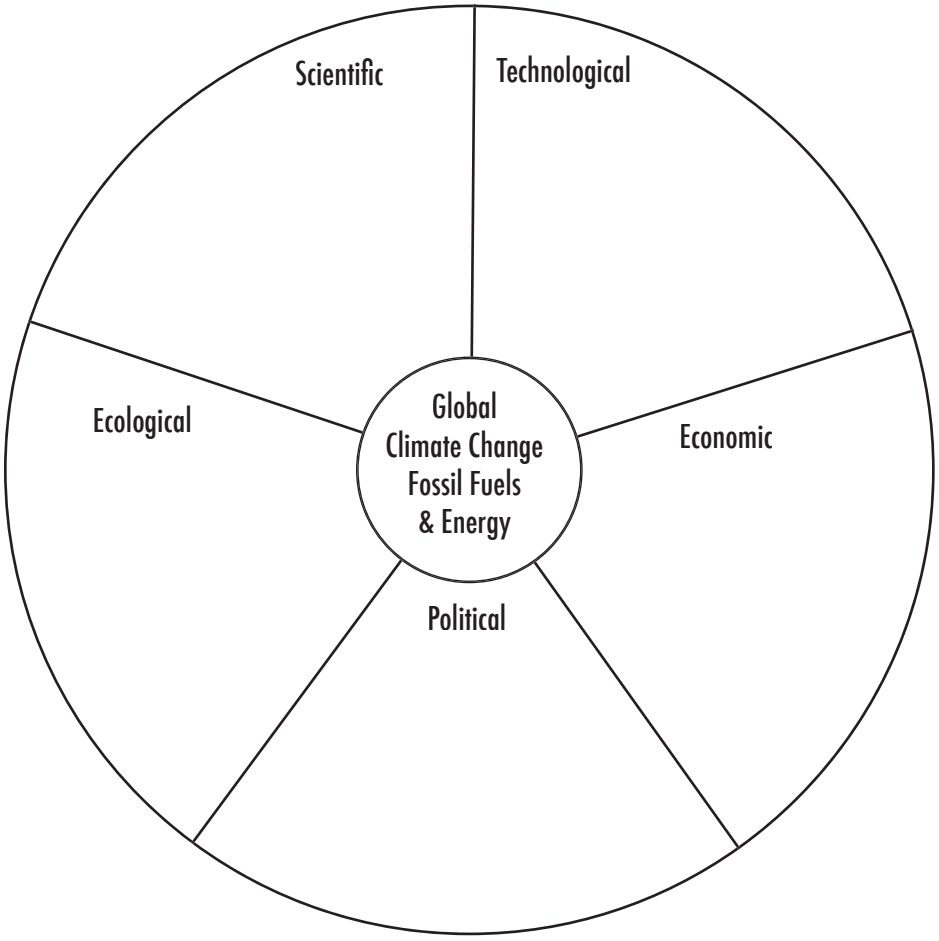
a. Combustion of 1.00 kg of methane produces _____kg of CO_2.
Combustion of 1.00 kg of octane produces _____kg of CO_2.
Combustion of 1.00 kg of $C_{(s)}$ produces _____kg of CO_2.

b. Which fossil fuel produces the most CO_2/kg? _____
Which fossil fuel produces the least CO_2/kg? _____.

5. **Identifying the issue: Perspectives brainstorming**

Briefly describe how each perspective could be used to understand CO_2 emissions as an issue. What sorts of things need to be considered when thinking about CO_2 emissions from burning of fossil fuels?

PERSPECTIVES WHEEL DIAGRAM



6. **Decision-making: Energy efficiency makes sense!**

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Heavy equipment operator

Chemist

Office administrator

Computer technician

Management consultant

Engineer

Electrician

Sales and marketing

Instrumentation

Pipefitter

Other (choose your own)

INTERNET WEBSITES ON ENERGY-RELATED TOPICS

The following annotated sites may assist you in researching topics such as climate change, energy sources and energy careers. These sites are suggested as sources of information only.

International Sites

Energy Quest, California Energy Commission
http://www.energyquest.ca.gov
Good links to a variety of excellent science and science education sites.

Global Solar Partners
http://www.solarpartners.org
Teachers and students can be connected worldwide to share ideas on sustainable energy.

World Watch Institute
http://www.worldwatch.org
Presents information from a sustainable development position on a variety of environmental topics such as climate change.

Canadian Sites

BP Solarex
http://www.solarex.com
Good background information on solar energy.

Canadian Electricity Association
http://www.canelect.ca
Information on the generation, transmission and distribution of electricity in Canada.

Canadian Gas Association
http://www.cga.ca
Information on home energy audits and uses of natural gas in the home.

Canadian Nuclear Association
http://www.can.ca
Provides background on using nuclear energy. Section on climate change.

Canadian Wind Energy Association
http://www.canwea.ca
Good background information on wind energy.

Coal Association of Canada
http://www.coal.ca
Good background information on coal and related career information.

Energy Probe
http://www.energyprobe.org
Alternative points of view on energy development and use.

Global Thermoelectric
http://www.globalte.com
Good information on the development and application of fuel cells. Good related career information.

Independent Power Producers Society of Ontario, Renewable Energy and Sustainable Energy Systems in Canada
http://www.newenergy.org/indexappro.html
Good place to get links to wide variety of sites on alternative/renewable energy.

Natural Resources Canada
http://www.nrcan.gc.ca
Excellent background information on energy resources, efficiency and conservation. Related site, within the department is with the Office of Energy Efficiency. Good links to the Government of Canada's climate change site.
http://www.oee.nrcan.gc.ca/english
Excellent information on energy efficiency in the home, business, automobile, etc.

Canadian Centre for Energy
http://www.centreforenergy.com
Information, data and educational materials pertaining to Canada's energy sector and energy-related issues.

Pollution Probe
http://www.pollutionprobe.org
Source of information on pollution and other environmental issues. Good links into the environmental non-government sector.


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