



FUNDAMENTALS OF ENERGY

LABORATORY: EMISSION OF CO₂ FROM THE BURNING OF FOSSIL FUELS

(Adapted from: *Woodrow Wilson Leadership Program in Environmental Science, The Emission of CO₂ from the Burning of Fossil Fuels* by: Childers, Dileo & Hall)

SUMMARY/ABSTRACT

- Using a Bunsen burner, a ring stand and wire gauze, students will burn four types of coal. They will entrap the gaseous material using an inverted funnel and use rubber hosing to transfer the gases to a flask being monitored by a gas censoring device, CBL and graphing calculator. Following this experiment, students will be able to understand how CO₂ is produced from various types of coal.
 - Students will act as problem solvers and researchers to utilize critical thinking skills.
 - Students will be able to explain how global warming and specifically greenhouse gases are dangerous to the earth.
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INSTRUCTOR'S OBJECTIVES:

- Students will make use of group/cooperative learning.
 - Students will set up their lab following directions.
 - Students will learn how to use the CBL and graphing calculator.
 - Students will determine which coal source produces the most CO₂.
 - Students will be able to construct a data table and a graph.
 - Students will make correlations between emissions of CO₂ from coal and the formation of acid rain.
 - Students will make correlations between emissions of CO₂ from coal and the greenhouse effect; and the subsequent increase in surface temperatures.
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TARGET AUDIENCE OR AGE GROUP

- Environmental students
 - Grade Level 8-10
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NOTES TO THE TEACHER:

Pre Lab Discussion: During the weeks prior to this lab discuss the history of coal use in the world. Have students share with the class what they know about greenhouse gasses and the greenhouse effect.

Preparation Time: 15 min. (only preparation is to gather materials)

Class Time Needed: One class period (approx. 90 min) is sufficient. Extensions will require additional time.

Materials needed: Students can work in groups of 2-4.

Each group needs:

Approx. 1 gram of each sample of coal; Anthracite, Bituminous, Lignite, Peat

Bunsen burner

Graph paper

Glass funnel

Graphing calculator

Tubing

CBL

CO₂ probe

Goggles

Erlenmeyer flask w/side arm

Aprons

Ring stand with wire gauze

Striker/match

Computer (optional)

Balance

Coal samples; these can be ordered from a science catalog

Calculator Based Laboratory and TI-83 Calculators or similar

Hazards and Precautions:

Be sure to use caution when burning materials

Activity should be performed under a hood or in a well ventilated area.

The coal, ring stand, gauze and funnel become very hot during the burning process

Sample Hypothesis: If a sample of each type of coal is burned, then anthracite will produce the most CO₂.

Sample Conclusions: Based on our data, anthracite and peat emit the most CO₂ into the atmosphere; although it appears that anthracite produce more CO₂ over a longer period of time. Peat started out slower but at approx. 3 minutes it was at the same level as anthracite. Our hypothesis was somewhat proven correct, but we were surprised that peat produced the same level of CO₂ as anthracite.

Glossary

Anaerobic – Occurring in an environment that has little or no oxygen.

Anthracite – A hard, black lustrous coal often referred to as hard coal, containing a high percentage of fixed carbon and low percentage of volatile matter. It produces 15,000 Btu/pound.

Bituminous (soft coal) - The most common type of coal. It is dense and black; its moisture content is usually less than 20%. It is harder than lignite and produces 11,000-15,000 Btu/pound. It is the form of coal that is used in the home.

Coal - A combustible rock that contains carbonaceous materials and moisture. It is formed during the earlier geological periods from the compaction of plant remains.

Combustion - The production of heat from the burning of coal. It produces 14,100 Btu/pound of carbon. It combines atmospheric oxygen with carbon to produce carbon dioxide.

Fossil fuel - An energy resource, such as coal, natural gas, or petroleum that is the product of decomposition of plants and animals in an anaerobic environment.

Greenhouse gases - CO₂, O₃, H₂O, CH₄, and other trace gases that are emitted to the atmosphere to add to the global warming.

Greenhouse effect - A shield formed in the earth's atmosphere from the collection of greenhouse gases. This shield allows heat (from the sun) in but does not let the heat out.

Lignite - A form of coal that is crumbly and contains the highest percentage of moisture. It is usually a light brown to very dark brown in color. It is used to produce electricity and has a heating value of 4,000-15,000 Btu/pound.

Nonrenewable resource - A natural resource such as coal, gas and nuclear energy whose supply is limited and cannot be replaced.

Peat - A material that is in the early stages of coal development. It has a high (75%) moisture content and burns easily.

Photosynthesis - Photosynthesis is the reverse of respiration. It uses up carbon dioxide and releases oxygen that requires sunlight and chlorophyll.

The Emission of CO₂ from the Burning of Fossil Fuels

Student Lab

Problem: Which of the four types of coal produces the most CO₂?

Develop hypothesis: Read the background information supplied and formulate a hypothesis on which type of coal will produce the most CO₂. Explain the reasoning you used to develop this hypothesis.

Procedure Overview: Working in groups of two to four, set up the following experiment to measure CO₂ emissions from various types of coal. Using a Bunsen burner, a ring stand and wire gauze, each group will burn four types of coal. The groups will entrap the gaseous material using an inverted funnel and use rubber hosing to transfer the gases to a flask being monitored by a gas censoring device, CBL and graphing calculator.

Gather Materials: *(Each group of 4 needs one of the following)*

Four types of coal: Anthracite, Bituminous, Lignite, Peat

Bunsen burner

Glass funnel

Tubing

CO₂ probe

Erlenmeyer flask w/side arm

Ring stand with wire gauze

Striker/match

Balance

Graph paper

Graphing calculator

CBL

Goggles

Aprons

Computer (optional)

Procedure:

1. Wear goggles and apron.
2. Weigh 1 gram of each sample of coal.
3. Place wire gauze on top of ring stand.
4. Place Bunsen burner under ring stand.
5. Attach rubber tubing to a funnel and position the funnel so that it sits on the gauze.
6. Attach the other end of the tubing to the arm of an Erlenmeyer flask.(See fig. 1)
7. Set the CBL, graphing calculator and CO₂ probe according to the directions. Use the ChemBio Program on the graphing calculator.
8. Place the carbon dioxide probe in the top of the Erlenmeyer flask. Make sure that all connections are tight.
9. Burn one sample of the coal under the funnel and collect data for 10 minutes.
10. Graph the data.
11. Repeat this procedure for each the other samples of coal.

(Notes: The flask needs to be aired out between each monitoring of gas. Simply remove the probe for a few min.)

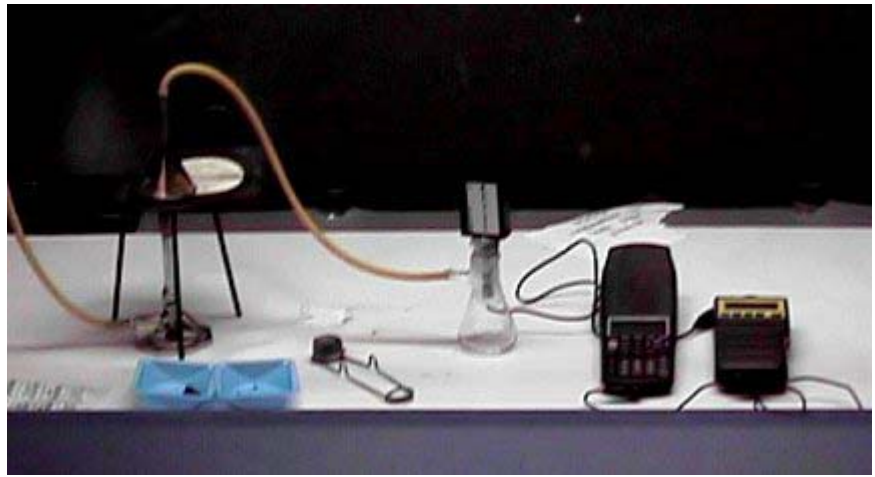


Figure 1

Weight of each coal sample:

Anthracite = Lignite =
 Bituminous = Peat =

CO₂ Emissions data collection sheet

Time(seconds)	Anthracite (ppm)	Bituminous (ppm)	Lignite (ppm)	Peat (ppm)
30				
60				
90				
120				
150				
180				
210				
240				
270				
300				
330				
360				
390				
420				
450				
480				
510				
540				
570				
600				

1. Construct a single graph. Plot CO₂ ppm over time, for each type of coal using the data collected.
2. Write up the results from your experiment
 3. Have students research alternate resources of energy.
 4. Have students design a lab to measure CO₂ emissions in other resources such as various types of wood or paper products.

Conclusion: