Performance Based Learning and Assessment Task

Exploring Coal Pillar Mining

I. ASSESSSMENT TASK OVERVIEW & PURPOSE:

The purpose of this activity is to assess the students' ability to calculate volume and surface area of a complex three dimensional object. Then using this information, the students will be responsible for using percentages to calculate data needed in the coal industry.

II. UNIT AUTHOR:

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III. COURSE:

Geometry

IV. CONTENT STRAND:

Geometry

V. OBJECTIVES:

Students will be able to: 1)Find the maximum volume of a complex three dimensional object/space, 2) Create a scale drawing (blueprint) of a coal bed that will maximize profit and safety for the company, 3) Use surface area to solve practical problems

VI. REFERENCE/RESOURCE MATERIALS:

Students will use: Geometry SOL formula sheets, Calculators, Exploring Coal Pillar Mining task sheets, Graph paper, Pencils, Colored pencils or markers, Rulers, The pictures/diagrams of coal pillar mining practices, Websites for background information on coal mining resources (these resources include information on coal mining in Buchanan County, VA: Cedar, Inc. : Coal Education Development and Resource http://www.cedarinc.org, Coal in Virginia http://www.virginiaplaces.org/geology/coal.html

VII. PRIMARY ASSESSMENT STRATEGIES:

The task includes an assessment component that performs two functions: (1) for the student it will be a checklist and provide a self-assessment and (2) for the teacher it will be used as a rubric

VIII. EVALUATION CRITERIA:

Students will complete the tasks found the attached activity. Student performance on the tasks will be assessed by using the attached rubric

IX. INSTRUCTIONAL TIME:

60 minutes instructional time

Exploring Coal Pillar Mining

Strand
Geometry

Mathematical Objective(s)
Students will be asked to: 1)Find the maximum volume of a complex three dimensional object, 2)Create a scale model (blueprint) of a coal bed that will maximize profit and safety for the company, 3)Use surface area to solve practical problems.

NCTM Standards

- analyze properties and determine attributes of two- and three-dimensional objects
- explore relationships (including congruence and similarity) among classes of two- and three-dimensional geometric objects, make and test conjectures about them, and solve problems involving them
- draw and construct representations of two- and three-dimensional geometric objects using a variety of tools
- visualize three-dimensional objects and spaces from different perspectives and analyze their cross sections
- use geometric models to gain insights into, and answer questions in, other areas of mathematics
- use geometric ideas to solve problems in, and gain insights into, other disciplines and other areas of interest such as art and architecture
- understand and use formulas for the area, surface area, and volume of geometric figures, including cones, spheres, and cylinders

Additional Objectives for Student Learning
Earth Science Standard:
ES.6 The student will investigate and understand the differences between renewable and nonrenewable resources. Key concepts include:
a) fossil fuels,
b) resources found in Virginia; and
c) environmental costs and benefits.

Materials/Resources

- Geometry SOL formula sheets
- Calculators
- Exploring Coal Pillar Mining task sheets
- Graph paper
- Pencils
- Colored pencils or markers
- Rulers
- The pictures/diagrams of coal pillar mining practices.

o Websites for background information on coal mining resources (these resources include information on coal mining in Buchanan County, VA):

- Cedar, Inc. : Coal Education Development and Resource
  http://www.cedarinc.org
- Coal in Virginia
  http://www.virginiaplaces.org/geology/coal.html
- U.S. Department of Energy Office of Fossil
  Energy Forrestal Building
  1000 Independence Avenue, SW
  Washington, DC 20585
  http://energy.gov/fe/about-us/students-and-teachers/study-guides-and-activities
- Wikipedia
  http://en.wikipedia.org/wiki/Room_and_pillar

Assumption of Prior Knowledge

Students should be familiar with using:

o VA DOE Geometry formula sheet
o formulas to calculate the volume of a three dimensional object
o percentages to calculate parts of a whole
o proportional reasoning and scale drawings

Introduction: Setting Up the Mathematical Task

Teachers should explain the following background information to the students:

COAL MINING AND TRANSPORTATION

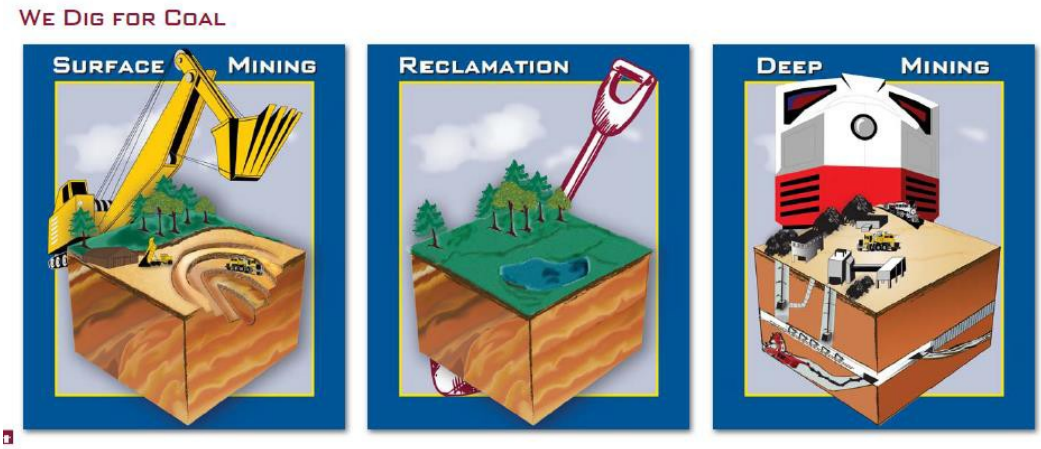
Most coal is buried under the ground. If coal is near the surface, miners dig it up with huge machines. First, they scrape off the dirt and rock, then dig out the coal. This is called **surface mining**.

After the coal is mined, they put back the dirt and rock. They plant trees and grass. The land can then be used again. This is called **reclamation**.

If the coal is deep in the ground, tunnels called mine shafts are dug down to the coal. Machines dig the coal and carry it to the surface. Some mine shafts are 1,000 feet deep. This is called **deep mining**, or **underground mining**.

In the mine, coal is loaded in small coal cars or on conveyor belts which carry it outside the mine to where the larger chunks of coal are loaded into trucks that take it to be crushed (smaller pieces of coal are easier to transport, clean, and burn).

The crushed coal can then be sent by truck, ship, railroad, or barge. You may be surprised to know that coal can also be shipped by pipeline. Crushed coal can be mixed with oil or water (the mixture is called a **slurry**) and sent by pipeline to an industrial user.



Information and illustrations provided by: U.S. Department of Energy (cited in resources above)
Students will complete the tasks in groups of 2 or 3.

Student Exploration

Individual Work

Each individual student will be responsible for contributing to the necessary calculations and recording keeping needed to complete each tasks assigned.

Small Group Work

Each task assigned will be completed in groups of 2 or 3 students. Groups are expected to work together on all necessary calculations and construction needed to complete the task assigned.

Whole Class Sharing/Discussion

Students will share their results with the class after completing the tasks. This would be a good time for the teacher to use any discrepancies in different group results to open mathematical discussions about the tasks performed in the activity.

Student/Teacher Actions

Mining Task #1

Students will need to create a blueprint of a coal bed. This blueprint should maximize the company's profit while upholding all necessary mining safety regulations. Students will need to create and sketch a scale model (the blueprint). Students will need to calculate volume and surface area of complex three dimensional objects/space to complete this task. The teacher should be monitoring the groups to look for group collaboration and communication.

Questions can be posed to students who are struggling on task, such as, "How could you use placement of the coal pillars to help you mine the most earth?"

Mining Task #2

Students will need to use the data that they calculated from task #1 to now find the amount of mined earth (and coal profit) that their blueprint will yield. The teacher should be monitoring the groups to look for group collaboration and communication. Questions can be

posed to students who are struggling on task #2, such as, “What information does your blueprint provide that will help you to complete this task?”

Mining Task #3
Students will need to use their knowledge of surface area to calculate the amount/cost of materials needed to support the coal pillars. The teacher should be monitoring the groups to look for group collaboration and communication. Questions can be posed to students who are struggling on task #3, such as, “How could you use patterns in determining the information that you need to find in this task?”

Monitoring Student Responses
The teacher should monitor group progress as they work on each assigned task. The teacher should not give answers to working groups. Instead he/she should propose guiding questions to struggling student groups to help them come to a reasonable conclusion.\

Assessment List and Benchmarks
Assessments and rubrics are attached.

Students will be assessed by using the following rubric.

Task Assessed:	3	2	1	0
Mining Task #1 Students will need to create a blueprint of a coal bed.	Blueprint is complete, and accurate	Blueprint is Partially complete, and accurate	Attempted to blueprint but scale was incorrect	Task not completed: left blank
Mining Task #1 Students will need to determine how much of the mined earth their blueprint will yield that is actually profitable coal.	All calculations are shown, complete, and accurate	Partial calculations are shown, complete, and accurate	Attempted to complete tasks but calculations were incorrect	Task not completed: left blank
Mining Task #2 Students will need to find the amount of mined earth (and coal profit) that their blueprint will yield.	All calculations are shown, complete, and accurate	Partial calculations are shown, complete, and accurate	Attempted to complete tasks but calculations were incorrect	Task not completed: left blank
Mining Task #3 Students will need to use their knowledge of surface area to calculate the amount/cost of materials needed to support the coal pillars.	All calculations are shown, complete, and accurate	Partial calculations are shown, complete, and accurate	Attempted to complete tasks but calculations were incorrect	Task not completed: left blank

Total score:

What is Coal Pillar Mining?

Room and pillar

From Wikipedia, the free encyclopedia

Room and pillar (variant of breast stoping), also called **pillar and stall**,[1] is a mining system in which the mined material is extracted across a horizontal plane, creating horizontal arrays of rooms and pillars. The ore is extracted in two phases. In the first, "pillars" of untouched material are left to support the roof overburden, and open areas or "rooms" are extracted underground; the pillars are then partially extracted in the same manner as in the "Bord & Pillar method". The technique is usually used for relatively flat-lying deposits, such as those that follow a particular stratum.

The room and pillar system is used in mining coal, iron and base metals ores, particularly when found as manto or blanket deposits, stone and aggregates, talc, soda ash and potash. [2]

The key to successful room and pillar mining is in the selection of the optimum pillar size. In general practice, the size of both room and pillars are kept almost equal, while in Bord & Pillar, pillar size is much larger than bord (gallery). If the pillars are too small the mine will collapse, but if they are too large then significant quantities of valuable material will be left behind, reducing the profitability of the mine.[2] The percentage of material mined varies depending on many factors, including the material mined, height of the pillar, and roof conditions; typical values are: stone and aggregates 75 percent, coal 60 percent, and potash 50 percent.[2]

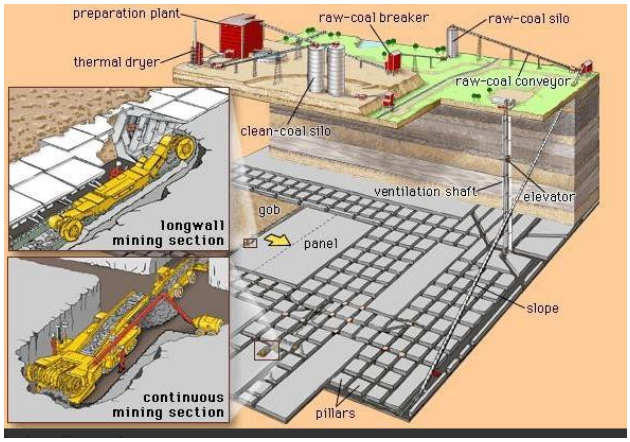


Diagram of an underground mining operation.

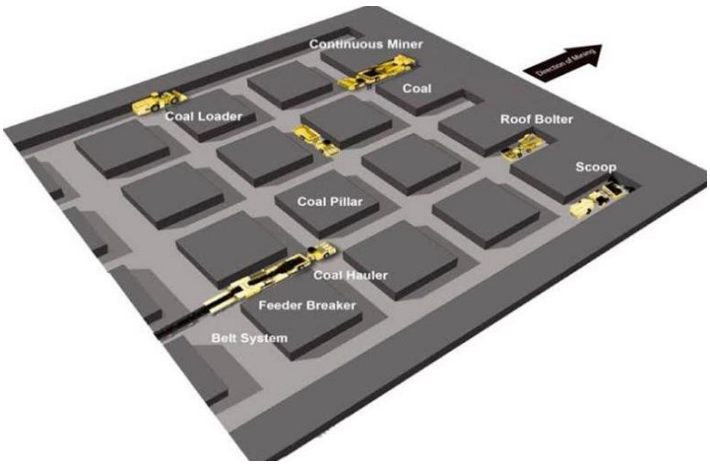
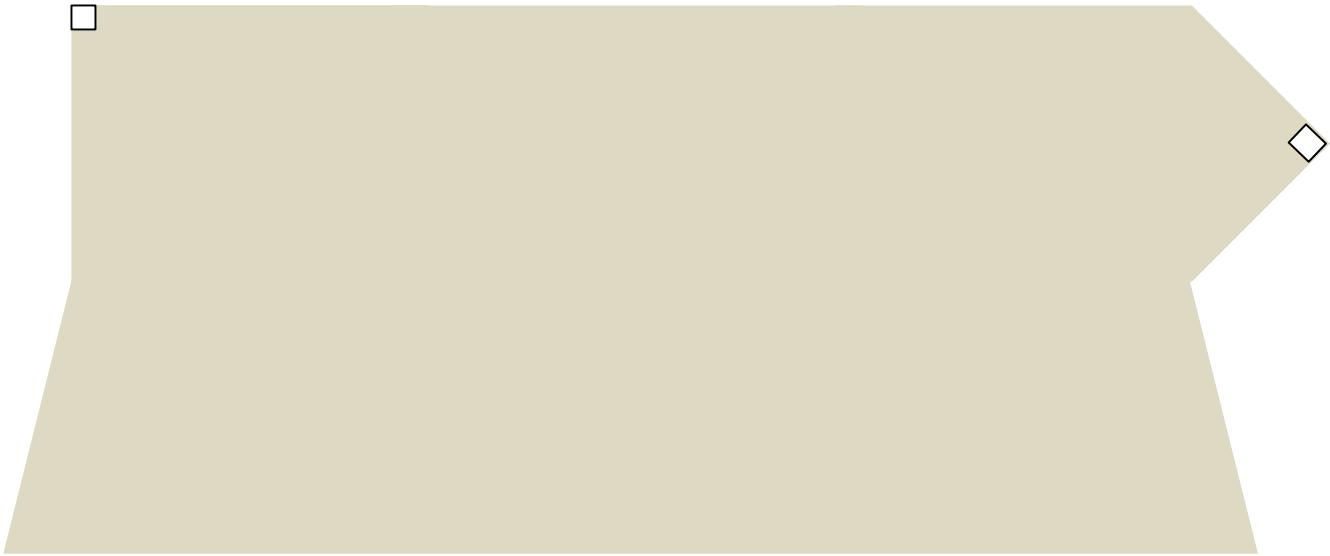


Diagram of the coal pillar method of underground mining.

Exploring Coal Pillar Mining

As chief engineer of operations of the local coal company you must determine the amount of coal that can be safely mined from a designated coal bed. You are provided with a map of the coal bed to be mined. You are also responsible for designing a layout that will maximize the amount of the coal that can be mined for a profit. Most importantly! You will need to include the appropriate coal pillars in your design that are needed to ensure the mining crew's safety. (Note: You will need to use the information from the activity Coal Silos: Storing Energy for Tomorrow to help with your work).

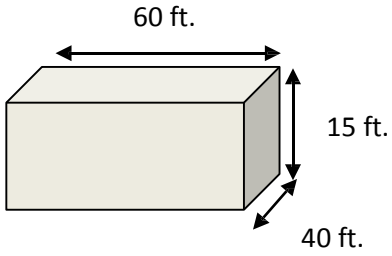
Map of coal bed to be mined for profit:



Scale 1 cm = 1,625 ft. Height of coal bed is 15ft.

These parameters are in place to ensure the safety of the mining crew:

Each pillar should have the following dimensions to provide safe working conditions. All pillars cannot be more than 60 ft. from any other pillar (in any direction).



Pillar Task #1:

Design a coal pillar based underground mining blueprint that will keep your crew safe and help your company to make the best profit possible. Create a top view sketch of your blueprint (mining plan) on your graph paper. Make sure to provide all the necessary labeling (and scale) in your sketch to prove you followed all the coal pillar mining safety regulations.

Pillar Task #2:

Calculate the maximum amount of mined earth that your pillar mining blueprint will yield for the company. Approximately 25% of the mined earth that is brought to the surface is considered to be “reject” (or a non-coal substance). Using this information determine how much of the mined earth your blueprint will yield is actually profitable coal.

Pillar Task #3:

The exterior wall of each coal pillar will need to be supported by steel beams. The cost of this material is $61.30 per 5 feet. Each side of the pillar must have at least one vertical steel beam to provide the appropriate amount of support to keep the mine safe. Calculate the least amount of steel beams you would need to support your coal pillars. Then, determine what the how much the steel beams needed to provide a safe working environment will cost