

The Cookie Mine: Ore Grade, Costs and What Mining Leaves Behind

Investigation question: When does a deposit count as ore? Mine two cookies of different chip density with real costs for land, tools, time and cleanup, and find out which one makes a profit and what the land looks like afterward.

Physical model

Groups of 4

1 session

Setup 8 · Activity 35 · Cleanup 7 min

MS-ESS3-1 · practice

MS-ETS1-2 · practice

Name _____

Group _____

Date _____

Your role today

- ☐ **Miner:** Extracts chips with the chosen tools, one tool at a time, and stops the instant the timer calls time. A different student mines the second cookie.
- ☐ **Surveyor and timer:** Traces the cookie outline on the grid before mining, counts the squares covered, runs the timer and announces each minute.
- ☐ **Accountant:** Records every cost and sale in the ledger as it happens and computes the profit.
- ☐ **Reclamation inspector:** Judges which chips count as whole or fragment, times the one-minute cleanup, and counts the squares with crumbs outside the original outline.

Safety

- Food allergies: cookies may contain wheat, dairy, soy, eggs and nuts or traces of them. Check the allergy list first and use the non-food alternative for any class with a severe allergy. Nothing is eaten during or after the lab.
- Toothpick points can puncture skin; mine with the tool pointed away from fingers and dispose of broken pieces in the trash, not on the floor.
- Keep the work surface on paper and wash hands after cleanup; crumbs on the floor are a slip hazard and attract pests, so wipe desks before leaving.

Procedure

1. Prospect before you buy. Look at the top surface of your high-grade cookie without touching it. Count the chips you can see and record the number. Then trace the cookie's outline on the grid paper and count every square the outline touches, including partial squares. That is your land area; the land costs \$4 per square.
2. Compute your estimated grade (visible chips divided by land squares) and record it. Decide which tools to buy from the price list (flat toothpick \$4, round toothpick \$6, straightened paper clip \$8; a broken tool must be replaced at full price) and record the tool cost.

3. Mine. The miner may use only the tools bought, may not use fingers to pry chips out, and may not lift the cookie off the paper. Mining time costs \$3 per minute, and any started minute counts as a full minute. Stop at five minutes at most. The inspector sorts what comes out: a whole chip (about pea-sized or larger, with little dough attached) sells for \$20; a fragment sells for \$8.
4. Reclaim. The inspector starts a one-minute timer. The miner uses the tools to push all cookie material back inside the original outline. When time is called, count the squares outside the outline that still hold crumbs; each costs \$4. Also record in words what the deposit looks like now compared with the start.
5. Compute profit: sales minus land, tools, time and reclamation. Then compute the actual grade: total chips found (whole plus fragments) divided by land squares. Compare it with your estimate from the surface.
6. Repeat steps 1 to 5 with the low-grade cookie and a different miner. You may change your tool choice and plan a shorter mining time if you think the deposit will not pay.
7. Draw the before-and-after outline for one cookie on the recording sheet. Clear all cookie material into the trash, wipe the desk and wash hands.
8. Answer the analysis questions individually, then compare profits across the class on the board: high-grade and low-grade cookies in two columns.

Record your observations

Lab 2 recording sheet: The cookie mine

Price list (same for every group; teaching prices, not real market values) — Land: \$4 per grid square touched. Tools: flat toothpick \$4, round toothpick \$6, straightened paper clip \$8; replace a broken tool at full price. Mining time: \$3 per started minute, 5 minutes maximum. Sales: whole chip \$20, fragment \$8. Reclamation: \$4 per square with crumbs outside the outline after one minute of cleanup.

Prospecting (before mining)

Deposit	Visible chips on top	Land squares touched	Estimated grade (chips per square)	Tools bought and cost	Planned mining minutes
High-grade cookie					
Low-grade cookie					

Mining ledger

Line	High-grade cookie	Low-grade cookie
Land cost (\$4 x squares)		
Tool cost (including replacements)		
Minutes mined x \$3		

Line	High-grade cookie	Low-grade cookie
Whole chips found x \$20		
Fragments found x \$8		
Total sales		
Squares with crumbs outside outline x \$4		
Total costs (land + tools + time + reclamation)		
Profit (sales minus total costs)		
Actual grade (all chips found per square)		

-  Draw the outline of one cookie on its grid before mining and, beside it, what the same claim looked like after reclamation. Shade the squares that still had crumbs outside the outline and label the number of chips removed.

1. In words, describe what the deposit looked like after mining and cleanup compared with the start. Could it be mined again for the same resource?

2. How close was your estimated grade (from the surface) to your actual grade? What does that tell you about prospecting from the surface?

Analysis questions

3. Show the profit calculation for your high-grade cookie, line by line, and state whether the deposit was ore (worth mining) at these prices.

4. A low-grade cookie covered 22 squares, cost \$4 in tools, was mined for 3 minutes, produced 4 whole chips and 3 fragments, and left crumbs in 4 outside squares. Compute the profit. Then find the whole-chip price at which this deposit would just break even (fragments stay at \$8).

5. Explain what 'ore' means using your two cookies. Why can the same rock be ore in one decade and not in another?

6. In real copper mining the ore is crushed and the metal is separated, and the leftover rock and the pit remain. Which parts of the cookie model matched that, and which parts did not?

- 7.** A mining company has two cookies' worth of ore left in a region and no new deposits. Describe two things the company, or the people who buy copper, could do when the deposits are gone, and say which of them comes closest to renewing the supply.

- 8.** The reclamation charge was small compared with chip sales. If it were \$40 per square instead of \$4, how would your group have mined differently, and why might a community want the charge to be high?
