

Crayon Rocks: Press It, Warm It, Melt It, Then Recycle It

Investigation question: Which rock-cycle processes can we model with crayon shavings, what energy does each one need, and where does the wax stop behaving like rock?

Physical model

Groups of 4

1 session

Setup 5 · Activity 40 · Cleanup 8 min

MS-ESS2-1 · practice

Scientific purpose

Students turn crayon shavings into model sediment, sedimentary rock, metamorphic rock and igneous rock by applying cold pressure, warm pressure, and melting followed by fast or slow cooling. They then choose a route of their own to recycle one model rock into another, predicting the texture before they run it. The lab makes the three families a sequence of energy inputs students supplied with their own hands, and it forces them to say where a wax model matches real rock and where it fails.

Why this helps students with this chapter

Students hear that heat and pressure change rock without melting it and that cooling speed sets texture, but both ideas stay abstract until they feel them. Squeezing cold shavings makes a crumbly cake; squeezing warm shavings smears the colors into bands with no liquid anywhere; melting erases the grains entirely. The contrast between the warm-pressed and the melted sample is the clearest argument against the 'metamorphic rock melts a little' misconception, and the recycle step shows that any model rock can re-enter the cycle.

Standards connections

MS-ESS2-1 (practice, the process-and-energy half of the model, built one step at a time): Students physically perform weathering, deposition and compaction, deformation without melting, and melting followed by crystallization, and record the energy source for each in the model and on Earth. The complete multi-route model with energy labels is assessed in Lab 3 and W4; here students build the pieces.

Roles (rotate each session)

- **Shaver:** Makes the crayon shavings with the sharpener or plastic knife, keeps colors separate at first, and later shaves the finished igneous sample for the recycle step.
- **Presser:** Folds the foil packets, applies cold pressure for the sedimentary step and warm hand pressure for the metamorphic step, timing each press.
- **Observer:** Examines every sample with the hand lens before and after each step, describes grain size, edges and color boundaries aloud, and draws the textures.
- **Recorder and runner:** Fills in the process log, carries the foil cups to and from the teacher's warm-water station, and writes the group's predicted texture before the recycle step.

Materials

Item	Quantity	Per	Note
Old crayons, paper removed, in three or four contrasting colors	4 crayons	group	Broken crayons from the lost-and-found bin work; light and dark colors show the banding best.
Handheld pencil sharpener or plastic picnic knife	2	group	A sharpener makes thin curls; a plastic knife scraped along the crayon makes grit. No metal graters.
Aluminum foil squares, about 15 cm	6	group	
Paper muffin liners set inside a cup made from foil	3	group	The foil cup floats in the warm-water bath; the liner keeps wax off the foil. The third set is a spare for a recycle route that includes a teacher melt.
Hand lens	2	group	
Heavy textbook or wooden block for pressing	1	group	
Cup of ice water	1	group	
Paper towels and a zip bag for scraps	1 set	group	
Warm-water bath: large bowl or tray of water at 65 to 75 °C, with a thermometer, tongs and an oven mitt	1 station	class	Teacher only. Hot tap water or kettle water cooled below 75 °C; never boiling, never on a flame or hot plate during the lab.
Timer or clock with a second hand	1	group	
Recording sheet	1	student	

Estimated cost: 8 to 12 per class (an estimate; Estimate. One 24-pack of crayons (about \$3) supplies six groups if old crayons are not available; a roll of foil (about \$4) and a pack of muffin liners (about \$2) cover the class; sharpeners, lenses and books are classroom stock.)

Safety

- The warm-water bath is handled by the teacher only. Water at 65 to 75 °C can scald; students never carry, touch or lean over it. The teacher moves foil cups in and out with tongs and sets them on the cooling tray before a runner collects them.
- Melted wax is hot enough to burn skin. Nobody touches a cup until the wax has gone fully solid and dull (about two minutes in ice water, five or more in air).
- Safety goggles for everyone during the melting and ice-water steps; wax can spit if water gets into a cup.
- Sharpeners and plastic knives only. Scrape away from fingers. No metal graters or craft blades.
- Use only crayons labeled non-toxic, and treat them as not food. No eating or drinking in the lab, and wash hands at the end.
- Wax must not go down a drain. All scraps go in the zip bag; foil is folded and binned.

- Keep the ice-water cup on the desk, not in a hand, when a cup of melted wax is lowered into it, and lower slowly so water does not splash into the wax.

Teacher preparation and setup

1. Run the whole sequence yourself once with your crayons: brands differ, and some wax needs the bath nearer 75 °C to melt within four minutes. Note the time it took so you can pace the class.
2. Set up the warm-water station on a tray at the front, away from student traffic, with the thermometer in the water, tongs, an oven mitt, a towel and a labeled cooling area (a second tray lined with paper towels).
3. Pre-fold a demonstration foil packet so students see the envelope fold that keeps shavings in during pressing.
4. If any student has a wax or crayon allergy (rare, but check), assign that student the Recorder role and keep the shavings in packets.
5. Print the recording sheet and have the slide-20 energy-budget diagram visible, because students will be asked to match each model step to an Earth energy source.

Investigation design

Independent variable	The process applied to the same wax: shaving (weathering), cold pressure (compaction), warm pressure (heat and pressure without melting), or melting followed by fast or slow cooling
Dependent variable	The texture of the sample afterward: whether grains are still separate, whether edges are sharp, flattened or gone, whether colors stay separate, smear into bands, or blend completely
Controlled	Same crayon colors and roughly the same amount of shavings in every sample; Same pressing times (60 s cold, 120 s warm plus 30 s under the book); Same bath temperature and melt time for cups A and B; Same observer and lens for every description
Trials	One sample per process per group, plus one chosen recycle route; the class pools the fast-versus-slow cooling observations on the board.
Comparison	Cold-pressed versus warm-pressed (did heat change the texture without melting?) and ice-water versus slow-cooled (does cooling speed change the texture in wax the way it does in rock?).

Student procedure

1. Make sediment. The Shaver shaves each crayon onto its own foil square until there is about a tablespoon of each color. The Observer looks at one color under the lens and the group records the texture: loose, sharp-edged, separate pieces. Decide which Earth process this step models and what supplied the energy in the model (your hand) and on Earth.
2. Mix the colors on one square and spread them in a layer about 1 cm thick. Fold the foil into a flat envelope.

3. Make sedimentary rock. The Presser puts the envelope under the heavy book and presses straight down with both hands for 60 seconds. No warming. Open the packet carefully, examine with the lens, and record: do the grains still have edges? Are the colors still separate? Does the cake hold together or crumble?
4. Make metamorphic rock. Re-fold the same cake in fresh foil. The Presser holds the packet flat between both palms and squeezes as hard as possible for two full minutes while the Timer counts; palms warm the wax to body temperature. Then press under the book for another 30 seconds. Open and examine: look for flattened grains, smeared color boundaries and bands. Record whether any part of the sample became liquid.
5. Split the metamorphic sample in half. Put each half in a muffin liner inside a foil cup. The Runner carries both cups to the teacher's station and returns to the desk.
6. Make igneous rock (teacher step). The teacher floats both cups in the warm-water bath until the wax is fully liquid, about three to five minutes, then uses tongs to set cup A on the cooling tray for the group to collect and lowers cup B, still in its foil, into the group's ice-water cup held on the desk. Cup A stays on the tray at room temperature so it cools slowly.
7. While the cups cool, fill in the energy columns of the process log for every step so far, and write a prediction: will the fast-cooled and slow-cooled samples look different? How?
8. When both samples are solid and dull, examine them with the lens. Compare surface texture, cracks and color blending between the ice-water sample and the slow-cooled sample. Record what is the same and what differs.
9. Choose a recycle route. As a group, pick one finished sample and one new route from the rock cycle (for example igneous to sediment to sedimentary rock, or sedimentary straight to metamorphic, or the slow-cooled igneous sample shaved and re-melted). Write the route and the predicted texture on the recording sheet before you start.
10. Run your chosen route using the same steps as before (shaving, cold press, warm press, or a teacher melt). Record the result next to your prediction.
11. Draw the four textures (sediment, sedimentary, metamorphic, igneous) in the drawing box with labels, then answer the analysis questions individually.

Expected observations

- Shavings are loose, curled or gritty pieces with sharp edges and fully separate colors.
- The cold-pressed cake holds together loosely but crumbles at the edges; grains are still visible as separate pieces and colors do not mix.
- The warm-pressed sample is a flattened, firm slab; grains are squashed, color boundaries are smeared and streaky, and light and dark colors often form bands. No liquid appears at any point.
- Both melted samples are a single blended color (usually muddy brown or purple) with no grains at all; the ice-water sample may be smoother and more cracked, the slow-cooled one may show a slightly dimpled top, but the difference is small.
- Shaving the igneous sample gives single-color grains, proof that the material can re-enter the cycle at the sediment station.

Likely difficulties

- The warm press does not band if palms are cold or the press is short. Have students rub their hands together first and insist on the full two minutes; a 10-second rest and re-press helps.
- Shavings escape the foil during pressing. Demonstrate the envelope fold and press straight down rather than sliding the book.
- Some crayon brands do not melt within five minutes at 65 °C. Raise the bath toward 75 °C (not above) or slice the sample thinner before sending it to the station.
- Groups expect dramatic fast-versus-slow differences and may invent them. Ask for the specific feature they see; accept 'about the same' as a valid result and discuss it in the debrief.
- Runners crowd the warm-water station. Call groups up one at a time by number, and keep the cooling tray on the teacher's side.

Structured debrief

1. Pool the fast-versus-slow cooling observations on the board. Most groups will report only small differences (the ice-water sample may be smoother and show more surface cracks). Use this honestly: wax does not grow visible crystals, so this is where the model stops matching rock. Ask what a better model of crystal growth would need (a substance that forms crystals you can see, such as a cooling salt solution).
2. Line up one group's cold-pressed and warm-pressed samples under the document camera. Ask the class to point to the evidence that the warm sample changed without melting: flattened grains, smeared boundaries, bands. Say the word deformation and connect it to the plate-collision slide.
3. Collect every recycle route the class ran and draw them on the slide-19 cycle. Count how many different routes appeared. Make the point that no group was told an order, and that the Earth does not have one either.
4. Close on energy. Go through the process log row by row and have students call out S or I for each Earth energy source. The only step that was not driven by a student's hands or body heat was the melt, which took a far bigger energy input: that is why melting on Earth needs the interior, not the Sun.

Recording sheet: what students fill in

Lab 1 recording sheet: Crayon rocks

Fill in one row after each step. In the energy columns, say what supplied the energy in the model (for example, your hand, your body heat, the warm water) and what supplies it on Earth (the Sun and gravity, or Earth's hot interior).

Process log

Step	Earth process this models	Energy source in the model	Energy source on Earth	Texture afterward (grain size, edges, color boundaries, liquid?)
1. Shaving the crayons				
3. Cold press, 60 s				
4. Warm press, 2 min				
6A. Melt, then slow cool in air				
6B. Melt, then fast cool in ice water				
10. Our recycle route				

Our recycle route

Starting sample	Route (list the processes in order)	Predicted texture (before)	Observed texture (after)

 Draw what you saw under the lens for each of the four stages: sediment, sedimentary, metamorphic, igneous. Label each drawing with its stage and one word for the texture (loose, cemented, banded, blended).

Answer: Four labeled sketches: sediment as loose separate curls or grains with gaps between them; sedimentary as grains packed together but still outlined and separate in color (cemented or compacted); metamorphic as flattened, elongated grains with smeared boundaries arranged in bands (banded); igneous as a single uniform blended color with no grain outlines, perhaps with surface cracks (blended).

Why: The drawings should show a progression from separate grains to no grains. The metamorphic sketch must show flattening or banding, not simply 'smaller grains.'

- Four stages drawn and labeled
- Sediment and sedimentary show separate grains; sedimentary shows them packed
- Metamorphic shows flattened or banded grains
- Igneous shows no grains

1. Did any part of the sample become liquid during the warm press (step 4)? What evidence tells you it changed anyway?

Answer: No part became liquid; the sample stayed solid wax the whole time. The evidence that it changed is in the texture: grains were flattened and pressed into each other, color boundaries smeared, and light and dark colors formed streaks or bands that were not there after the cold press.

Why: This is the core observation for the no-melting idea. Full credit needs both the 'no liquid' statement and specific texture evidence.

- States that nothing melted or turned liquid
- Gives at least two texture changes (flattened grains, smeared colors, bands)

2. Compare your recycle-route prediction with what you observed. What was right, and what surprised you?

Answer: Group-specific. A typical prediction is that re-shaving the igneous sample would give mixed-color grains; students are often surprised that the grains come out as single blended-color pieces, because the colors had already merged in the melt. Another common surprise is that a second warm press of the sedimentary cake bands more strongly than the first.

Why: Any honest comparison earns credit. Look for the prediction being written before the run and for the student explaining the difference, not just naming it.

- Refers to the written prediction
- States at least one specific match or difference with a reason

Analysis questions: answer key

3. The cold press and the warm press used the same wax and the same amount of force. Describe how the two results differed and explain which Earth process each one models.

Answer: The cold press made a crumbly cake in which the grains kept their edges and colors, like sediment that has been compacted into sedimentary rock. The warm press made a firm slab in which the grains were flattened and the colors smeared into bands, with no liquid, like solid rock deformed by heat and pressure into metamorphic rock. Same force, but adding warmth let the wax grains change shape and flow into each other without melting.

Why: The pairing of the same force with different temperature isolates heat as the variable that produces deformation. Full credit requires both models named and the role of warmth explained.

- Describes the cold result as separate grains loosely held (compaction)
- Describes the warm result as flattened, smeared, banded grains with no liquid (deformation)
- Attributes the difference to warmth, not force

4. For each of these model steps, name the energy source on Earth and say whether it belongs to the surface budget (Sun and gravity) or the interior budget: shaving the crayon, pressing under the book, warming with your palms, melting in the bath.

Answer: Shaving: weathering, driven on Earth by the Sun (rain, wind, freeze-thaw) and gravity, surface budget. Pressing under the book: compaction by the weight of overlying layers, which is gravity, surface budget. Warming with palms: the heat for metamorphism, which comes from Earth's interior (and the pressure from plate collisions and burial), interior budget. Melting in the bath: melting rock into magma, Earth's interior, interior budget.

Why: Students must do the translation from model energy to Earth energy. Accept 'gravity' alone for compaction; accept 'Earth's interior plus burial weight' for the warm press.

- All four steps assigned to an Earth energy source
- Shaving and pressing placed in the surface budget
- Warming and melting placed in the interior budget

5. In real igneous rock, slow cooling makes large crystals and fast cooling makes tiny ones. Did the slow-cooled and ice-water wax samples show that difference? Explain what this tells you about the limits of the crayon model.

Answer: Mostly no. Both melted samples came out as a blended, grain-free solid; the ice-water sample may have been smoother or more cracked, but there were no crystals in either to compare. This shows a limit of the model: wax cools into a solid without growing visible crystals, so it cannot show the crystal-size difference that makes granite coarse and basalt fine. The model is good for 'melting erases the old texture' and poor for 'cooling speed sets crystal size.'

Why: An honest 'about the same' is the scientifically correct result. Students who claim large differences should be asked for the specific evidence. Full credit requires naming what the model can and cannot show. *Also acceptable: If a group genuinely saw a textural difference (for example a frosted surface on the slow-cooled sample), accept it with the caution that it is a surface effect, not crystal size.*

- Reports the observed result accurately (small or no difference)
- Explains that wax does not form visible crystals
- States what the model does show (melting removes the old texture)

6. Your group chose one recycle route, but other routes were possible. List two other routes a group could have run starting from the metamorphic sample, naming the processes in order.

Answer: Any two of: metamorphic sample shaved into sediment, then cold-pressed into sedimentary rock (weathering and erosion, deposition and compaction); metamorphic sample melted and cooled into igneous rock (melting, crystallization); metamorphic sample warm-pressed again into a more strongly banded metamorphic rock (more heat and pressure); metamorphic sample shaved, then melted (weathering, then melting); metamorphic sample melted, cooled, then shaved (melting, crystallization, weathering).

Why: The point is that the starting sample does not fix the route. Any valid chain with the processes in a sensible order earns credit.

- Two different routes given
- Processes named in a possible order
- Neither route requires a step that does not exist (for example sediment turning directly into metamorphic rock without burial)

7. Real sediment is cemented by minerals that water leaves between the grains. Your cold-pressed cake had no cement. What held it together, and how does this make the model different from real sandstone?

Answer: The cake was held together only by wax grains sticking to each other where they were pressed into contact, which is why it crumbled at the edges. Real sandstone is held together by mineral cement (for example quartz or calcite) that water deposits in the spaces between grains over a long time, so it can be hard even though the grains never deformed. The model shows compaction but not cementation.

Why: Separates the two parts of lithification. Full credit requires naming cement as mineral left by water and identifying compaction as the only part modeled.

- Identifies wax-on-wax sticking as what held the cake
- Explains real cement as mineral deposited from water
- States that the model shows compaction but not cementation

8. A group shaved 10.0 g of crayon at the start and, after all the steps, their finished samples and scraps added up to 9.6 g. Where did the missing 0.4 g most likely go, and what does this say about matter in the rock cycle on Earth?

Answer: 0.4 g is missing ($10.0\text{ g} - 9.6\text{ g} = 0.4\text{ g}$, which is $0.4 \div 10.0 = 4$ percent). It most likely stuck to the foil, the sharpener, the muffin liners and fingers, or fell as dust; wax barely evaporates at bath temperatures, so almost none escaped as vapor. The wax was not destroyed; it was moved to places the group did not weigh. On Earth the same holds: rock material is not created or destroyed in the rock cycle, it changes form and location, which is why the cycle can run for billions of years.

Why: Conservation of matter in the model and on Earth. Full credit needs the subtraction and a sensible destination for the missing mass, plus the conservation statement.

Also acceptable: Accept 'about 4 percent lost to the equipment'. Do not accept evaporation as the main explanation; wax gives off far too little vapor at these temperatures.

Individual evidence of learning

Each student submits their own process log with all energy columns filled, the labeled drawing of the four textures, the recycle-route prediction and result, and written answers to q1 through q8. The process log's energy columns and q4 are the main evidence for the energy half of the model; q3 and q5 show whether the student can state what the model shows and where it fails.

Assessment criteria

Criterion	Proficient looks like
Process log	Every step is matched to the correct Earth process, with the model energy source and the Earth energy source named, and texture descriptions that mention grain edges, color boundaries and whether any liquid formed.
Metamorphism without melting	States that the warm-pressed sample changed texture (flattened, banded) with no liquid, and connects this to heat and pressure changing solid rock on Earth.
Model limits	Explains that wax does not grow visible crystals, so the cooling-speed comparison cannot show what it shows in rock, and names at least one other way the model differs from rock (no mineral cement, human-scale time and temperature).

Routes and energy	Describes the group's recycle route and two alternative routes correctly, and sorts the energy for shaving, pressing, warming and melting into the surface and interior budgets.
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Accessibility adaptations

- Pre-shave crayons for students with limited hand strength and let them run the Observer or Recorder role; the pressing can be done with a book and body weight instead of palms.
- Provide the process-log column headers as a printed strip with pictures (hand, body, warm water; Sun, gravity, Earth's interior) for multilingual learners and students who need more support.
- Allow texture descriptions to be dictated to a partner or recorded on a device, and accept photographs through the lens in place of drawings for students with low vision or limited fine-motor control.
- Use strongly contrasting colors (black, white, yellow) so banding is visible to students with color-vision differences; describe bands by light and dark rather than by hue.

Low-cost alternative

If crayons are scarce, use colored candle stubs or birthday candles shaved with a plastic knife; if no warm-water station is possible, skip the melt step and compare only the cold-pressed and warm-pressed samples, using the slide-9 diagram for the igneous half. Foil can be replaced by wax paper folded inside a sheet of card.

Model limitations

Crayon wax models texture changes caused by pressure, warmth and melting, but it is not rock: wax does not form visible crystals, so the fast-versus-slow cooling step shows surface differences rather than the crystal-size difference that defines intrusive and extrusive rock; the cold-pressed cake is held together by wax sticking to wax, not by mineral cement; the warm press reaches only body temperature and hand pressure, while real metamorphism needs hundreds of degrees and the weight of kilometers of rock; and every step takes minutes instead of years to millions of years. This activity has not been physically tested by the authors; melt times and the degree of banding are estimates for standard paraffin crayons.

Teacher notes

Check q1 and q3 together: the student must say the warm sample never melted and must give texture evidence that it changed. Accept 'no difference' in q5 as the correct answer; the lab is designed to reveal that limit. If a group's recycle route included a second teacher melt, their q6 alternatives should not simply repeat the route they ran. For q8, any mass numbers from your own class can replace the given values; what matters is the subtraction, the destination of the mass and the conservation statement.