Mantle Motion Loop

Trace matter through convection and plate tectonics.

HS-ESS2-3 "Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. Clarification Statement: Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density..."

NAME _____ DATE _____

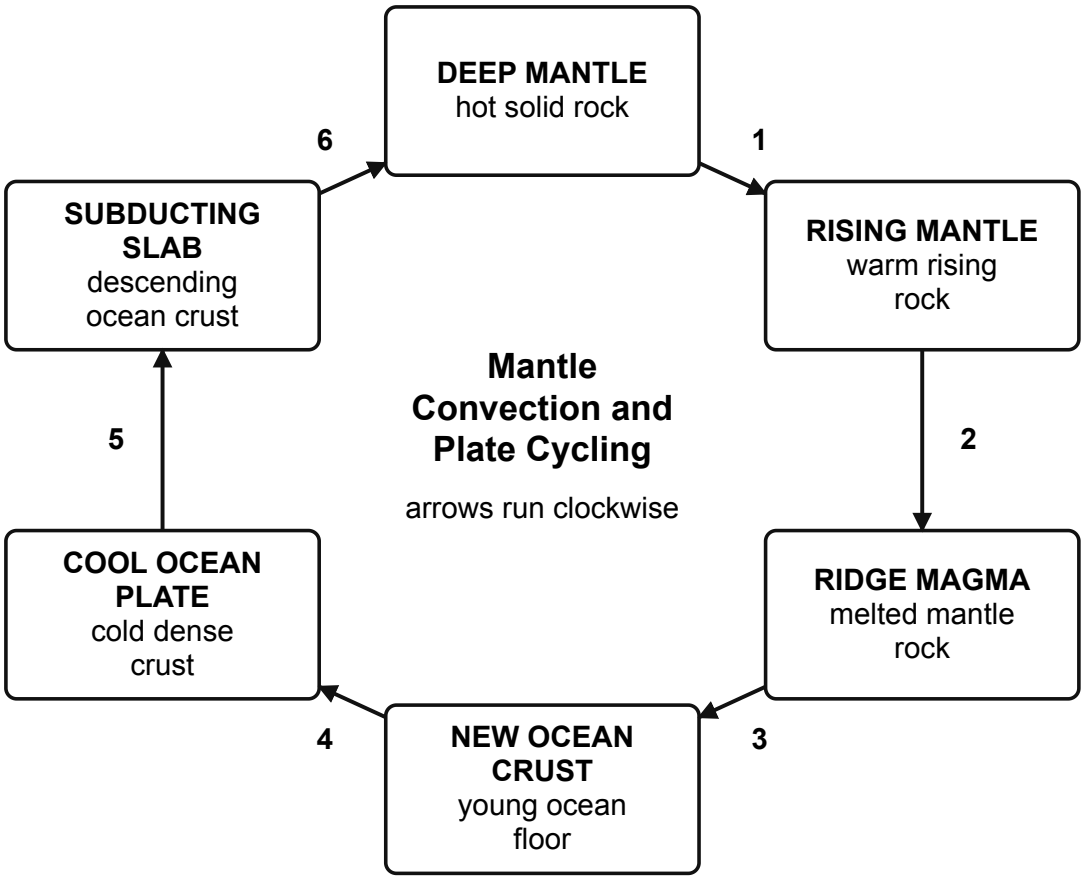
1 LABEL THE MODEL

Word bank below

Write one process from the word bank in each numbered arrow box. Then use the completed cycle and the seismic evidence question to explain how Earth scientists test this model.

WORD BANK

- Cooling forms new crust
- Heating lowers density
- Pressure drop melts rock
- Slab sinks and reheats
- Spreading and cooling
- Subduction sends slab down



Arrow numbers match the response boxes on the next student section.

Label the arrows

Use the word bank to write the process for each numbered arrow.

Arrow 1 _____	**Arrow 2** _____	**Arrow 3** _____
Arrow 4 _____	**Arrow 5** _____	**Arrow 6** _____

2 RUN THE MODEL

Use your finished diagram

1. Which process changes RISING MANTLE into RIDGE MAGMA?

2. Why is the COOL OCEAN PLATE more likely to move into the SUBDUCTING SLAB stage than NEW OCEAN CRUST?

3. Seismic wave maps show a cold, high-speed slab deep below an ocean trench. Which stage represents this material, and which process placed it there?

Revise the Model

Develop a cross-section model of Earth's interior. Show crust, mantle, liquid outer core, and solid inner core. Use arrows to distinguish the slow movement of mostly solid mantle matter from transfer of thermal energy toward the surface. Show a cool slab descending and warmer, less dense mantle rising. Use this evidence: S waves do not travel through the outer core; seismic waves are generally faster in cold slabs than in nearby hotter mantle. Label how each observation supports your model.

3 CHECK IT

Before you turn it in

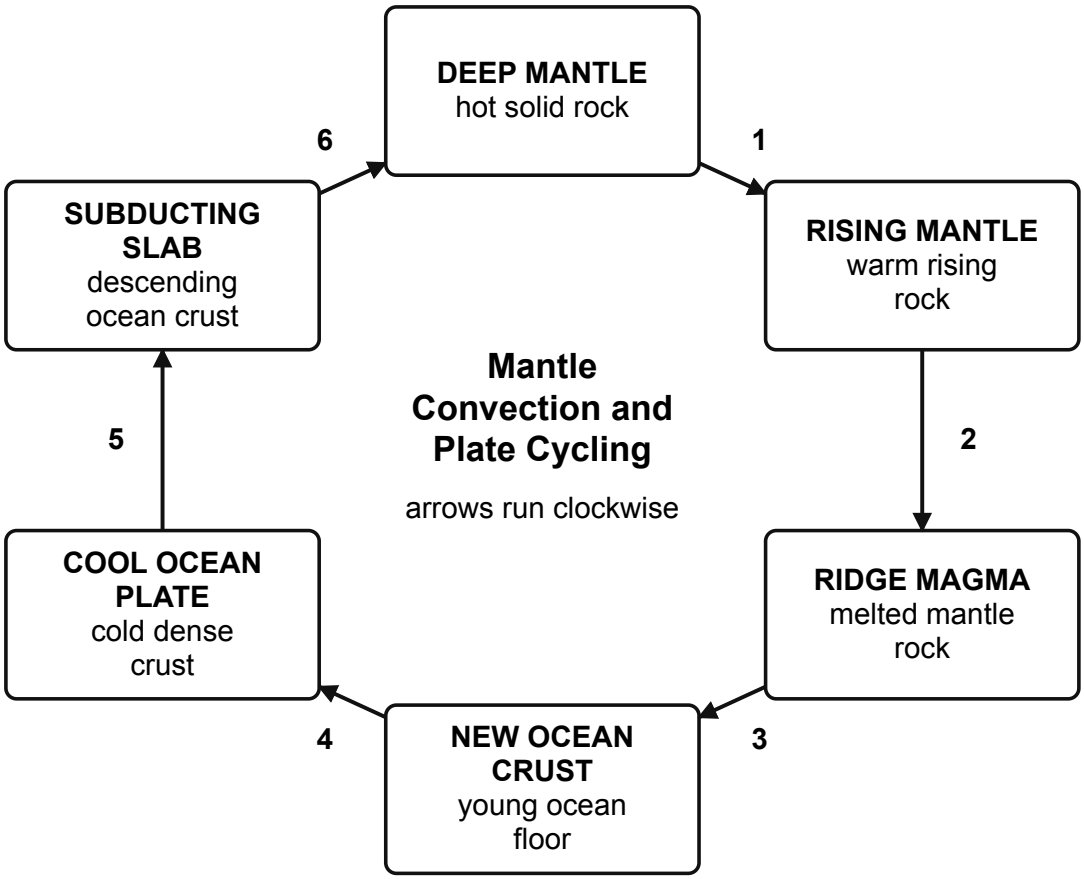
- [ ] I distinguished matter movement and energy transfer.
- [ ] I labeled Earth's main internal layers.
- [ ] I connected both seismic observations to my model.

TEST THE MODEL

What important feature of real mantle convection or Earth evidence does this simple loop leave out?

ANSWER KEY # Mantle Motion Loop

PART 1 · COMPLETED MODEL



Arrow 1 Heating lowers density	**Arrow 2** Pressure drop melts rock	**Arrow 3** Cooling forms new crust
Arrow 4 Spreading and cooling	**Arrow 5** Subduction sends slab down	**Arrow 6** Slab sinks and reheats

PART 2 · RUN THE MODEL

1. **Pressure drop melts rock.** (Which process changes RISING MANTLE into RIDGE MAGMA?)
2. **It is cooler and denser, so it can sink.** (Why is the COOL OCEAN PLATE more likely to move into the SUBDUCTING SLAB stage than NEW OCEAN CRUST?)
3. **SUBDUCTING SLAB, placed there by subduction sends slab down.** (Seismic wave maps show a cold, high-speed slab deep below an ocean trench. Which stage represents this material, and which process placed it there?)

REVISE THE MODEL · SAMPLE

Accept a labeled cross section with thin crust, a mostly solid convecting mantle, liquid outer core and solid inner core. Matter arrows show warmer mantle rising and cooler, denser slabs sinking; distinct energy arrows show thermal energy transferring from deeper, hotter regions toward the cooler surface, including energy transported by moving matter. S-wave absence supports a liquid outer core; faster waves in a cold slab support the modeled descending, cooler material. The mantle flows slowly as a solid over geologic time and is not a global ocean of magma. Require evidence links and distinguish matter movement from energy transfer.

TEST THE MODEL (SAMPLE ANSWERS)

- It leaves out the many separate convection cells in the mantle.
- It does not show how seismic wave speeds reveal cold slabs and hot mantle.

The process list is in cycle order, from each stage to the next stage. The seismic evidence item connects the model to three-dimensional maps of Earth's interior, where cold subducting slabs commonly produce faster seismic-wave speeds.