Atoms: a black-box practical and a half-life model

Name: Class: Date:

Page 1 is a black box to make and swap with another group. Page 2 models half-life with coins. Page 3 follows radon-222 as it decays to stable lead-206.

PRACTICAL What is under the board?

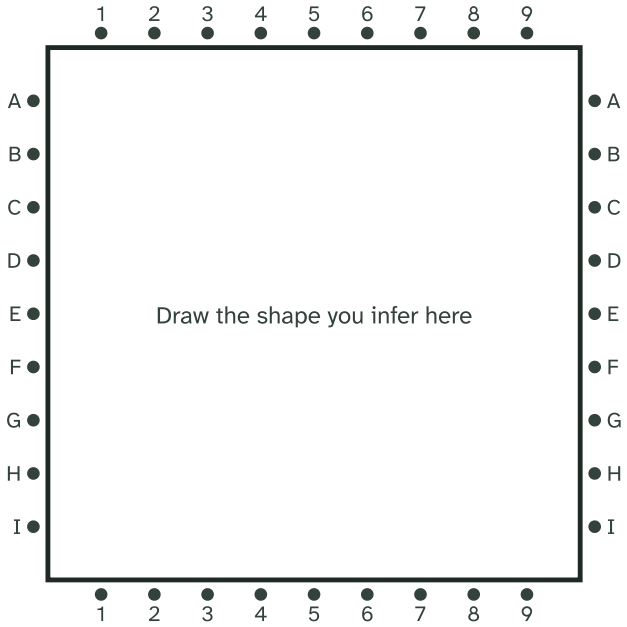
Each group needs: a stiff board, such as a tray or a large piece of thick card, four blocks or erasers to hold it up so that a marble can roll underneath, a flat shape cut from thick card or wood, sticky tape, a few marbles and a pencil.

> **Safety.** Roll the marbles on a table, not on the floor, and pick up every marble when you finish. Marbles on the floor can make people slip.

Make it. Make a black box for another group. Tape your shape under the middle of the board, out of sight, then prop the board up on the blocks. Don't let anyone see the shape.

1. Swap boards with another group. Don't lift their board or look underneath it.
2. Roll a marble straight under the board from one of the points on the plan below, and watch where it comes out.
3. On the plan, draw an arrow where the marble went in and an arrow where it came out.
4. Roll at least 15 marbles from different points, then draw the shape you infer inside the square.

Plan of the board from above



1. What shape do you infer is under the board? What is your evidence?

2. Write one observation and one inference from your rolls.

3. Scientists can't lift the lid off an atom. If you lifted the board now, how would that be different from what scientists can do?

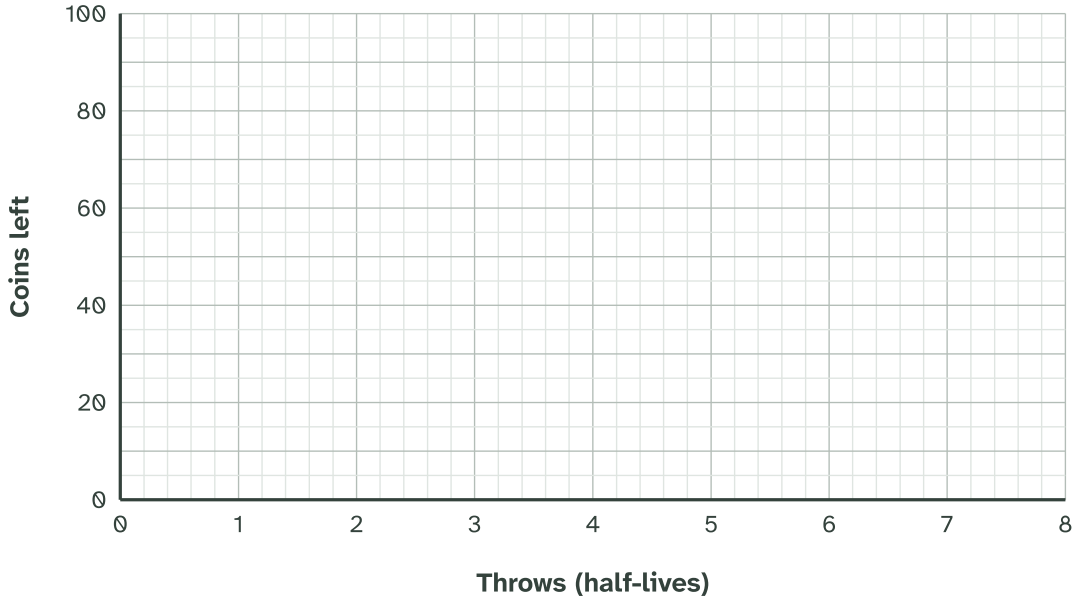
MODEL A half-life model with coins

Each group needs: 100 coins, or counters with one side marked, a cup and a tray.

1. Put all 100 coins in the cup, shake it and tip the coins onto the tray. Each coin stands for an unstable nucleus.
2. Take out every coin that lands heads up: these nuclei have decayed. Count the coins that are left and record the number.
3. Put the coins that are left back in the cup and repeat. Each throw stands for one half-life.
4. Stop when fewer than 3 coins are left, then plot your results on the graph.

Throw (half-lives)	0	1	2	3	4	5	6	7	8
Coins left	100								

Coins left after each throw



1. About what fraction of the coins was left after each throw?

2. Could you tell which coins would be taken out in the next throw? What does that tell you about radioactive decay?

3. Each nucleus has a 50% chance of lasting one half-life, like a coin landing tails up (OpenStax). How is the coin model different from a real radioactive sample?

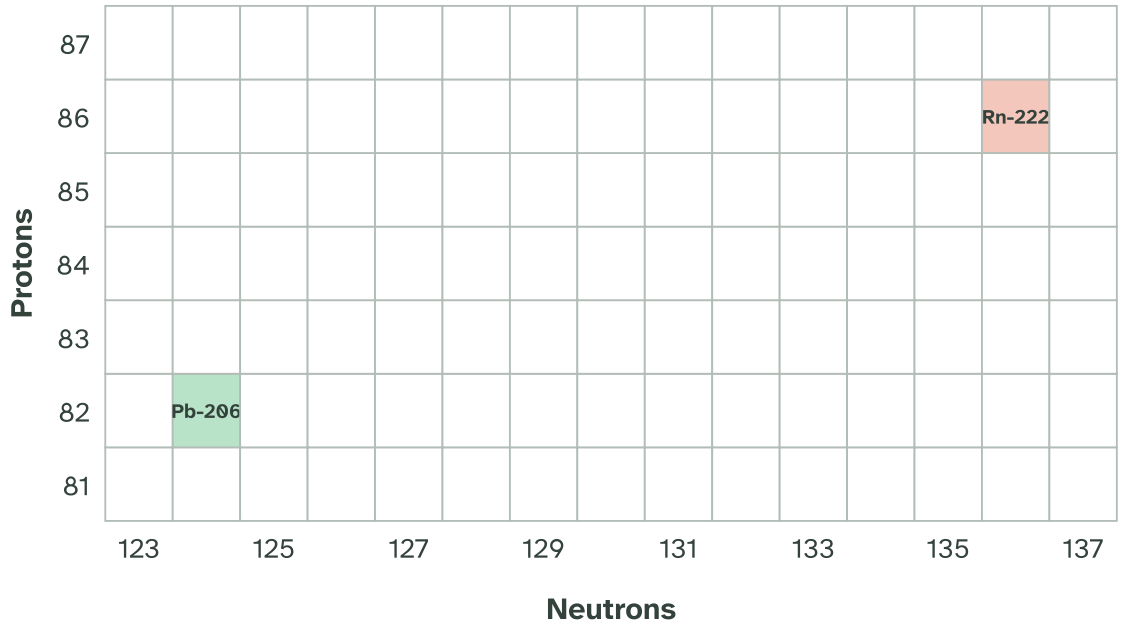
CHART Follow radon-222 to stable lead-206

Radon-222 has 86 protons and 136 neutrons. It decays eight times before it becomes stable lead-206. In alpha decay the nucleus loses 2 protons and 2 neutrons. In beta decay a neutron turns into a proton, so the nucleus gains 1 proton and loses 1 neutron (OpenStax).

The elements: 82 protons is lead (Pb), 83 bismuth (Bi), 84 polonium (Po) and 86 radon (Rn).

Step	Decay	Protons	Neutrons	Mass number	Nuclide
0	Start	86	136	222	Radon-222
1	Alpha				
2	Alpha				
3	Beta				
4	Beta				
5	Alpha				
6	Beta				
7	Beta				
8	Alpha				

Plot each nucleus on the chart and join them with arrows: one colour for alpha decay and another for beta decay.



1. How many alpha decays and how many beta decays are there?

2. Why does the chain stop at lead-206?