

Energy levels, radioactive decay and binding energy

AP Physics 2 (algebra-based) · Lab

Name: _____ Date: _____ Class: _____

Radioactive decay is random for each nucleus, yet a large sample decays in a predictable way. You will model this with dice, plot the decay curve and find the half-life of your model.

Level: AP Physics 2 (algebra-based) · **Curriculum:** AP P2 Unit 15

Aim

Model radioactive decay with dice, plot the number of remaining dice against throw number, and find the half-life of the model sample.

Equipment

- 100 identical dice (or 100 coins and a rule that tails decay)
- large shallow tray with edges
- graph paper or spreadsheet
- pencil

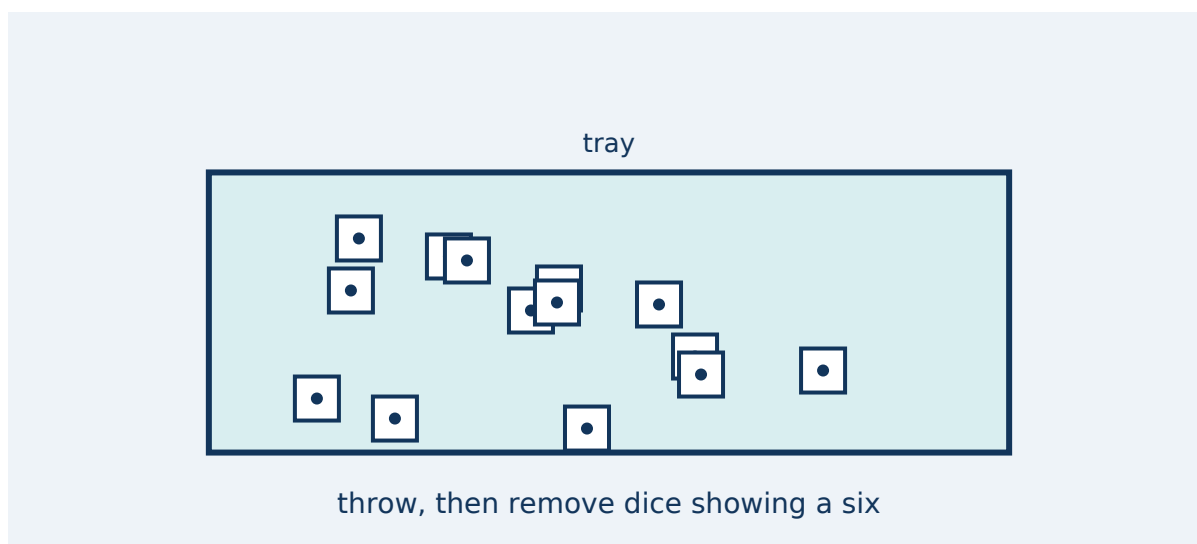
Safety

Safety

Throw the dice gently into the tray and never at another person. Pick up any dice that fall on the floor straight away, because they are a slipping hazard.

Method

1. Place 100 dice in the tray. This is throw 0 with $N = 100$.
2. Shake and tip the dice out, then remove every die that shows a six. These represent nuclei that have decayed.
3. Count and record the dice still in play.
4. Throw the remaining dice again and repeat until fewer than 15 dice are left.



Lab set-up: a tray of dice stands in for a sample of radioactive nuclei.

Results

Sample data from Mei in Singapore:

Throw number	0	1	2	3	4	5	6	7	8
Dice left N	100	84	70	59	49	41	35	29	24

Analysis questions

Question 1 Fraction remaining

Calculate N / N_0 for each throw.

Question 2 Plot the graph

Plot N against the throw number and draw a smooth curve through the points. Describe its shape.

Question 3 Half-life from the graph

Read the number of throws needed for N to fall to 50. This is the half-life of the model.

Question 4 Check from later readings

Use the readings at throw 4 and throw 8 to give a second value of the half-life.

Question 5 Theoretical value

Each die has a $5/6$ chance of surviving a throw. Calculate the theoretical half-life using $(5/6)^n = 0.5$ and compare with your result.

Question 6 Randomness

Explain why the points do not lie exactly on a smooth curve, and what would happen with 1000 dice.

Question 7 Change the rule

Predict the half-life if dice showing a one or a two are removed, and explain.