Topic 7 – Guidance for Practical 1

Exponential decay and half-life of dice

Safety

Although great care has been taken in checking the accuracy of the information provided in this guidance, Cambridge University Press shall not be responsible for any errors, omissions or inaccuracies.

Teachers and technicians should always follow their school and departmental safety policies. You must ensure that you consult your employer's model risk assessments and modify them as appropriate to meet local circumstances before starting any practical work. Risk assessments will depend on your own skills and experience, the skills and experience of your students, and the facilities available to you. Everyone has a responsibility for his or her own safety and for the safety of others. The notes below should not be regarded as a risk assessment.

You should carry out the practical yourself before presenting it to students. Make sure you are comfortable with the procedures, and can anticipate any difficulties your students may encounter.

Guidance

Students will practice recording measurements in appropriate tables, processing data to linearise graphs and using graphical methods to determine experimental values. This experiment helps students to understand the statistical nature of radioactive decay.

If students use Excel to plot their graph, they can add an exponential trend-line to fit their data. The equation of this line will be in the form of $y = \mathrm{A}\, e^{-\mathrm{B}x}$, where A and B are constants. Comparing this with the theoretical equation ($N = N_0\, e^{-\lambda t}$) the students can determine the value of the decay constant λ and half-life ($= \ln 2/\lambda$).

Apparatus and materials

Each group will need:

- 100 dice
- cup or container (large enough for 100 dice)
- lab tray

Answers to questions

1 $T_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$

2 Both, due to the statistical nature of the process.

Topic 7 – Guidance for Practical 2

Exponential decay and half-life of water in burette

Safety

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Guidance

Students will practice recording measurements in appropriate tables, processing data to linearise graphs and using graphical methods to determine experimental values.

The starting volume can have any value. The end volume cannot be too large, otherwise the measurements will not have reached the part of the graph where it asymptotically tends to the x-axis. If the graph does not approach this region, then the students stopped the experiment too soon. If the graph is not smooth, the students could adjust the stopcock to reduce the flow rate.

Apparatus and materials

Each group will need:

- burette
- stand and clamp
- beaker (of volume at least equal to the burette capacity)
- water
- stopwatch
- ruler

Supporting the practical

The students need to decide from which point they will measure the length of water in the burette, given that the lower part of the burette becomes narrower and does not have the same diameter as the rest of the burette. One option is be to consider the level just above the stopcock as 'zero'.

Answers to questions

1 A curve, gradually increasing towards an asymptote.

2 Exponential growth.