

Halloween maths activities for A Level

A Level Math Revision · A Level Maths (Year 12 and Year 13) · 31 October · Student sheet

Name _____

Class _____

Date _____

The starter is non-calculator. A calculator is needed for the main activity.

Starter (5 minutes)

1. Solve $e^x = 7$.
2. Differentiate $5e^{2x}$.
3. $P(A) = 0.4$ and $P(B | A) = 0.25$. Find $P(A \cap B)$.
4. Find the centre and radius of the circle $x^2 + y^2 - 6x + 4y - 12 = 0$.

Main activity (35 minutes)

Task A: Zombie outbreak

The number of zombies t hours after midnight on 31 October is first modelled by $Z = 30e^{kt}$. After 4 hours there are 90 zombies.

- a. Find the exact value of k .
- b. Find the time when the model predicts 1000 zombies, to 3 significant figures.
- c. (Year 13) A town has 1000 people. A better model is $dZ/dt = 0.5Z(1 - Z/1000)$ with $Z = 10$ when $t = 0$. Use partial fractions to show that $Z = 1000 \div (1 + 99e^{-0.5t})$.
- d. Using the logistic model, find when 900 people are zombies, to 3 significant figures. What is the long-term number of zombies?

Task B: The growing pumpkin (Year 13)

A prize pumpkin is a sphere of radius r cm. Its volume grows at a constant 50 cm^3 per day.

- a. Find the rate at which the radius is increasing when $r = 10$. Give an exact answer and a decimal to 3 significant figures.
- b. Find the rate at which the surface area is increasing at the same moment.

Task C: Trick or treat

60% of houses have a pumpkin outside. At a house with a pumpkin, $P(\text{treat}) = 0.9$; without one, $P(\text{treat}) = 0.4$.

- a. Find $P(\text{treat})$ and $P(\text{pumpkin} \mid \text{treat})$.
- b. Are the events 'pumpkin' and 'treat' independent? Give a reason.
- c. You visit 12 houses chosen at random. Find the probability of at most 6 treats, to 3 significant figures.

Task D: The haunted room

The floor of a round haunted room is the circle $x^2 + y^2 - 10x - 4y + 4 = 0$. A ghost walks along the line $y = x + 2$.

- a. Find the centre and radius of the room.
- b. Find where the ghost enters and leaves the room, and the length of its path inside.
- c. Find the equation of the tangent to the room at $(5, 7)$.

Extension

1. For $dZ/dt = 0.5Z(1 - Z/1000)$, show that the zombies spread fastest when $Z = 500$. Find this greatest rate and the time it happens, to 3 significant figures.