Activity description

This activity gives students practice in using logarithmic graphs to check that a power law is a good model for data and find the associated parameters.

Suitability and Time

Level 3 (Advanced)
1–2 hours

Resources

Student information sheet

Optional: slideshow

Further information is at http://www.chemetron.com/utcfs/ws-5230/Assets/AI%20App%20Guide_High%20Ceilings.pdf

Equipment

Graph paper, calculators

Key mathematical language

Gradient, intercept, natural logarithms

Notes on the activity

The student sheets include an information sheet (page 1) and questions based on it (page 2).

Before attempting the questions, students need to know how to use logarithmic graphs to predict a power law and find the associated parameters.

Points for discussion

The slideshow can be used to introduce the context. Some questions are included to aid class discussion.

Students should be able to see from the table of values that the smoke layer falls as the temperature difference increases, and also that the data will give a curve rather than a straight line.

Discuss the shape of the curve, and suggestions for ways of obtaining a linear graph.

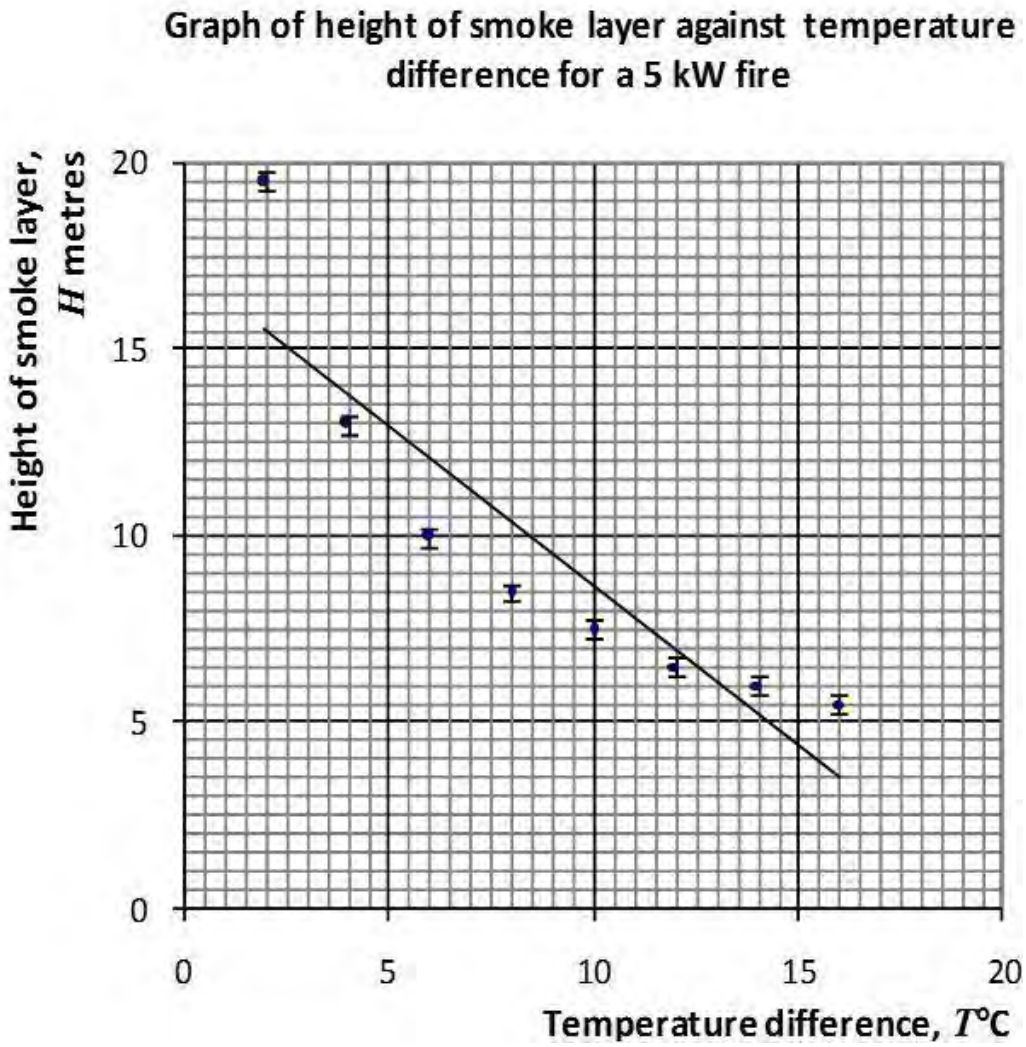
At the end of the session, use the reflection section at the end of the slideshow or student sheets to help students reflect on their work.

Answers

A graph of H against T for the 5 kW fire is given below and that for the 10 kW fire is of a similar shape.

a Taking natural logs and the laws of logarithms gives ln H = ln a + ln T^n

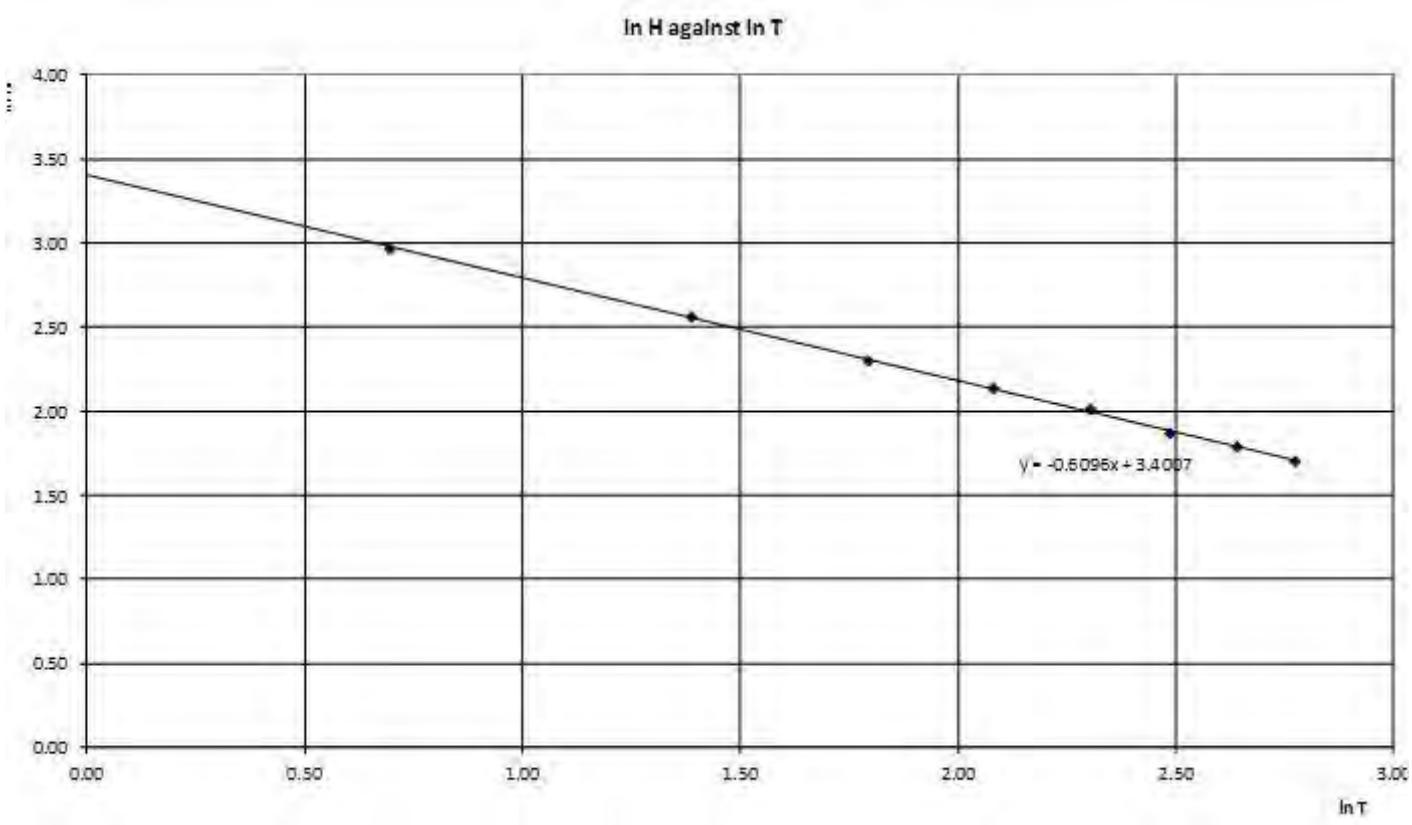
then ln H = ln a + n ln T



b i

ln T	0.69	1.39	1.79	2.08	2.30	2.48	2.64	2.77
ln H	2.97	2.56	2.30	2.14	2.01	1.87	1.79	1.70

b ii A hand-drawn log–log graph should give a graph similar to that below, which was produced using an Excel spreadsheet.



b iii A straight line indicates that the model is appropriate.

b iv The gradient gives $n \approx -0.6$

The intercept gives ln $a \approx 3.4 \Rightarrow a \approx e^{3.4} \approx 30$

c i approx 15.5 m

c ii curve of the shape suggested by the graph on page 1

c iii As $T \to 0$, $H \to \infty$, but in reality the height of the smoke layer is limited by the ceiling or roof of the building.

d i Substitution of given values gives b = 38.7 (3sf)

d ii Use of only one data pair rather than the full data set leads to a greater error.

Extensions

Students could be asked to fit different types of functions to the graph of H against T (the whole curve or parts of it).