Plotting the planets

Teacher notes

Why use this resource?

In this resource, students use logarithms to explore real data, investigate relationships and produce modelling formulae. Seeing the curved data set transformed to a straight line graph whose gradient and intercept can be measured, students can appreciate how important this is when working with real data.

Preparation

This resource is designed to be tackled using graph paper and a calculator.

However, it can also be approached using graphing technology such as GeoGebra, graphing calculators or spreadsheets. It is possible to use non-linear regression analysis tools to fit graphs to the data directly, but this may detract from the understanding to be gained by manually linearising the data.

Possible approach

Students could initially be given graph paper and the data (either on a printout of the problem page or displayed on the screen) and tasked with finding A and k in the relationship between period and distance. After sharing ideas in small groups or as a whole class they might need to be steered towards linearising the data using logarithms.

The second task (under the Temperature toggle) involves comparing two different possible models and uses some less well-behaved data from the same source.

Note that...

- There is extra data in the given table beyond what is needed for this particular task.
- The linearisation can be done equally well with logarithms to base 10, natural logarithms or indeed logarithms to any other base. The intermediate numbers will be different but the final results should be the same.
- Students ignoring the hint about absolute temperature are likely to encounter problems with the logarithms of negative numbers! This might be a useful learning experience.
- A range of different values can be obtained for the temperature relationship because of the scatter of the data.

Key questions

- What are the two unknown values in the relationship?
- What would happen if we took logs of both sides?
- Now that you have a straight line, could you tell me its equation?
- What does the intercept of the linear graph tell us about the relationship $P = A r^k$?

Possible extension

The data table includes numbers for orbital velocity.

- How does this vary with distance from the sun?
- Can you use circular motion and the relationship between P and r to explain this result?

Students with an interest in the Physics could investigate the theoretical models behind the relationships being explored here.

Students could be given the link to the NASA fact sheet and could look for other relationships between data.