

Eclipse geometry for A Level

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

Name _____

Class _____

Date _____

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

Starter (5 minutes)

1. Convert 30° to radians.
2. Using $\sin \theta \approx \theta$, estimate $\sin 0.01$.
3. Find the arc length of a sector of radius 5 and angle 0.3 radians.
4. Using $\cos \theta \approx 1 - \theta^2/2$, estimate $\cos 0.2$.

Main activity (35 minutes)

Task A: Angular size

A ball of diameter D at distance d fills an angle $\theta = 2 \arctan(D/(2d))$. Take: Sun diameter 1 400 000 km at 150 000 000 km; Moon diameter 3500 km at 380 000 km.

- a. Find the Sun's angular size in degrees, to 3 significant figures.
- b. Using $\tan \theta \approx \theta$, show that $\theta \approx D/d$. Find the Moon's angular size in radians and in degrees, to 3 significant figures.
- c. Find the percentage error of the approximation D/d compared with the exact $2 \arctan(D/(2d))$ for the Moon, to 2 significant figures.

Task B: Total or annular?

Take the Moon's distance as 360 000 km when nearer and 405 000 km when further away. The eclipse can be total only when the Moon looks bigger than the Sun.

- a. Find the Moon's angular size at 360 000 km and at 405 000 km, in degrees to 3 significant figures.
- b. Find the distance at which the Moon exactly covers the Sun.
- c. Taking the Moon's distance to vary evenly between 360 000 and 405 000 km, what fraction of that range allows a total eclipse?

Task C: The Moon's shadow

The Moon's umbra is a cone whose tip is where the edges of the Sun and Moon line up. Take the Sun as 150 000 000 km from the Moon and ignore the size of the Earth.

- a. Find the length L of the shadow cone, to 3 significant figures.
- b. Find the half-angle of the shadow cone, in radians, to 3 significant figures.
- c. Find the diameter of the shadow 360 000 km behind the Moon, to 3 significant figures.

Extension

1. A pinhole projector makes an image of the Sun on a screen s metres behind the pinhole. Find s for an image 2 cm across, to 3 significant figures.