

Eclipse geometry for IB Maths SL and HL

IB Math Revision · IB Maths SL and HL (AA and AI) · Student sheet

Name _____

Class _____

Date _____

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

Starter (5 minutes)

1. Convert 0.5° to radians, in terms of π .
2. Find the arc length of a sector of radius 10 and angle 0.2 radians.
3. At the same moment, a 1.8 m person casts a 2.4 m shadow and a tree casts a 12 m shadow. How tall is the tree?
4. Write down $\tan(\pi/4)$.

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 these rounded values: Sun diameter 1 400 000 km at 150 000 000 km; Moon diameter 3500 km at 380 000 km.

- a. Find the angle the Sun fills, in degrees, to 3 significant figures.
- b. Find the angle the Moon fills, in degrees, to 3 significant figures.
- c. For small angles, $\theta \approx D/d$ radians. Use this to find the Moon's angle in radians and in degrees, each to 3 significant figures. Is the approximation good?

Task B: Total or annular?

The Moon's distance varies. Take 360 000 km when it is nearer and 405 000 km when it is further away. If the Moon looks bigger than the Sun, an eclipse can be total; if smaller, the eclipse is annular (a ring of Sun is left).

- Find the Moon's angular size when it is nearer, in degrees to 3 significant figures. Can the eclipse be total?
- Find the Moon's angular size when it is further away, to 3 significant figures. What kind of eclipse happens?
- Use similar triangles to find the distance at which the Moon exactly covers the Sun.

Task C: The Moon's shadow

The Moon's dark shadow (the umbra) is a cone. Its tip is where the edges of the Sun and Moon line up. Take the Sun to be 150 000 000 km from the Moon, and ignore the size of the Earth.

- Let L be the length of the shadow cone behind the Moon. Explain why $L/3500 = (L + 150\,000\,000)/1\,400\,000$ and find L to 3 significant figures.
- With the Moon 380 000 km away, by how much does the cone fail to reach us? Give 3 significant figures.
- With the Moon 360 000 km away the cone reaches us. Find the diameter of the shadow 360 000 km behind the Moon, to 3 significant figures.

Extension

- A pinhole in a card makes an image of the Sun on a screen 1 m behind it. Using the rounded values above, find the diameter of the image in millimetres, to 3 significant figures.