

Eclipse geometry for IB Maths SL and HL: answers

IB Math Revision · IB Maths SL and HL (AA and AI) · Teacher answers and notes

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

Teacher notes

- Safety first: never look at the Sun directly, even during an eclipse. A pinhole projector (extension) is a safe way to see it.
- Every physical value is a rounded value given in the question; the real values vary.
- Task C is the key idea: the Moon's shadow only just reaches the Earth, which is why total eclipses are seen only along a narrow path.

Starter

1. $\pi/360$

- $0.5 \times \pi/180 = \pi/360$

2. **2**

- $r\theta = 10 \times 0.2 = 2$

3. **9 m**

- $12 \times 1.8/2.4 = 9$

4. **1**

- $\tan 45^\circ = 1$

Task A: Angular size

a. **0.535°**

- $2 \arctan(700\,000/150\,000\,000) = 0.5347\dots^\circ$

b. **0.528°**

- $2 \arctan(1750/380\,000) = 0.5277\dots^\circ$

c. **0.00921 rad = 0.528°: very good**

- $3500/380\,000 = 0.009210\dots \text{ rad}$
- $\times 180/\pi = 0.5277\dots^\circ$: the same as the exact value to 3 s.f.

Task B: Total or annular?

a. **0.557°: yes, it is bigger than the Sun's 0.535°**

- $2 \arctan(1750/360\,000) = 0.5570\dots^\circ$

b. **0.495°: annular**

- $2 \arctan(1750/405\,000) = 0.4951\dots^\circ$, smaller than the Sun's.

c. **375 000 km**

- $d/3500 = 150\,000\,000/1\,400\,000$
- $d = 3500 \times 150\,000\,000/1\,400\,000 = 375\,000 \text{ km}$

Task C: The Moon's shadow

a. **376 000 km**

- Similar triangles with a common tip: diameter $\div$ distance from the tip is the same for the Moon and the Sun.
- $1\,400\,000L = 3500L + 525\,000\,000\,000$, so $L = 525\,000\,000\,000/1\,396\,500 = 375\,939.8\dots$

b. **4060 km**

- $380\,000 - 375\,939.8 = 4060.2\dots$

c. **148 km**

- The diameter shrinks linearly from 3500 km at the Moon to 0 at the tip.
- $3500 \times (1 - 360\,000/375\,939.8\dots) = 148.4\dots$

Extension

1. **9.33 mm**

- $\text{Image}/1000\text{ mm} = 1\,400\,000/150\,000\,000$
- $\text{Image} = 1000 \times 1\,400\,000/150\,000\,000 = 9.333\dots\text{ mm}$

Every question is original and every answer was recomputed by computer before publishing.