

Eclipse geometry for A Level: answers

A Level Math Revision · A Level Maths (Year 12 and Year 13) · Teacher answers and notes

The starter is non-calculator. A calculator 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 A (c) shows why small-angle approximations are so useful in astronomy: the error is far smaller than the uncertainty in the data.

Starter

1. $\pi/6$
 - $30 \times \pi/180$
2. **0.01**
 - θ is small and in radians.
3. **1.5**
 - $5 \times 0.3 = 1.5$
4. **0.98**
 - $1 - 0.04/2 = 0.98$

Task A: Angular size

- a. **0.535°**
 - $2 \arctan(700\,000/150\,000\,000) = 0.5347\dots^\circ$
- b. **0.00921 rad = 0.528°**
 - $\tan(\theta/2) = D/(2d)$, and for small θ , $\theta/2 \approx D/(2d)$.
 - $3500/380\,000 = 0.009210\dots$; $\times 180/\pi = 0.5277\dots^\circ$
- c. **0.00071%**
 - Exact: $0.00921046\dots$; approximate: $0.00921053\dots$
 - $(0.00921053 - 0.00921046)/0.00921046 \times 100 = 0.000707\dots\%$

Task B: Total or annular?

- a. **0.557° and 0.495°**
 - $2 \arctan(1750/360\,000) = 0.5570\dots^\circ$
 - $2 \arctan(1750/405\,000) = 0.4951\dots^\circ$
- b. **375 000 km**
 - Equal angles: $3500/d = 1\,400\,000/150\,000\,000$, so $d = 375\,000$ km.
- c. **1/3**
 - Total when $d < 375\,000$: $(375\,000 - 360\,000)/(405\,000 - 360\,000) = 15\,000/45\,000 = 1/3$.

Task C: The Moon's shadow

a. **376 000 km**

- $L/3500 = (L + 150\,000\,000)/1\,400\,000$ gives $L = 525\,000\,000\,000/1\,396\,500 = 375\,939.8\dots$

b. **0.00465 rad**

- $\tan \alpha = 1750/L = 0.004655\dots$, and $\alpha \approx \tan \alpha$ for small angles: 0.00465.

c. **148 km**

- $3500 \times (1 - 360\,000/375\,939.8\dots) = 148.4\dots$

Extension

1. **2.14 m**

- $\text{Image}/s = 1\,400\,000/150\,000\,000$, so $s = 0.02 \times 150\,000\,000/1\,400\,000 = 2.142\dots$

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