

STARS RESOURCES

Teacher notes

Comparing sizes of Saturn, Jupiter and Mars

ACTIVITY

Calculate and compare the diameters of Jupiter, Saturn and Mars.

Students will:

- take photos of Jupiter, Saturn and Mars using a telescope and smartphone camera adapter.
- roughly calculate the diameters of Jupiter, Saturn and Mars.

This activity is aimed at students in middle secondary school.

CURRICULUM LINKS

YEAR 10 MATHEMATICS V.9

Measurement

use mathematical modelling to solve practical problems involving proportion and scaling of objects; formulate problems and interpret solutions in terms of the situation; evaluate and modify models as necessary, and report assumptions, methods and findings AC9M10M05

- estimating the scale of an object, such as a toy car, by measuring a linear dimension and using a typical car dimension to work out the scale factor

identify the impact of measurement errors on the accuracy of results in practical contexts AC9M10M04

- describing settings where measurement errors may impact research results and how measurement data impacted by error can result in biased findings

YEAR 9 MATHEMATICS V.9

Measurement

calculate and interpret absolute, relative and percentage errors in measurements, recognising that all measurements are estimates AC9M9M04

- estimating the accuracy of measurements in practical contexts and giving suitable lower and upper bounds for measurement values

use mathematical modelling to solve practical problems involving direct proportion, rates, ratio and scale, including financial contexts; formulate the problems and interpret solutions in terms of the situation; evaluate the model and report methods and findings AC9M9M05

Teacher notes

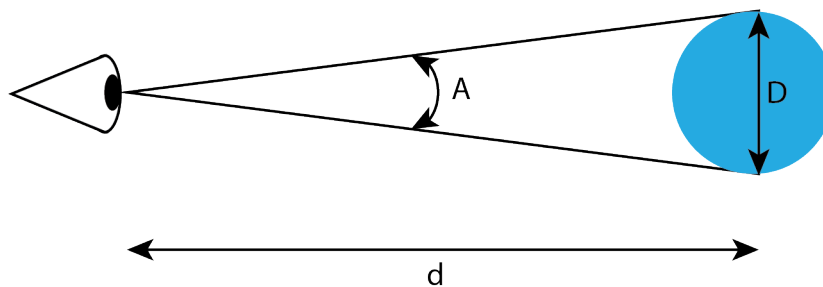
Comparing sizes of Saturn, Jupiter and Mars

CURRICULUM LINKS cont'd

- modelling situations involving direct proportion such as pro rata pay rates, exchange rates, multiple quotes or a job, conversion between scales or other appropriate science contexts; for example, Hooke's law and other science contexts involving wave lengths and frequencies

BACKGROUND INFORMATION

If you know how far something is away from you, you can determine its diameter (D) (if it is facing you face-on).



$$D = \frac{2\pi dA}{360}$$

In the equation above:

'd' is the distance (usually in kilometres) from Earth to the planet.

'A' is the angular size of the planet.

'D' is the diameter of the planet (in kilometres).

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BACKGROUND CALCULATIONS

It is necessary to do some initial calculations that are specific to your telescope and eyepiece before going any further.

Firstly, you need the telescope's field of view.

a) Magnification

$$\frac{\text{telescope focal length}}{\text{focal length of eyepiece}} = \text{magnification of eyepiece}$$

For your Dobsonian, your dimensions are most likely:

$$\frac{1200 \text{ mm}}{10 \text{ mm}} = 120 \text{ times magnification}$$

b) True field of view

$$\frac{\text{apparent field of view of eyepiece}}{\text{magnification}} = \text{true field of view (in units of degrees)}$$

You'll find the value for apparent field of view written on the eyepiece itself.

Depending on the magnification of your eyepiece, your final answer will be somewhere between 2.2 degrees to 0.5 degrees. This is the difference between seeing the Moon as a small object, and having a close-up image of the Moon.

If you prefer, you can use an online calculator once you have all of your numbers:

'Telescope calculator: How does your telescope perform?', Sky and Telescope website, <https://skyandtelescope.org/observing/telescope-calculator/> (31 August 2017).

So now you know how much of the sky your telescope, and therefore your smartphone, can see.

Assumptions:

1. Your smartphone is aligned so that it captures ALL of the light from the telescope. You should be able to see the full circle of view from the opening of your telescope displayed on the screen of your smartphone.
2. You are not using the zoom function on your smartphone. If you do, there will be more calculations needed to account for the amount of zoom.

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PLANNING AHEAD

1. This activity will need to be planned well in advance to ensure optimal viewing times for the three planets. Use Stellarium (<https://stellarium.org>) and the Time and Date website (<https://www.timeanddate.com/astronomy/night/>) to find out which planets are visible, and their rise and set times.
2. Read the Astrophotography Teacher Notes regarding planning for the best observing conditions and setting up the equipment.

OBSERVATION NIGHTS (STUDENT-LED)

1. Set up the telescope, smartphone camera adapter with smartphone attached.
2. Find the target planet/s.
3. Take a 5 - 10 second exposure photo of the planet/s of interest. Consider taking multiple photos in case some are better than others.

POST-OBSERVATION

1. Upload the photo into a software program like PowerPoint, or simply print out the image onto paper.
2. Calculate the percentage diameter of your planet compared to the full width of the photo.
3. Convert this percentage into a number of degrees, using the number from your earlier calculations of the true field of view, to obtain 'A'.
4. Find out how far away your object of choice is from the Earth using 'Distance, Brightness, and Size of Planets', Time and Date website, <https://www.timeanddate.com/astronomy/planets/distance>
5. Insert your numbers into the above equation to obtain 'D'.
6. Double check your number against true measurements of your planet's diameter. How close were your calculations?

(All websites accessed April 2023)