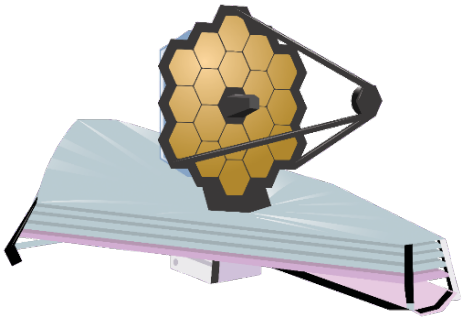
# Destination Space
## Beyond the Visible Universe

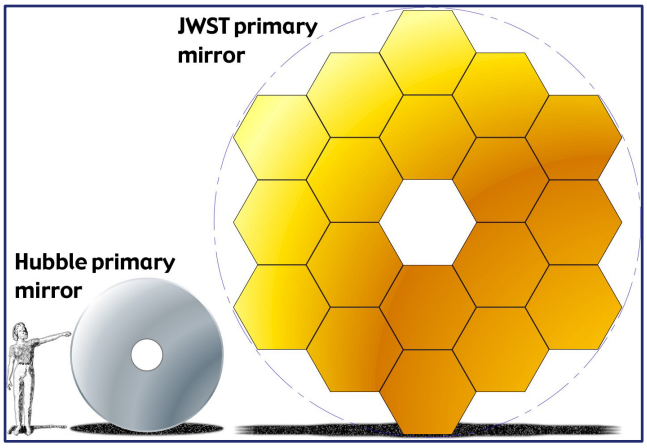
## Activity Pack 3 – Scale and Mirrors

*Please watch video 3 – 'Webb's Journey and Mirrors'.*



Webb is an infrared telescope, and infrared light is given off by anything that is warm. Infrared cameras are used by police helicopters to find people at night, and firefighters so they can see areas of heat through smoke or darkness. Because there are so many warm things on Earth (people, buildings, cars, animals, planes etc.) it is challenging to use an infrared telescope on Earth. So Webb will be a space telescope, positioned sufficiently far from Earth to avoid all the infrared light pollution.

After its launch and four week journey, Webb will eventually be located four times further away from Earth than the Moon. Comprehending distances and scale in space is a challenge, so the first activity idea is for a classroom-sized scale model of the Earth-Moon-Webb positions.




Size comparison between mirrors of Hubble Space Telescope and Webb

As a general rule with telescopes – the larger the mirror, the more light can be gathered and the fainter the objects observable. Consequently, the scientists and engineers building Webb wanted as large a mirror as possible. Owing to rocket constraints, the size of the mirror they planned was too large to fit into any rocket payload in one single piece. The solution – make the mirror foldable, so that it can be launched while folded, taking up less space.

Webb's mirror consists of 18 hexagonal gold-plated mirror sections. For the second activity idea, the task is to colour, cut out and assemble a miniature Webb mirror.

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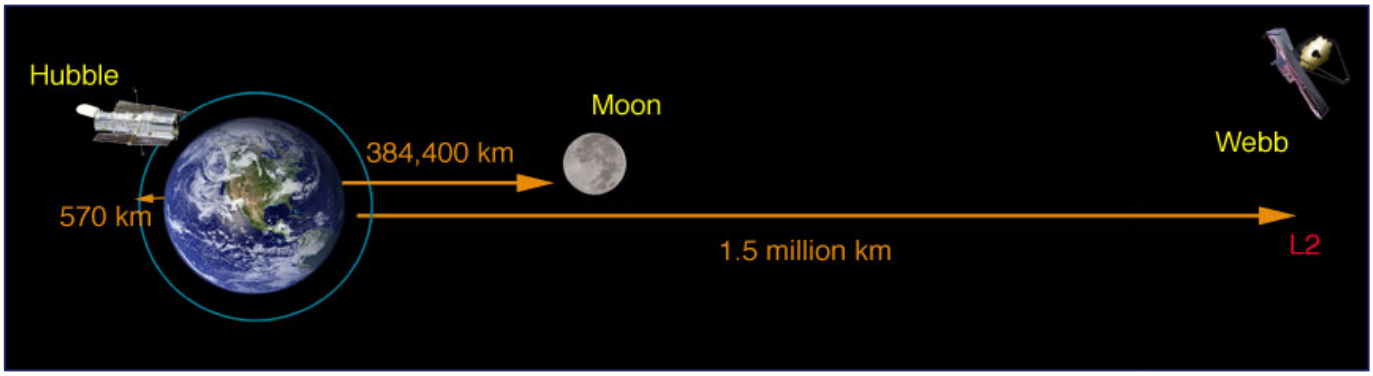
### Activity Idea 1 – Where is Webb Going?

Comprehending the vastness of space is a challenge for everyone, but using scale demonstrations can help us to obtain a better idea of the scale of space. Generally, the distance to the Moon is a surprising fact, and having learners make predictions during the following demonstration can be a fun way to involve everybody.




Webb will be located 1.5 million kilometres (1 million miles) from the Earth. Note: the graphic above is NOT to scale.

**Resources**

- Tennis ball (Earth)
- Marble/bouncy ball/blu-tack ball 1.8 cm diameter (Moon)
- Large tape measure

**Instructions**

This demonstration requires three volunteers – someone to be Earth (holding the tennis ball), someone to be the Moon (holding the marble/bouncy ball/blu-tack ball) and someone to represent where Webb will go.

If using the tennis ball-sized Earth, the Moon will be located **2 metres** from Earth. Webb will be located **8 metres** from Earth.

*At this scale, the Sun would be a ball 7.3 metres in diameter, and would be located about 780 metres away (approximately 8 football pitches).*

**Additional Notes**

While a tennis ball is suggested as the scale Earth, it is possible to use any sized ball. The guide below will help you calculate the required Moon size, and Earth-Moon-Webb distances for your chosen Earth.

First, establish your scale factor. To do this divide the size of your model Earth by the diameter of the actual Earth (make sure to be consistent with units – convert everything to metres):

$$scale\ factor = \frac{scale\ Earth\ diameter\ (in\ metres)}{12{,}750{,}000}$$

Then to determine the diameter of your scale Moon, multiple the scale factor by the Moon's diameter:

$$scale\ Moon\ diameter = scale\ factor \times 3{,}475{,}000$$

To work out the Earth-Moon distance in your scale demo, multiply the scale factor by the distance from the Earth to the Moon:

$$scale\ Earth\ to\ Moon\ distance = scale\ factor \times 384{,}000{,}000$$

Finally, for the Earth-Webb distance in your scale demo, multiply your scale Earth-Moon distance by four:

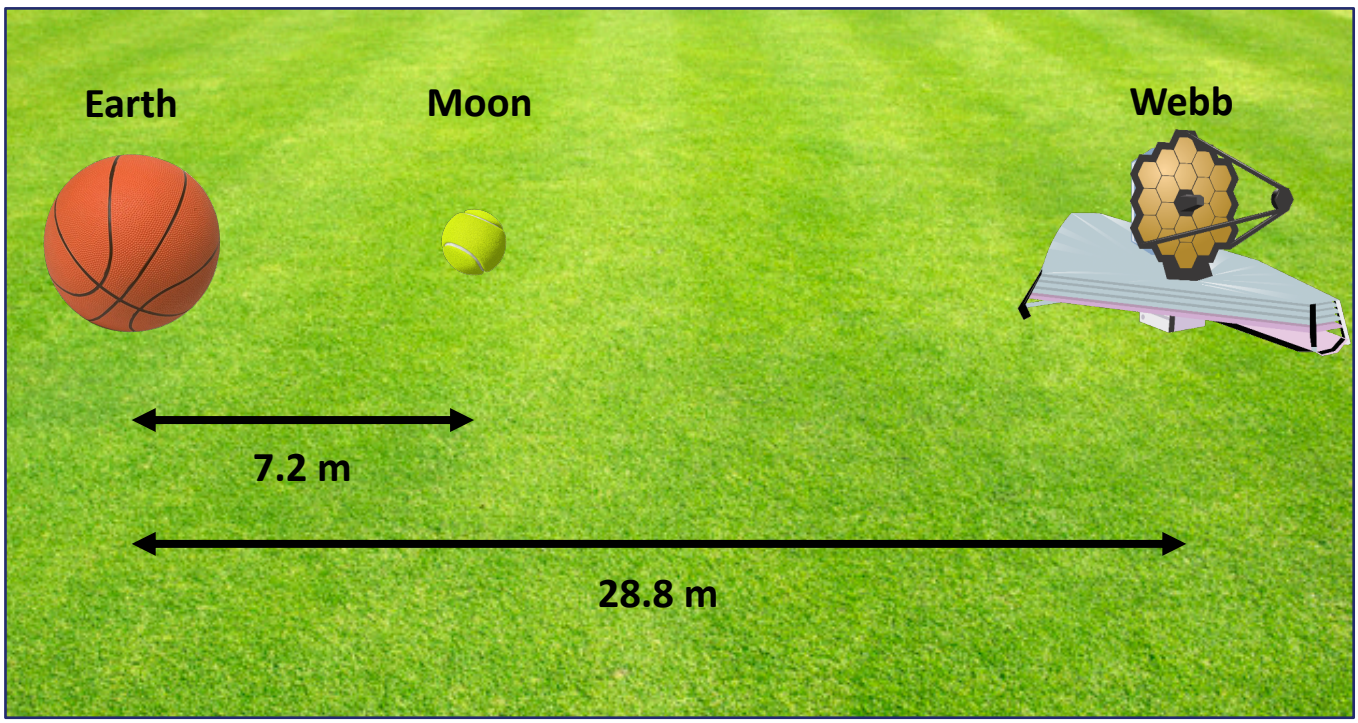
$$scale\ Earth\ to\ Webb\ distance = scale\ Earth\ to\ Moon\ distance \times 4$$

**Worked Example (Earth as a basketball)**

Using the maths detailed previously, we will now establish the scale sizes if the scale Earth was a basketball. This is an ideal scale to use for an outdoor demonstration of where Webb will go.

1. $Basketball\ diameter = 24\ cm = \mathbf{0.24\ m}$
2. $scale\ factor = \frac{scale\ Earth\ diameter\ (in\ metres)}{12{,}750{,}000} = \frac{0.24}{12{,}750{,}000} = \mathbf{1.88 \times 10^{-8}}$
3. $scale\ Moon\ diameter = 1.88 \times 10^{-8} \times 3{,}475{,}000 = 0.065\ m = \mathbf{6.5\ cm}$
4. $scale\ Earth\ to\ Moon\ distance = 1.88 \times 10^{-8} \times 384{,}000{,}000 = \mathbf{7.2\ m}$
5. $scale\ Earth\ to\ Webb\ distance = 7.2 \times 4 = \mathbf{28.8\ m}$

In this scale, a tennis ball would be ideal for representing the Moon.




Not to scale

## Activity Idea 2 – Webb Mirror Assembly

It can be a fun challenge to try and assemble 18 hexagonal mirrors in the arrangement Webb uses. The most common mistake is to forget that there is a gap in the middle where the camera assembly is fitted. For an extra challenge, make sure to hide any pictures of Webb.

**Resources**

- Printed hexagonal template, see next page (one per learner)
- Scissors
- Colouring pencils
- Thick paper/card
- Glue stick

**Instructions**

1. Colour in the individual hexagonal mirror pieces.
2. Cut out the pieces.
3. Try to arrange them in the formation used by the Webb telescope.
4. After checking to make sure the arrangement is correct, stick them to a base, for example thick paper or card. This page can then be decorated.

**Solution**