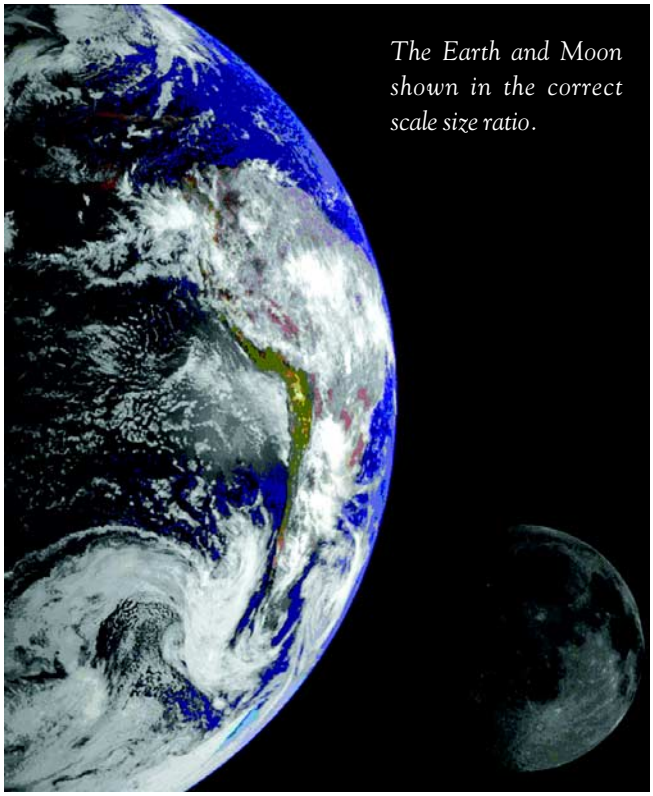
Setting the scale straight

This month the full Moon will be the largest for the entire year. No, the Moon is not growing in actual size, but its apparent size as we see and measure it from Earth will be at its greatest point. This increase in size is part of a regular rhythm the Moon has with the Earth as the two revolve together around the Sun. The Moon has an elliptical orbit with respect to the Earth and, at two distinct points along its orbit, the Moon hits its furthest from the Earth (*apogee*) and closest (*perigee*). If a full Moon occurs at apogee, it appears smaller relative to other full Moons. If a full Moon occurs at perigee, as it does this month, then it will appear much larger. This changing distance is easily graphed and provides accessible data for students to model the Moon's elliptical orbit (see Figure 1).

So how big is our Moon and how does this size compare to the Earth? An interesting way to answer this question is to set up a scale model of the Earth/Moon system that shows not only the distance, but the relative sizes as well. While most textbooks give values for the diameter of the planets and their moons, and perhaps the average distances between these objects, students may not have a good sense of the true distances or sizes just from reading this information. However, constructing a scale model provides students with a more concrete and tangible method for relating to the distances within our local Solar System neighborhood, and beyond into the farthest reaches of space.



The Earth and Moon shown in the correct scale size ratio.

FIGURE 1 **Dates and distances for lunar apogee and perigee**

Perigee	Apogee
Jan 23: 369,911 km	Jan 11: 404,342 km
Feb 19: 364,843 km	Feb 7: 404,549 km
Mar 19: 359,817 km	Mar 7: 405,382 km
Apr 17: 357,157 km	Apr 4: 406,209 km
May 15: 357,448 km	May 1: 406,528 km
Jun 12: 360,426 km	May 28: 406,169 km
Jul 10: 365,142 km	Jun 25: 405,232 km
Aug 6: 369,436 km	Jul 22: 404,329 km
Aug 31: 367,927 km	Aug 19: 404,101 km
Sep 28: 362,836 km	Sep 16: 404,712 km
Oct 26: 358,548 km	Oct 14: 405,691 km
Nov 23: 356,811 km	Nov 10: 406,297 km
Dec 22: 358,341 km	Dec 7: 406,279 km

Following some research into the sizes and distances of the other planets and their respective moons, students should discover that, with the exception of Pluto and Earth, there are no other planets and moons that have similar size ratios. Pluto is about twice the size of its moon Charon, while the Earth is about four times the size of her moon Luna. Our Moon has a diameter of 3,475 km compared to 12,756 km for the Earth. The Moon is roughly one quarter of the diameter of the Earth and approximately 384,500 km away, while Charon has an estimated diameter of 1,172 km and is only 19,640 km from Pluto on average.

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One activity idea is to prepare a paper-cutout model of the Moon set to the correct scale (example: Earth = 12 cm; Moon = 3 cm). Have students estimate how far apart the Earth and Moon are using the model cutouts. Interestingly, the distance is about 30 Earth diameters, which may be demonstrated by setting 30 Earth cutouts side by side and then placing one Moon cutout at the end of the line. You can then remove the 29 Earth cutouts to see how far apart the two objects really are.

How does this model compare with other planets and their moons in our Solar System? For example, Mars is very small when compared to the Earth, but it is still more than 300 times larger than either of its two moons. While the giant soupy planet Jupiter, at about 10 times the diameter of the Earth, is almost 300 times larger than its largest moon (Ganymede) and nearly 9,000 times larger than its tiniest moon (Leda).

Once students have seen how the Earth/Moon system looks when set to a scale size, encourage them to figuratively leave their celestial neighborhood and explore the sizes and distances of other objects within our Solar System. One way to do this is for them to make their own scale models. (See the Internet resources listed below for some great places to start your exploration of the Solar System and scale model building.)

Moon phases

April

New Moon	4/01
First quarter	4/09
Full Moon	4/16
Third quarter	4/23

Visible planets

- Mercury is over the west-northwestern horizon at sunset.
- Venus is very low over the southeastern horizon at sunrise.
- Mars rises after midnight and is over the southeastern horizon at sunset.
- Jupiter is over the southwestern horizon at sunset and sets before sunrise.
- Saturn is over the southwestern horizon at sunset and sets before midnight.

Celestial events

- 4/1–8 National Dark Sky Week
- 4/6 Daylight savings
- 4/15 Launch of SIRTF (Space Infrared Telescope Facility)
- 4/16 Largest full Moon of 2003

Internet resources

Lunar Perigee/Apogee calculator—*www.fourmilab.ch/earthview/pacalc.html*

National Dark Sky Week—*www.nationaldarkskyweek.htmlplanet.com*

Case of the Missing Stars—*www.plugged-in.org/Trans_network.html*

Daylight saving time—*scienceworld.wolfram.com/astronomy/DaylightSavingTime.html*

SIRTF—*sirtf.caltech.edu*

World's largest Solar System model—*www.bradley.edu/las/phy/solar_system.html*

Solar System meta page—*www.vendian.org/mncharity/dir3/solarsystem*