Mr. Standifer

Astronomy Earth and Moon

**Tools of Astronomy**

* The light that comes to Earth from distant objects is the best tool that astronomers can use to learn about the universe.
* In most cases, there is no other way to study the cosmos except to analyze the light that we receive from it.

**Radiation**

* Electromagnetic radiation consists of waves of electrical and magnetic disturbances.
* It includes visible light, infrared and ultraviolet radiation, radio waves, microwaves, X rays, and gamma rays.
* Electromagnetic radiation travels at the same speed and is classified by:
  + 1.\_\_\_\_\_\_\_\_\_\_\_\_—the distance between peaks on a wave.
  + 2.\_\_\_\_\_\_\_\_\_\_\_\_—the number of waves or oscillations occurring per second.

**Telescopes**

* When exploring space, telescopes have many benefits:
* 3.\_\_\_\_\_\_\_\_\_\_\_ can be attached to a telescope to observe all wavelengths, not just visible light.
* A telescope brings much more light to a focus than the human eye can, allowing the observation of faint objects.
* Specialized equipment, such as a 4.\_\_\_\_\_\_\_\_\_\_\_\_\_ which measures the intensity of visible light, can be used with a telescope.
* With the aid of imaging devices, telescopes can be used to make time exposures to detect objects that are too faint for the human eye to see.

**Refracting and Reflecting Telescopes**

* Two different types of telescopes are used to focus visible light.
* Refracting telescopes, or refractors, are telescopes that 5.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Reflecting telescopes, or reflectors, are telescopes that 6. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Reflectors make up the majority of telescopes that are in use today.
* Most major observatories are located in remote, high elevation locations in order to minimize light and atmospheric interference.

**Telescopes at Other Wavelengths**

* For all telescopes, the goal is to bring as much radiation as possible to a focus.
* 7.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the process of linking separate telescopes together so that they act as one telescope.
* This process has been used with radio telescopes for a number of years and is now being applied to other telescopes as well.
* The detail in the images that they produce improves as the distance between the telescopes increases.

**Satellites, Probes, and Space-Based Astronomy**

* Instruments often must be sent into space to collect information because:
* Earth’s atmosphere 8.\_\_\_\_\_\_\_\_\_\_infrared radiation, ultraviolet radiation, X rays, and gamma rays.
* When Earth’s atmosphere does allow certain wavelengths to pass through, the images are blurred.
* It is the only way to make close-up observations and even obtain samples from nearby objects in the solar system.
* The 9.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ *(HST)* makes observations in visible-light, infrared, and ultraviolet wavelengths.
* Other space-based telescopes, such as the *Far Ultraviolet Spectroscopic Explorer*, the *Chandra X-Ray Observatory*, and the *Spitzer Space Telescope*, observe other wavelengths that are blocked by Earth’s atmosphere.

**Spacecraft**

* Space-based exploration can be achieved by sending spacecraft directly to the bodies being observed.
* Robotic probes make close-up observations and sometimes land to collect information directly.
* More recently, the twin robots 10.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ conducted scientific experiments on Mars in 2004.

**Human Spaceflight**

* Exploring the short term effects of space has been accomplished with the space shuttle program, which began in 1981.
* Since habitation and research began in 2000, a multi-country space station called the 11.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ has been used to study the long-term effects of life in space.

**Spinoffs**

* Spinoffs are technologies that were originally developed for use in space programs that have been passed on to commercial industries for common use.
* More than 1400 different NASA technologies have been incorporated into products ranging from 12.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Reaching for the Moon**

* Plans for a crewed lunar expedition began in the late 1950s.
* In 1957 the Soviet Union launched the first satellite, 13.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* In 1961, Soviet cosmonaut Yuri A. Gagarin became the first human in space.
* On May 5, 1961, Alan B. Shepard Jr. became the first American in space as part of Project 14.\_\_\_\_\_\_\_\_\_\_\_\_ followed by the two-person crews of Project 15\_\_\_\_\_\_\_\_\_.
* On July 20, 1969, the Apollo program landed 16\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_and 17\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_on the Moon, during Apollo 11.

**Lunar Properties**

* Earth’s moon is 18\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_in the solar system, especially compared to the size of the planet it orbits.
* The Moon is 19\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_from Earth than most moons are from the planets they orbit.
* Earth’s moon is a 20\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_in contrast to the icy composition of the moons of the outer planets.
* Earth’s moon is the only large moon 21\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**The Lunar Surface**

* The 22\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the Moon, the amount of sunlight that its surface reflects, is only about 0.07 (7 percent) contrasted with Earth’s average of 0.31 (31 percent).
* Because the Moon has 23\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, surface temperatures can range from 400 K (24\_\_\_\_\_\_\_\_\_\_\_°C) in sunlight to 100 K (25\_\_\_\_\_\_\_°C) where it is dark.
* There is no erosion on the Moon—except for surface creep and wear caused by recent impacts—because it has no atmosphere or flowing water.
* Craters on the Moon are preserved until one impact covers another.
* The surface of the Moon consists of several features:
  + The Highlands are lunar regions that are light in color, mountainous, and heavily covered with craters.
  + The 26\_\_\_\_\_\_\_\_\_\_\_\_\_ (*singular*, mare) are lunar regions that are dark, smooth plains, which on average are 3 km lower in elevation than the highlands.
* Impact craters were formed when objects from space crashed into the lunar surface.
* 27\_\_\_\_\_\_\_\_\_ is material blasted out during impacts that fell back to the surface.
* Rays 28.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Rilles are meandering, valley like structures that are found in the Maria.

**Composition**

* The Moon is made up of 29.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* The highlands are predominately lunar breccias, which are rocks formed by the fusing together of smaller pieces of rock during impacts.
* The maria are predominately basalts that contain no water.

**History of the Moon**

* Radiometric dating of lunar rocks from the highlands indicates an age between 30.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* 31.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a layer of loose, ground-up rock on the surface of the Moon that formed as a result of the heavy bombardment during its first 800 million years.
* The maria which are between 3.1 and 3.8 billion years old formed when lava welled up from the Moon’s interior and filled in the large impact basins.

**Tectonics on the Moon?**

* The Moon, like Earth, has a layered structure, which consists of the 32\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Although the Moon experiences moderate moonquakes approximately once a year, scientists theorize that the Moon is not tectonically active.
* That the Moon has no active volcanoes and no significant magnetic field supports this conclusion.

**Formation Theories**

* The 33.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_proposes that as the solar system was forming, a large object ventured too near to the forming Earth, became trapped in its gravitational pull, and formed into what is now the Moon.
* The 34\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_states that the Moon and Earth formed at the same time and in the same general area, and thus the materials from which they formed were essentially the same.
* The impact theory is 35\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* This theory proposes that the Moon formed as the result of a gigantic collision between Earth and a Mars-sized object about 4.5 billion years ago, when the solar system was forming.

**The Sun-Earth-Moon System**

* The relationships between the Sun, Moon, and Earth are important to us in many ways.
* The Sun provides light and warmth, and it is the source of most of the energy that fuels our society.
* The Moon 36\_\_\_\_\_\_\_\_\_\_\_\_ in our oceans and illuminates our sky with its monthly cycle of phases.
* Every society from ancient times to the present has based its calendar and its timekeeping system on the apparent motions of the Sun and Moon.

**Daily Motions**

* The Sun rises in the 37\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, as do the Moon, planets, and stars as a result of Earth’s rotation.
* We observe the sky from a planet that rotates once every day, or 38\_\_\_\_\_\_\_\_\_.
* There are two relatively simple ways to demonstrate that Earth is rotating.

1. A 39.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, which has a long wire, a heavy weight, and will swing in a constant direction, appears from our point of view to shift its orientation.

2. Flowing air and water on Earth are diverted from a north-south direction to an east-west direction as a result of Earth’s rotation in what is known as the Coriolis effect.

**Earth’s Rotation**

* Our timekeeping system is based on the solar day, which is the time period from one sunrise or sunset to the next.

**Annual Motions**

* The annual changes in length of days and temperature are the result of Earth’s orbital motion about the Sun.
* The 40.\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the plane in which Earth orbits about the Sun.

**The Effects of Earth’s Tilt**

* Earth’s axis is tilted relative to the ecliptic at approximately 41\_\_\_\_\_\_\_\_\_\_\_°.
* As Earth orbits the Sun, the orientation of Earth’s axis remains fixed in space.
* At one point, the northern hemisphere of Earth is tilted toward the Sun, while six months later it is tipped away from the Sun.
* As a result of the tilt of Earth’s axis and Earth’s motion around the Sun, the Sun is at a 42\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in the sky during summer than in the winter.
* Altitude (similar to declination) is measured in degrees from the observer’s horizon to the object. There are 90 degrees from the horizon to the point directly overhead, called the zenith of the observer.

**Solstices**

* As Earth moves from position 1, through position 2, to position 3, the altitude of the Sun decreases in the northern hemisphere.
* Once Earth is at position 3, the Sun’s altitude starts to increase as Earth moves through position 4 and back to position 1.
* The summer solstice occurs around June 21 each year when 43.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* The summer solstice corresponds to the Sun’s 44.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in the sky in the northern hemisphere.
* The winter solstice occurs around December 21 each year when 45\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* The winter solstice corresponds to the Sun’s 46\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_in the sky in the northern hemisphere.

**Equinoxes**

* When the Sun is directly overhead at the equator, both hemispheres receive equal amounts of sunlight.
* The autumnal equinox occurs around 47.\_\_\_\_\_\_\_\_\_\_\_\_, halfway between the summer and the winter solstices when the Sun is directly over the equator.
* The 48\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ occurs around March 21, halfway between the winter and the summer solstices when the Sun is directly over the equator.
* For an observer at the Tropic of Cancer or Tropic of Capricorn, the Sun is 23.5° from the point directly overhead during the equinoxes.
* For a person standing at the *x* at 23.5º N, the Sun would appear in these positions on the winter solstice, the vernal equinox, and the summer solstice. On the autumnal equinox, the Sun would be at the same altitude as on the vernal equinox.

**Phases of the Moon**

* The sequential changes in the appearance of the Moon are called 49\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* A new moon occurs when the Moon is between Earth and the Sun and we cannot see the Moon because the sunlit side is facing away from us.
* As the Moon moves along in its orbit, the amount of reflected sunlight that we can see increases until we are able to see the entire sunlit side of the Moon, known as a full moon.
* Once a full moon is reached, the portion of the sunlit side that we see begins to decrease as the Moon moves back toward the new-moon position.

**Synchronous Rotation**

* Synchronous rotation is the state at which orbital and rotational periods are equal.
* As the Moon orbits Earth, 50.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_because the Moon has a synchronous rotation, spinning exactly once each time it goes around Earth.

**Motions of the Moon**

* The length of time it takes for the Moon to go through a complete cycle of phases is called a lunar month.
* The length of a lunar month is about 51\_\_\_\_\_\_\_\_\_\_\_\_.
* The Moon also rises and sets 50 minutes later each day because the Moon has moved 13° in its orbit over a 24-hour period, and Earth has to turn an additional 13° for the Moon to rise.

**Tides**

* The Moon’s gravity pulls on Earth along an imaginary line connecting Earth and the Moon, creating bulges of ocean water on both the near and far sides of Earth.
* As Earth rotates, these bulges remain aligned with the Moon.
* When the Sun and Moon are aligned along the same direction, the result is higher-than-normal tides, called 52\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* When the Moon is at a right angle to the Sun-Earth line, the result is lower-than-normal tides, called 53\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Solar Eclipses**

* A solar eclipse occurs when 54 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* When the Moon perfectly blocks the Sun’s disk, we see only the dim, outer gaseous layers of the Sun in what is called a total solar eclipse.
* A partial solar eclipse is seen when the Moon blocks only a portion of the Sun’s disk.
* The shadow that is cast on Earth consists of two regions.
* A total eclipse occurs in the inner portion called the 55\_\_\_\_\_\_\_\_\_\_\_\_, which does not receive direct sunlight.
* A partial eclipse occurs in the outer portion of the shadow called the 56\_\_\_\_\_\_\_\_\_\_\_\_\_, where some of the Sun’s light reaches.

**The Effects of Orbits**

* The Moon’s orbit is tilted 57\_\_\_\_\_\_\_° relative to the ecliptic and usually the Moon passes north or south of the Sun as seen from Earth, during a new moon.
* A solar eclipse can occur only when the intersection of the Moon and the ecliptic is in a line with the Sun and Earth.
* The Moon’s distance from Earth increases and decreases as the Moon moves in its elliptical orbit around Earth.
* 58\_\_\_\_\_\_\_\_\_\_\_\_ is the closest point in the Moon’s orbit to Earth.
* Apogee 59\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* When the Moon is near apogee, it appears smaller, and thus it does not completely block the disk of the Sun, resulting in an annular eclipse.

**Lunar Eclipses**

* A lunar eclipse occurs when the full Moon passes through Earth’s shadow.
* A lunar eclipse can happen only at the time of a 60\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, when the Moon is in the opposite direction from the Sun.
* A total lunar eclipse occurs when 61. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Solar and lunar eclipses occur in almost equal numbers, with slightly more lunar eclipses.