

## EMS Concepts

### Day/Night

- Caused by Earth's rotation on its axis ("spin").
- One Earth rotation takes 24 hours, therefore we have 24 hour days: roughly 12 hours of darkness when we are facing away from the sun and 12 hours of light when we are facing the sun directly.
- Earth spins counterclockwise, thus the sun appears to rise in the East and set in the West.

### Observing the Same Face of the Moon from Earth

- We always see the same face of the Moon when looking from Earth.
- On any given night/day, every place on the Earth sees the same face of the Moon.
- This occurs because the Moon spins on its axis once for every time it revolves around the Earth (28.5 days).

### Phases of the Moon

- Every 28 days we see a complete cycle of Moon phases:

New moon, waxing crescent, first quarter, waxing gibbous, full, waning gibbous, third quarter, waning crescent

- Thus, the Moon changes in appearance gradually each night.
- Phases are caused by the relative position of the Moon with respect to the Earth and Sun.
- The Moon's relative position changes as it revolves around the Earth.
- Waxing means increasing in size. A waxing phase appears to be lit on the right side.
- Waning means decreasing in size. A waning phase appears to be lit on the left side.
- One half of the Moon is always facing the sun and therefore one half is always lit.
- Because the Moon's position relative to the Earth is the same on any given day regardless of where one might be on Earth, the same phase of the Moon is visible from everywhere on Earth for any given night/day.
- Because the Moon revolves around the Earth in a counterclockwise direction, the Moon rises later each day (approximately 1 hour).
- The Moon rises in the east and sets in the west because the Earth rotates in a counterclockwise direction.
- The moon is in the sky for roughly 12 hours in a 24-hour period. Therefore, if the full moon rises at 6 PM, it will set at 6 AM.

- The full moon rises at sunset and the new moon rises at sunrise. Based on the position of the Moon in its orbit around the Earth, it is possible to determine the approximate rise time of each phase.

## Eclipses

### *Solar eclipses:*

- The sun is blocked (eclipsed) by the Moon, thus the Moon is between the Earth and Sun.
- In this position, the Moon is in a new phase.
- Totality lasts only a few minutes.
- The shadow that is cast on Earth covers a relatively small area, and so can be seen from only a few places on Earth.
- Can occur twice per (Earth) year — when the Moon, Earth, and Sun are aligned and in the same plane.

### *Lunar eclipses:*

- The Earth is between the Sun and the Moon and casts a shadow on the Moon, thus causing it to appear grey, black, or red.
- In this position, the Moon is in a full phase.
- Totality lasts a few hours.
- Lunar eclipses can be seen from any place on the Earth that is experiencing night at the time of eclipse.
- Can occur twice per (Earth) year — when the Moon, Earth, and Sun are in the same plane.

## Seasons

- Seasons are caused by the tilt of the Earth ( $23.5^\circ$ ) and the Earth's revolution around the Sun. Even though the Earth's orbit around the Sun is slightly elliptical, the distance of the Earth from the Sun IS NOT the cause of the seasons. (In fact, the Earth is closest to the Sun while the Northern Hemisphere is experiencing winter.)
- In the Northern Hemisphere, the Sun appears lower in the sky during the winter (is at its lowest noontime angular height on December 21), and higher in the sky during the summer (is at its highest noontime angular height on June 21).
- In winter, the Sun appears to rise in the Southeast and set in the southwest, and the daylength is at its shortest. In summer, the Sun appears to rise in the northeast and set in the northwest, and the daylength is at its longest.
- In winter, the Sun's rays are less direct.
- In summer, the Sun's rays are more direct.

- Seasons are reversed in the Northern and Southern Hemispheres.
- The Sun is never directly overhead (at a  $90^\circ$  angular height) at any latitude further north than the Tropic of Cancer ( $23.5^\circ\text{N}$ ), or further South than the Tropic of Capricorn ( $23.5^\circ\text{S}$ ). Within the tropics ( $23.5^\circ\text{S}$ - $23.5^\circ\text{N}$ ) the sun is directly overhead two times each year.