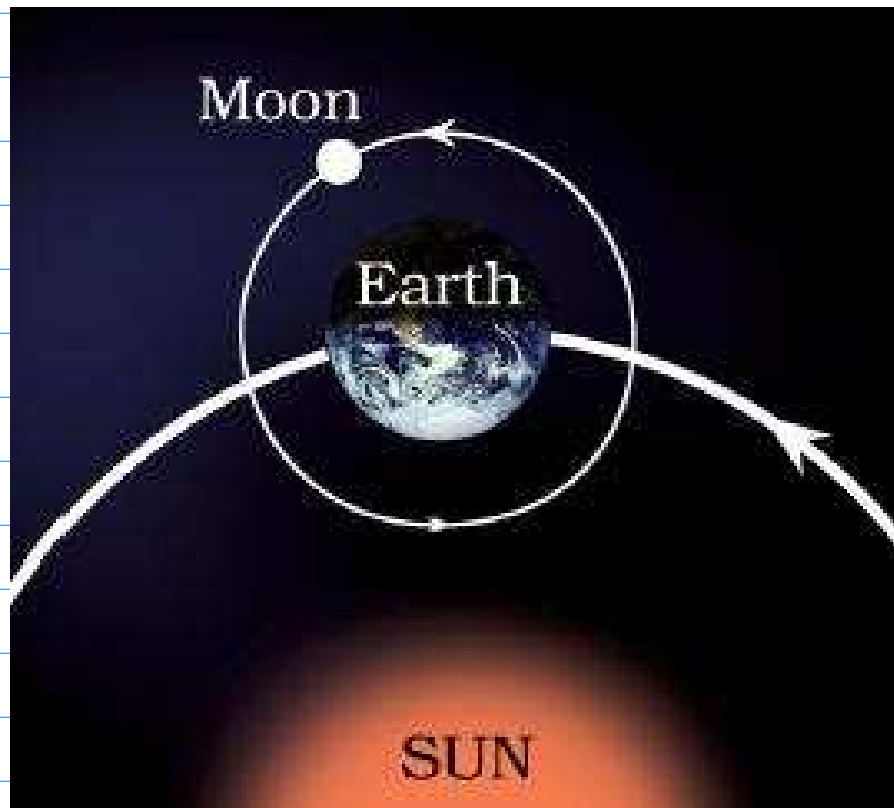


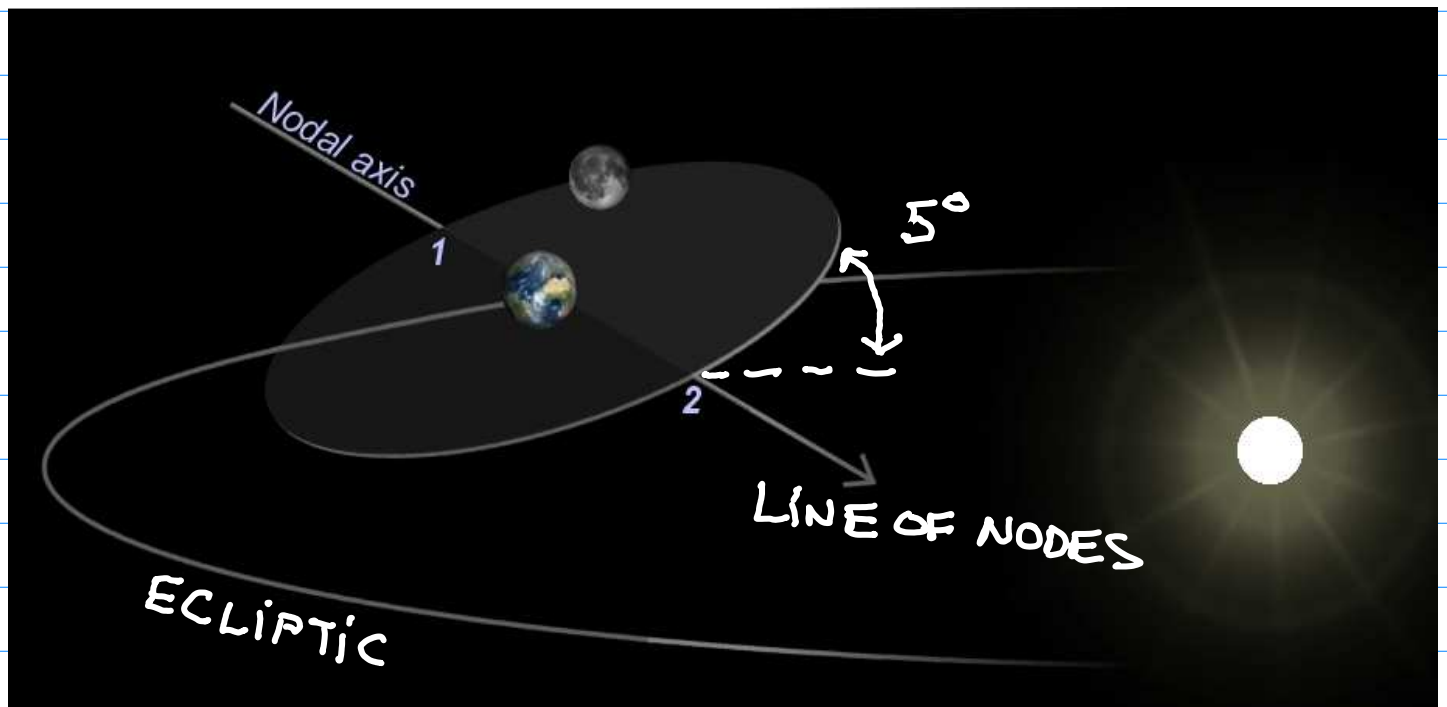
# THE PHASES OF THE MOON



THE MOON REVOLVES AROUND THE EARTH AS THE EARTH REVOLVES AROUND THE SUN.

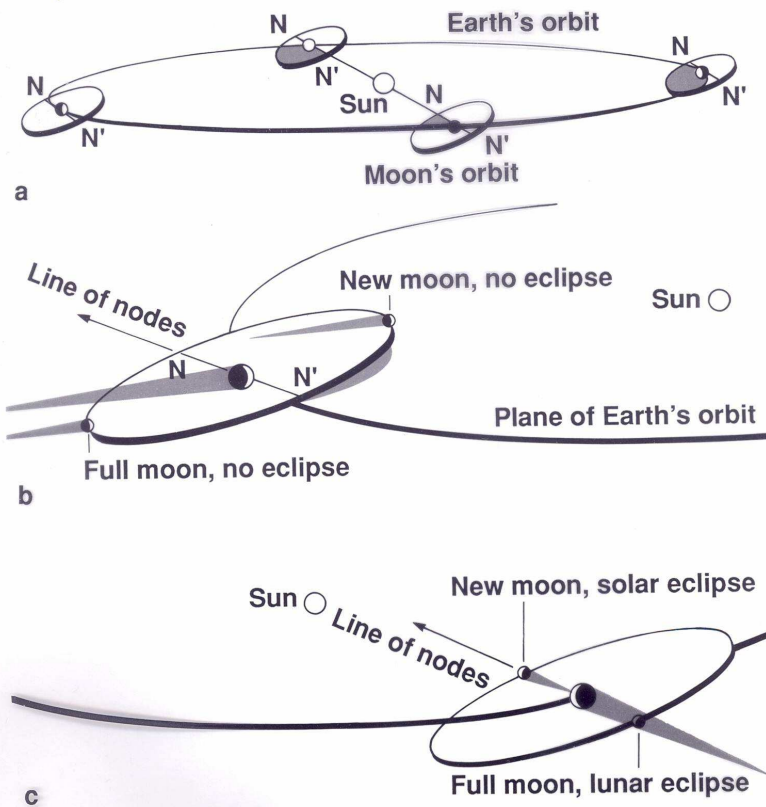
THE ORBITAL PERIOD OF THE MOON RELATIVE TO FIXED STARS (SO-CALLED SIDEREAL PERIOD) IS ABOUT 27.3 DAYS, OR JUST UNDER A MONTH.

THE MOON'S ORBIT IS TIPPED AT ABOUT  $5^\circ$  RELATIVE TO THE ECLIPTIC:



FOR HALF A MONTH THE MOON IS ABOVE THE ECLIPTIC AND FOR THE OTHER HALF IT IS BELOW THE ECLIPTIC.

THE POINTS WHERE THE MOON PASSES THROUGH THE EARTH'S ORBITAL PLANE (1 & 2) ARE CALLED NODES. IF THE LINE OF NODES DOES NOT POINT TOWARD THE SUN THERE IS NO CHANCE THAT THE MOON CAN ECLIPSE THE SUN.

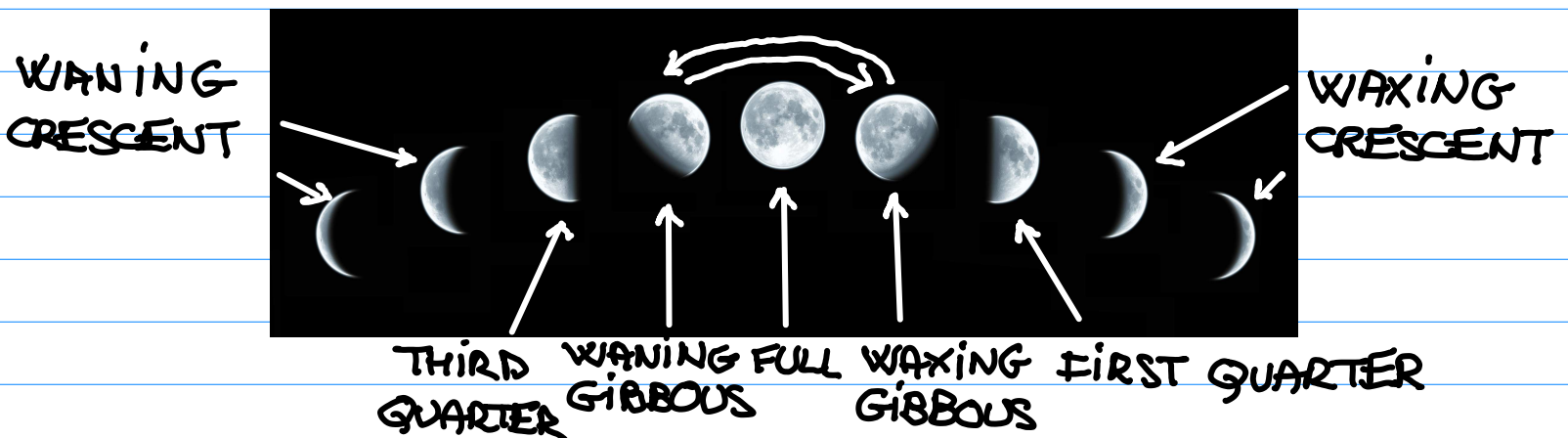


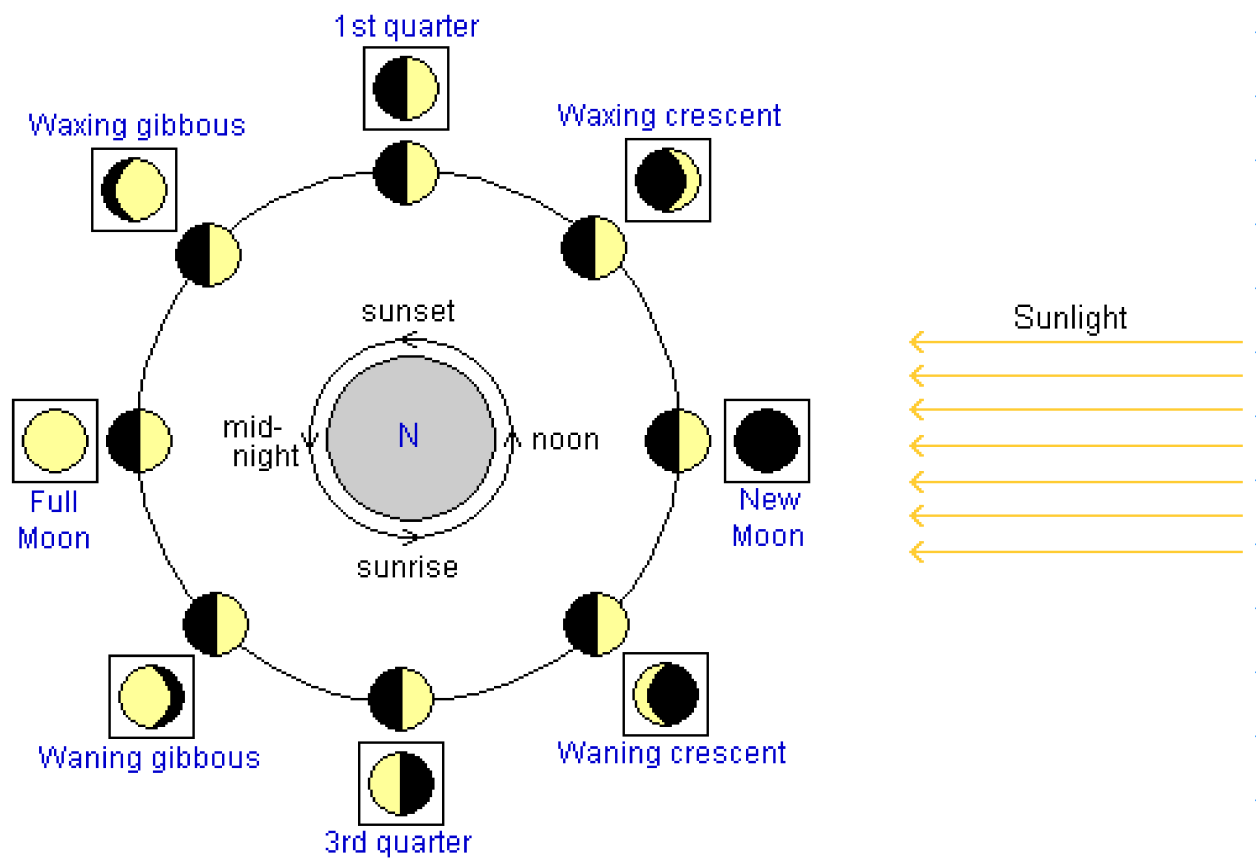
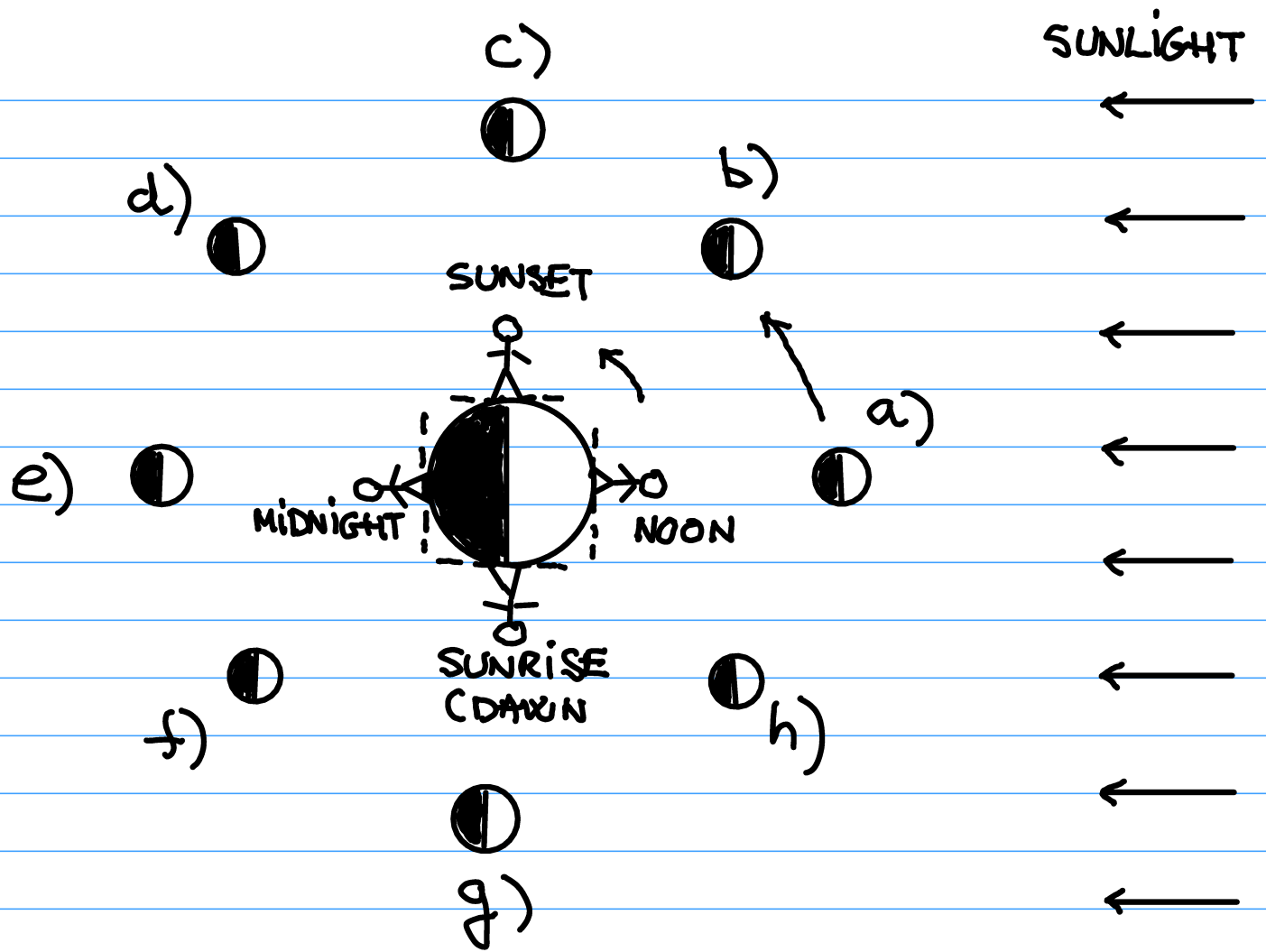
Eclipses and the line of nodes

Seeds, Horizons, 3rd ed., Fig. 3-23; Foundations of Astronomy, 1990 ed., Fig. 3-19

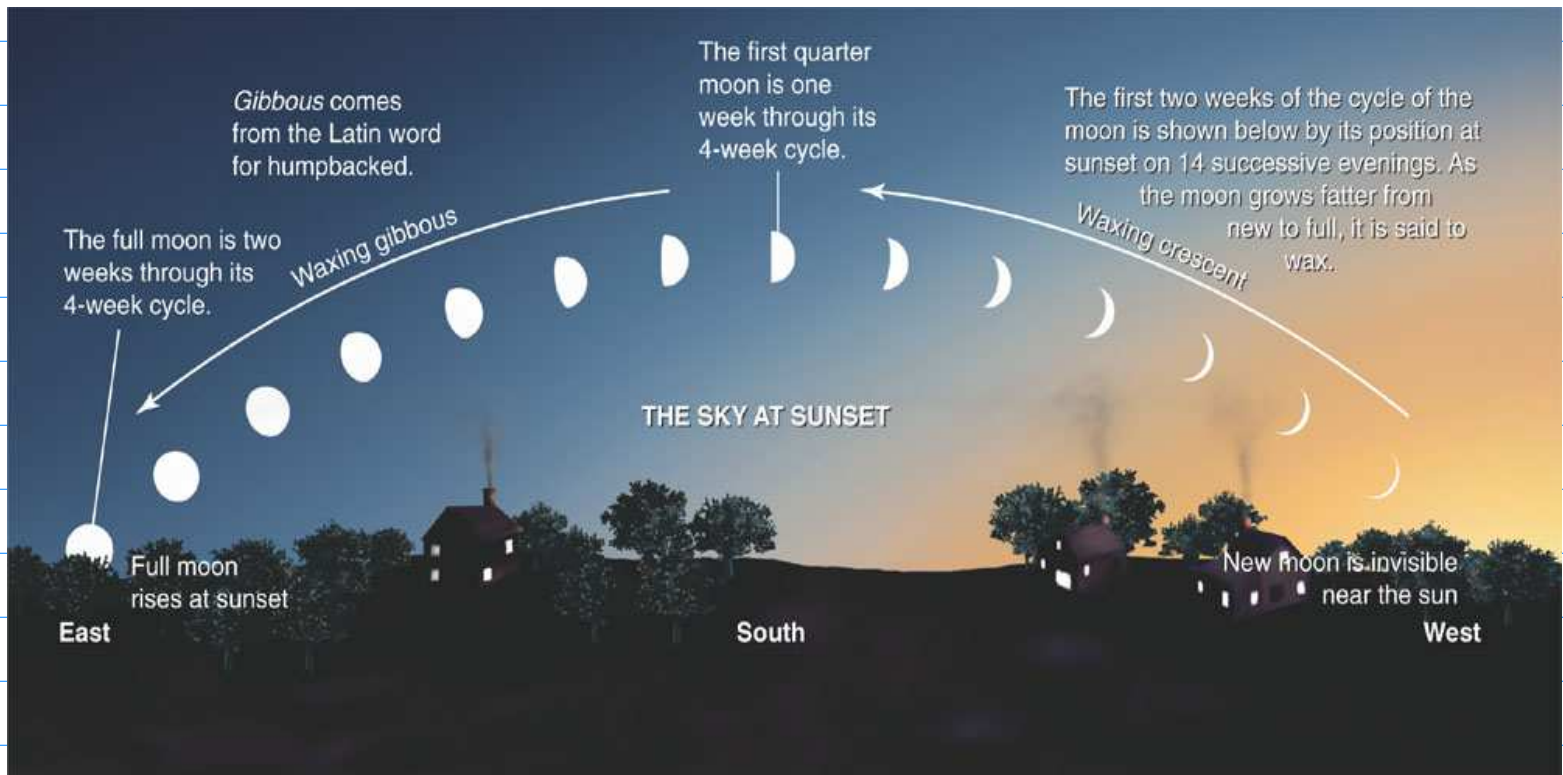
© 1991 Wadsworth, Inc.

THE PHASES OF THE MOON REFER TO DIFFERENT AMOUNTS OF THE ILLUMINATED SURFACE OF THE MOON THAT WE OBSERVE:





# LUNAR PHASES AT SUNSET (THE FIRST TWO WEEKS OF THE CYCLE)

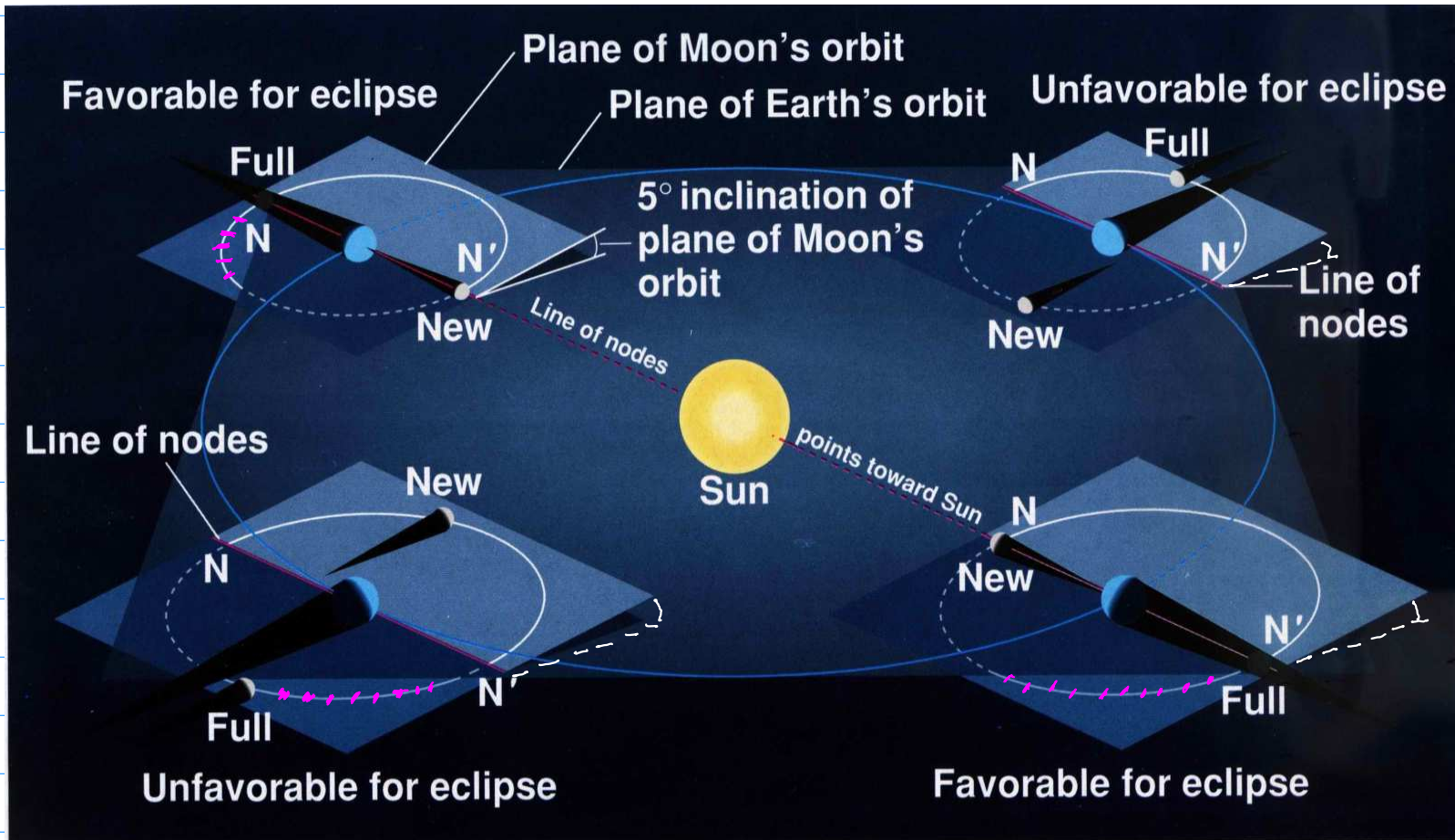


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THE CYCLE OF PHASES REPEATS WITH A PERIOD OF ABOUT 29.5 DAYS (SO-CALLED SYNODIC PERIOD).

THE EARLY CALENDARS ARE THE LUNAR CALENDARS BASED ON SYNODIC PERIOD.

# ECLIPSES



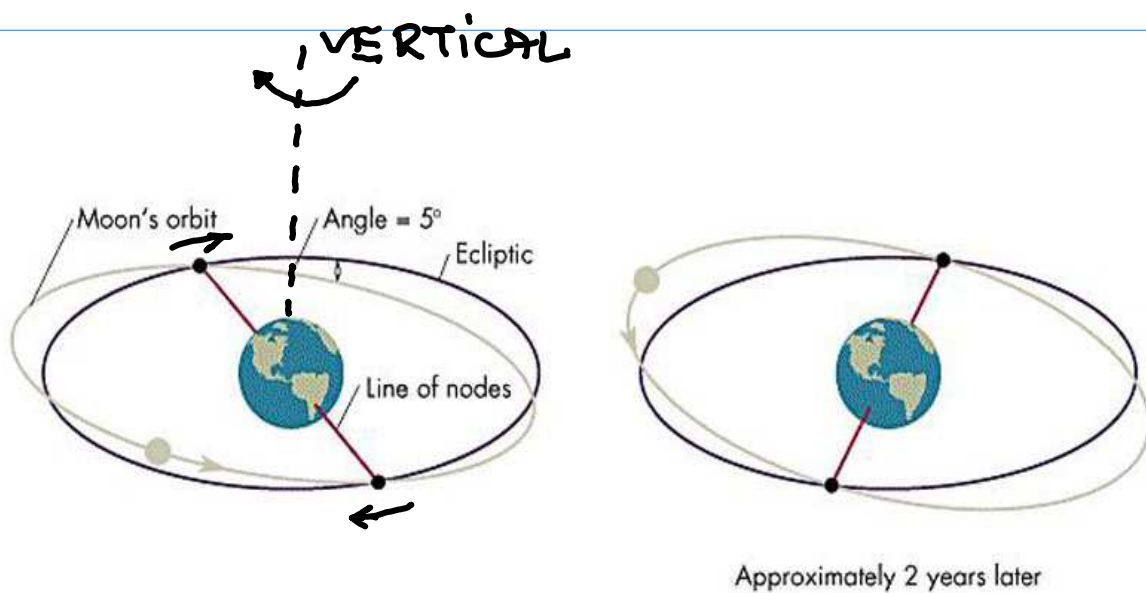
IF THE LINE OF NODES DOES NOT POINT AT THE SUN, THE SHADOWS MISS AND THERE ARE NO ECLIPSES AT NEW MOON AND FULL MOON.

WHEN THE LINE OF NODES POINTS AT THE SUN, ECLIPSES ARE POSSIBLE AT NEW MOON (SOLAR) AND FULL MOON (LUNAR).



THE MOON'S ORBIT KEEP NEARLY THE SAME DIRECTION OF TILT AND HENCE THE LINE OF NODES KEEPS NEARLY THE SAME DIRECTION. AS A RESULT ABOUT TWICE A YEAR THE LINE OF NODES POINTS AT THE SUN (ECLIPSE SEASON). ECLIPSES GENERALLY OCCUR IN PAIRS WITH A SOLAR ECLIPSE FOLLOWED APPROXIMATELY TWO WEEKS LATER BY A LUNAR ECLIPSE, OR VICE VERSA.

HOWEVER THE MOON'S ORBIT PREGESSES ABOUT THE VERTICAL TO THE ECLIPTIC:



AS A RESULT, THE LINE OF NODES ROTATES RELATIVE TO THE STARS ONCE EVERY 18.6 YEARS, I.E. BY  $360^\circ/18.6$  PER YEAR.

# IT TAKES THE EARTH

$$\frac{360^\circ/18.6}{360^\circ/\text{YEAR}} = \frac{1 \text{ YEAR}}{18.6} = \frac{365.25 \text{ DAYS}}{18.6} \approx 20 \text{ DAYS}$$

TO SWEEP THE SAME ANGLE. AS A RESULT THE DATES OF THE ECLIPSES SHIFT EACH YEAR BY ABOUT 20 DAYS.

FOR THIS REASON IT IS POSSIBLE TO HAVE AS MANY AS 5 SOLAR AND 2 LUNAR ECLIPSES IN A YEAR, OR 4 SOLAR AND 3 LUNAR ECLIPSES IN A YEAR.

THE LAST TIME THERE WERE 5 SOLAR ECLIPSES WAS IN 1935:

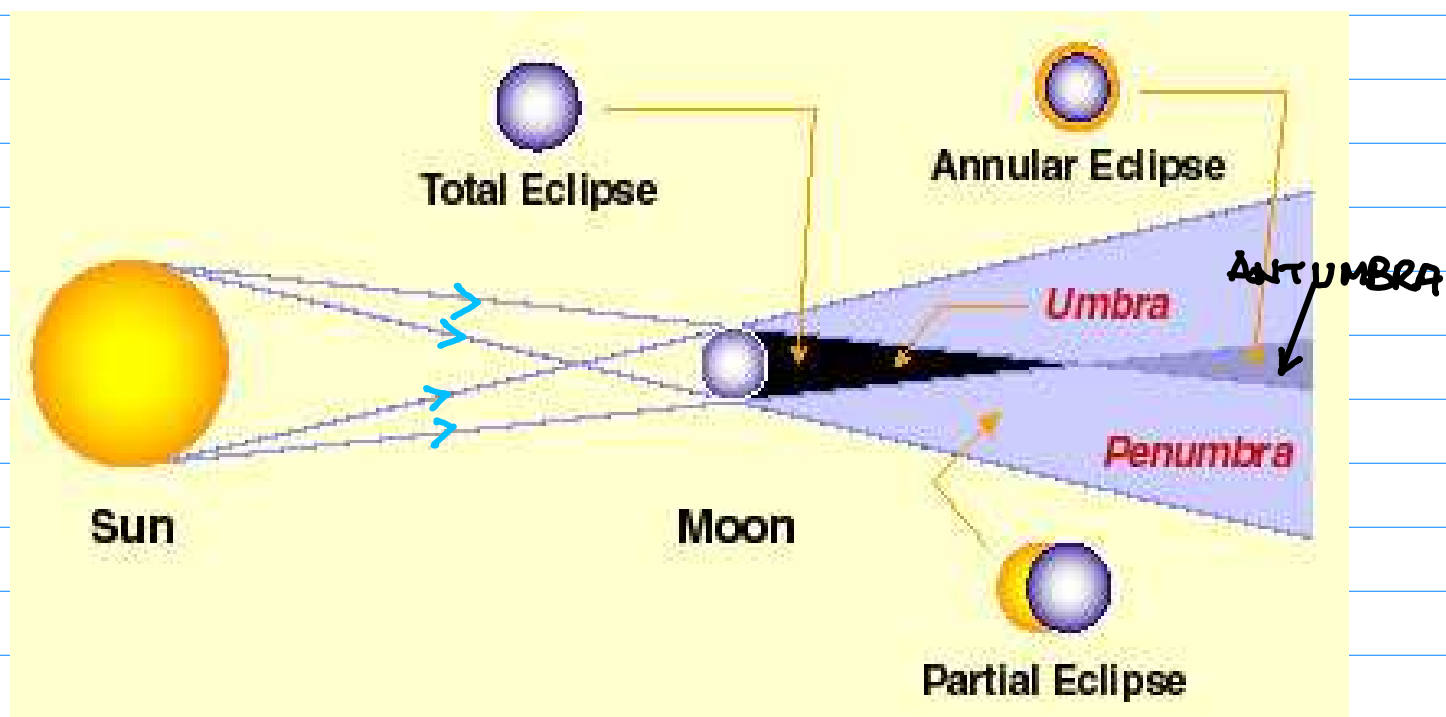
JAN 5, FEB 3, JUNE 30, JULY 30, DEC. 25

THE NEXT TIME THERE WILL BE 5 SOLAR ECLIPSES IS IN 2206:

JAN 10, JUNE 7, JULY 7, DEC. 1, DEC. 30



# THE TYPES OF THE ECLIPSES

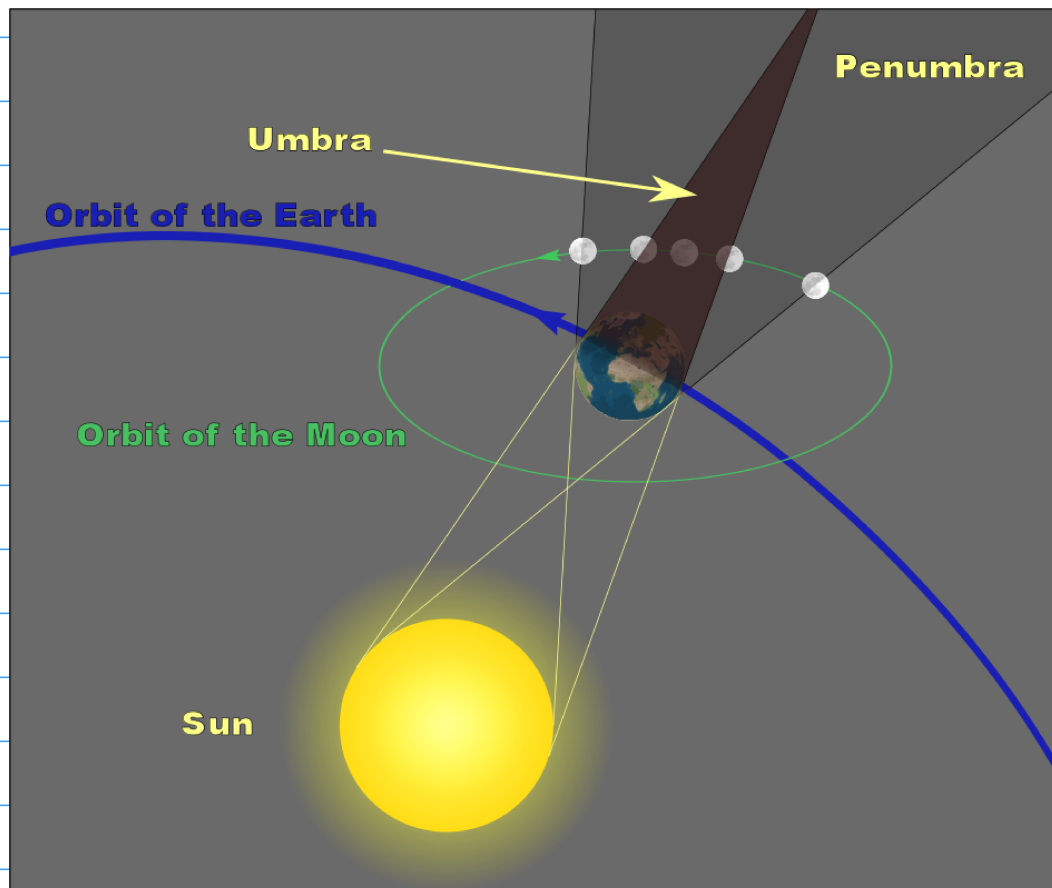


AN OBSERVER IN UMBRA (TOTAL SHADOW) WILL OBSERVE THE TOTAL ECLIPSE.

AN OBSERVER IN PENUMBRA (PARTIAL SHADOW) WILL OBSERVE A PARTIAL ECLIPSE.

AN OBSERVER AT ANTUMBRA WILL OBSERVE AN ANNULAR ECLIPSE.

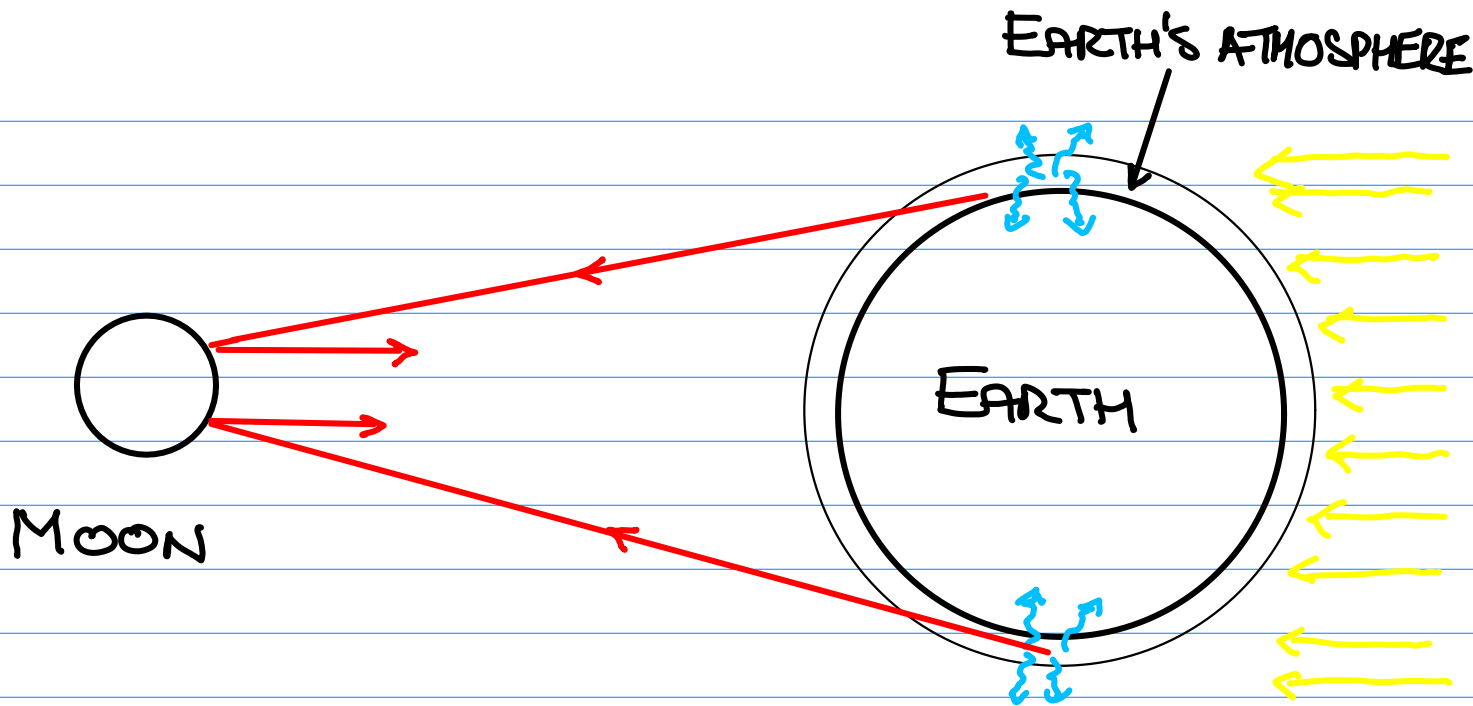
# LUNAR ECLIPSE:



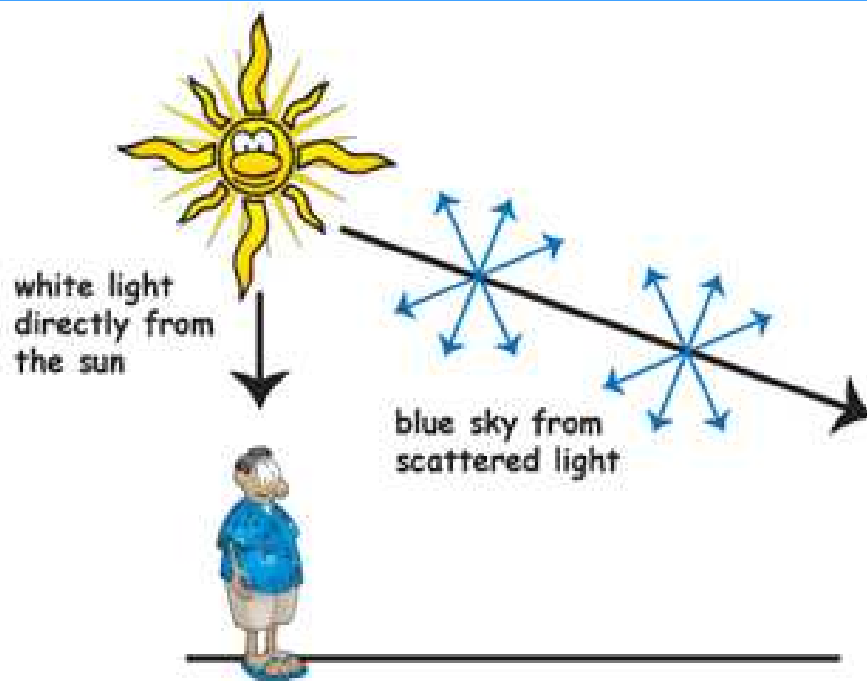
THE EARTH'S UMBRA AT THE MOON IS 9,200 km WIDE (THE DIAMETER OF THE MOON IS 3,476 km).



THE MOON DURING A TOTAL LUNAR ECLIPSE. HOW COME IT IS VISIBLE IF IT IS IN THE SHADOW OF THE EARTH.

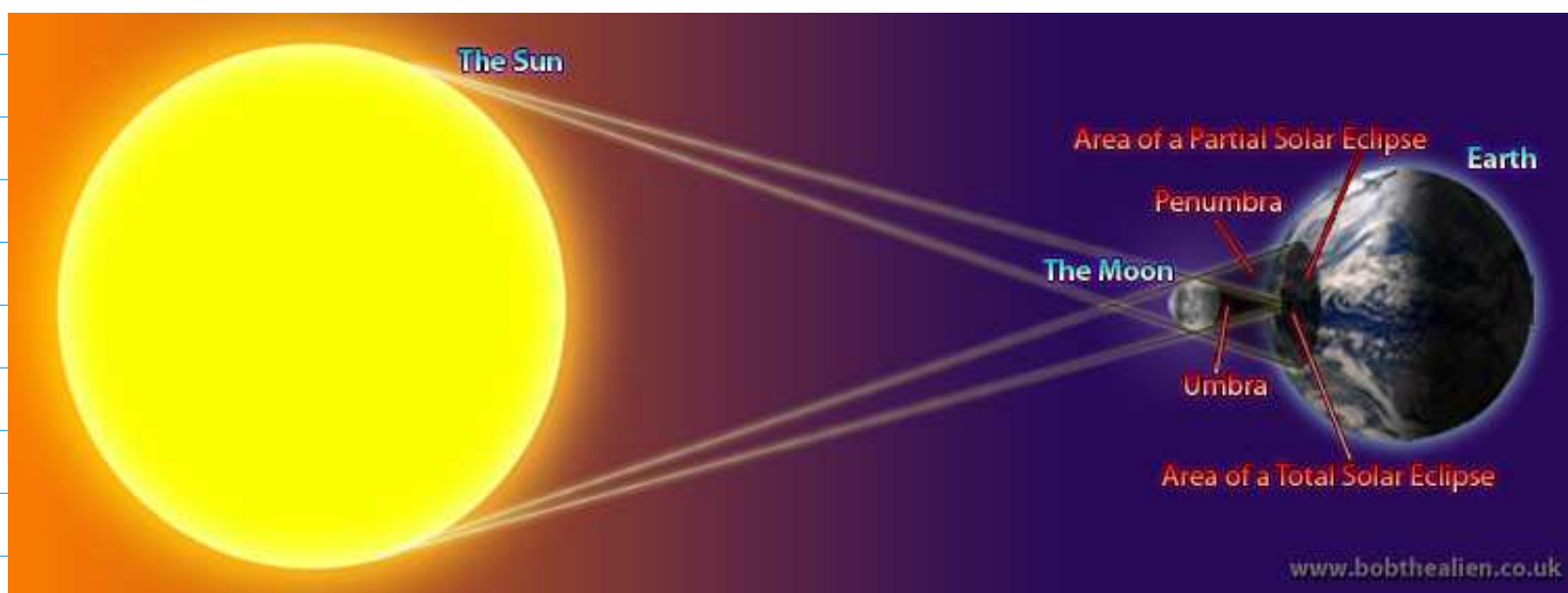


THE SHORTER WAVELENGTHS IN THE SPECTRUM OF SUNLIGHT (E.G. BLUE) ARE SCATTERED OUT BY THE DUST IN THE ATMOSPHERE - THAT'S WHY THE SKY IS BLUE ON A CLEAR DAY :



THE LONGER WAVELENGTHS, SUCH AS RED, ARE NOT SCATTERED OUT, BUT ARE BENT BY THE EARTH'S ATMOSPHERE AND DIRECTED AT THE MOON. THAT LIGHT IS REFLECTED OFF THE SURFACE OF THE MOON BACK TO EARTH.

## SOLAR ECLIPSE:

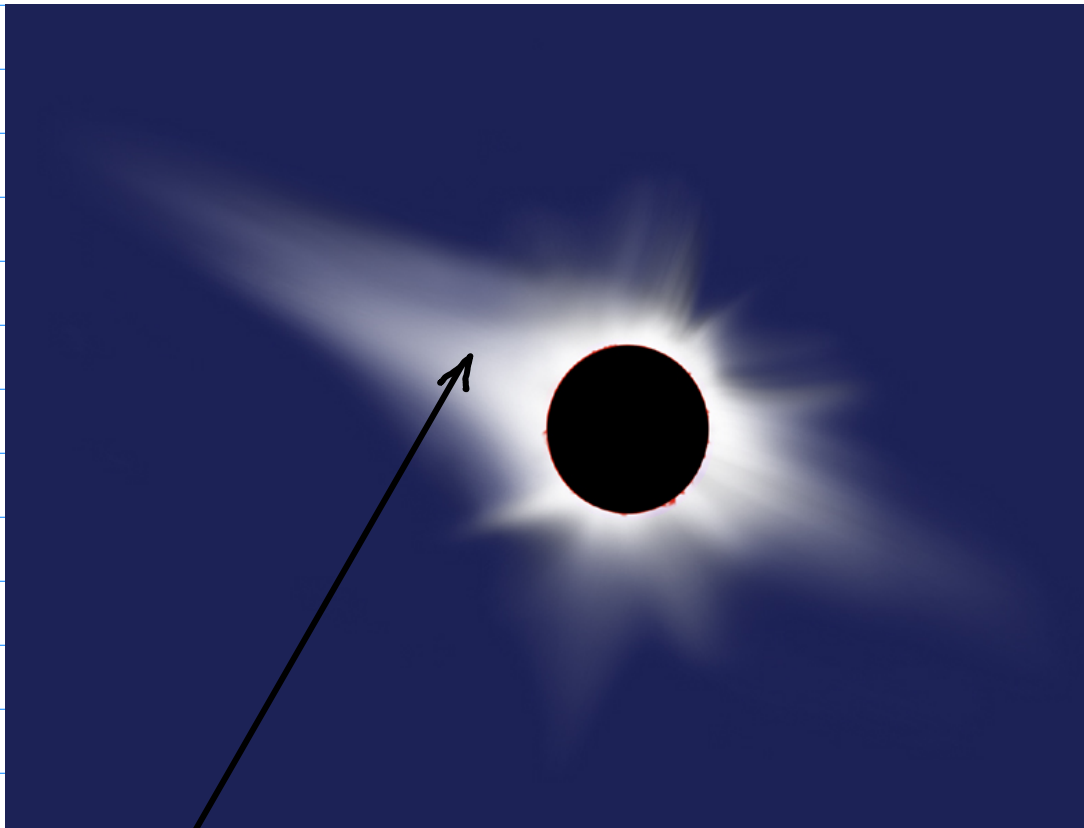


THE MOON'S UMBRA AT THE SURFACE OF THE EARTH IS 269 km WIDE AND THE MOON'S PENUMBRA IS 7,000 km WIDE.

THE ORBITAL SPEED OF THE MOON IS 3,400 km/h AND ITS SHADOW RACES

ON THE SURFACE OF THE EARTH. THE EARTH SPINS IN THE SAME DIRECTION WITH THE SPEED ON THE EQUATOR OF 1,670 km/h. THE NET EFFECT IS THAT THE TOTAL SOLAR ECLIPSE CAN NEVER LAST LONGER THAN  $7\frac{1}{2}$  MINUTES.

## A TOTAL SOLAR ECLIPSE



CORONA (THE SUN'S OUTER ATMOSPHERE)

# ANNULAR SOLAR ECLIPSE :

