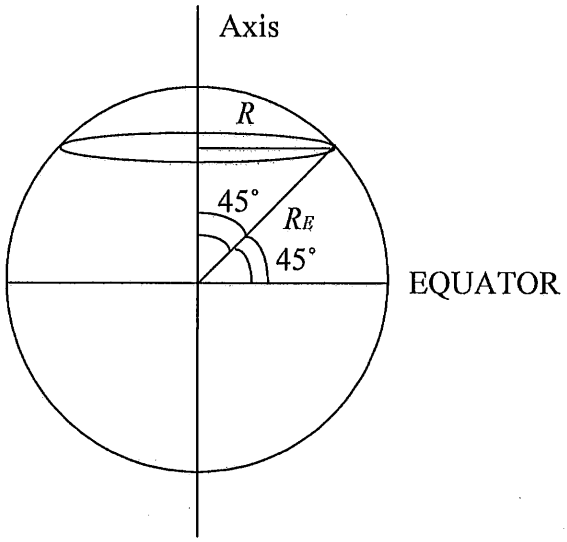
TWO FREE RIDES PLUS SPEED AND SIZE OF MOON

A The earth gives us two free rides

(i) Due to rotation of Earth about its axis



Time for Rotation = 24 hours

Radius of Earth = 4000 miles = 6400 km

Our Latitude = 45°

Radius of $6R = R_E \sin 45 = R_E \cos 45$

$$\text{Speed Due to Rotation} = \frac{2\pi R}{24}\text{ mph}$$

$$= \frac{2\pi \times 4000 \times \sin 45}{24} \approx 700\text{ mph}$$

$$\cong 1120\text{ km/hour}$$

(ii) Due to revolution of Earth around the sun

Radius of Earth's Orbit = 93,000,000 miles

Time for Revolution =1 year = (365.25 × 24) hours

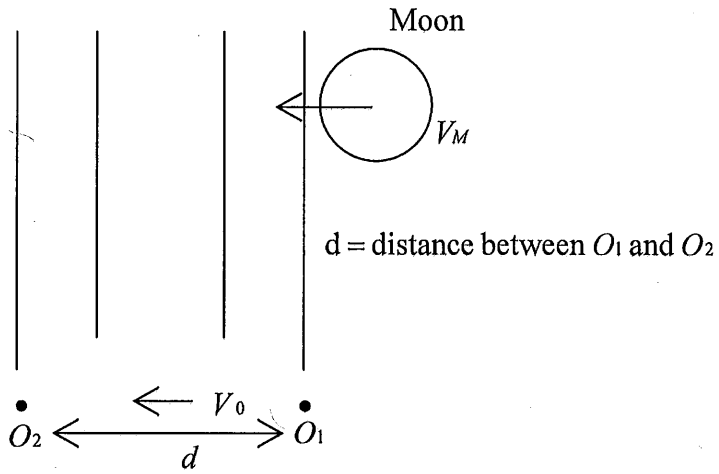
$$\text{Speed due to Revolution} = \frac{2\pi \times 93 \times 10^6}{235.25 \times 24}$$

$$\approx 67{,}000\text{ mph}$$

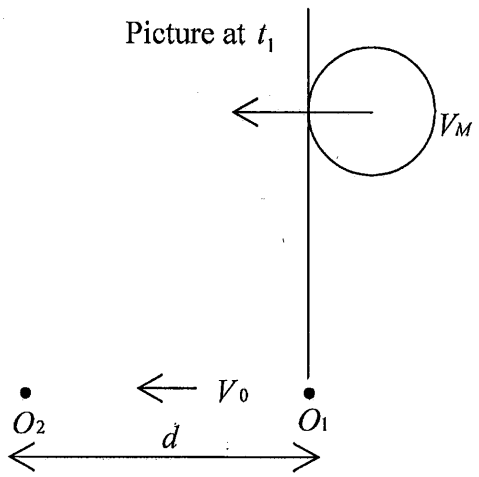
B Speed and Size of Moon:

To access speed of moon we need two observers to go out at midnight on a full moon night and observe a star such that the moon intercepts the light from the star. Star is very far so light from it is a parallel beam. Both observers on same latitude so both have same velocity V_0 due to Earth's rotation.

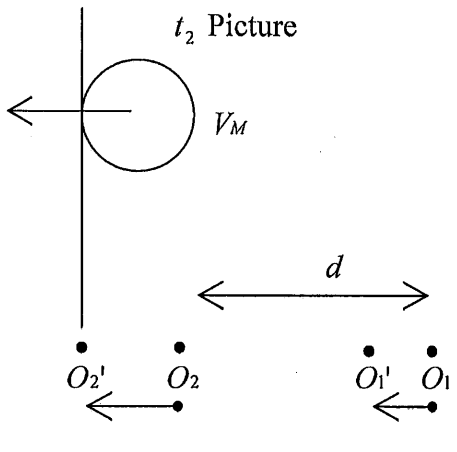
The picture is



At time t_1 moon intercepts light from star as seen by O_1



At time t_2 moon intercepts light from star as seen by O_2



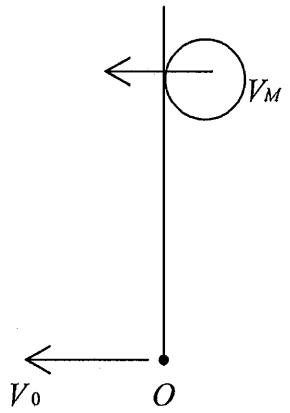
$O_2'O_2 = O_1'O_1$ = distance travelled by observer due to motion of Earth
Hence

$$V_M(t_2 - t_1) = d + V_0(t_2 - t_1)$$

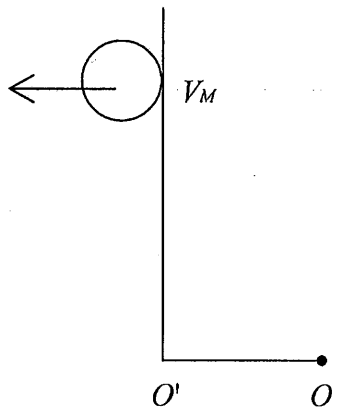
Speed of moon $$V_M = \frac{d}{(t_2 - t_1)} + V_0$$

Once we know V_M a single observer can "measure" diameter of moon.

Again, concentrate on light from a star being intercepted by moon.



at t_d light just disappears



at t_A light just appears

$$OO' = V_0(t_A - t_d)$$

Distance mobbed by moon = $d_M + V_0(t_A - t_d)$
Where d_M = diameter of moon

$$V_M(t_A - t_d) = d_M + V_0(t_A - t_d)$$
$$d_M = (V_M - V_0)(t_A - t_d)$$

Which will allow us to measure d_M.