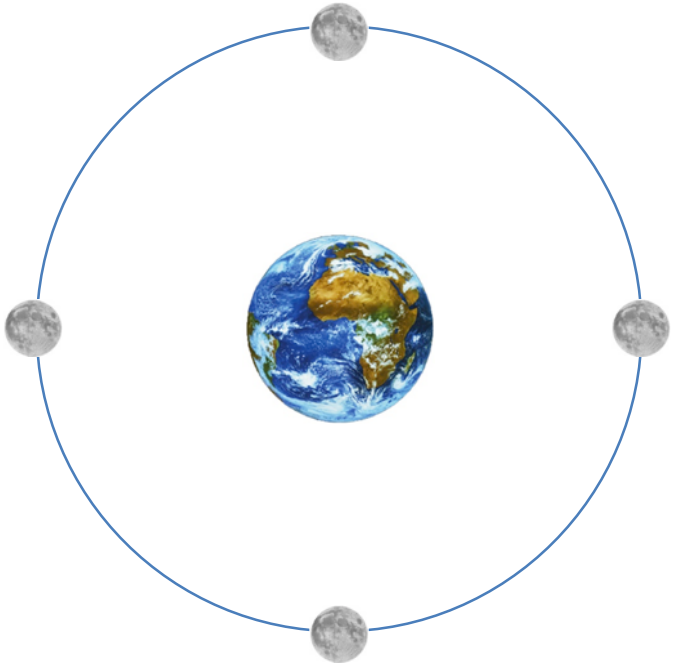
Uniform Circular Motion

Pre-Class Questions

Problem Set (due next time)
Ch 3 - 31, 33, 34, 36

Lecture Outline
1. Vectors and Uniform Circular Motion
2. Centripetal Acceleration

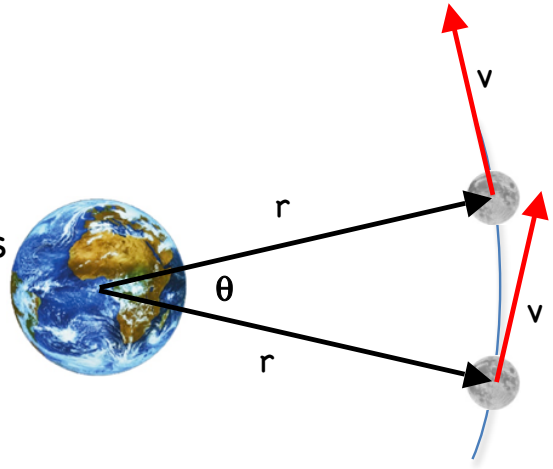


At the left is a sketch of the moon orbiting Earth. Use the center of Earth as the origin. For each of the four images of the moon:

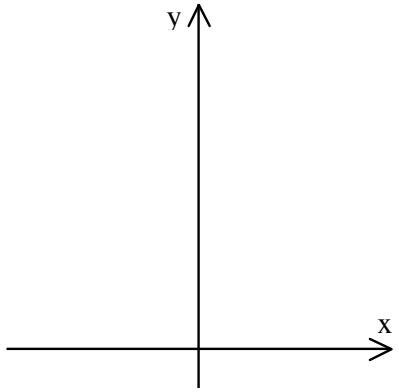
1. draw the position vector.
2. draw the velocity vector.
3. compare the lengths of each position vector?
4. compare the lengths of each velocity vector?
5. does the moon accelerate in its orbit? Explain.

Example 1:The moon is 3.84×10^8m from Earth and it takes 27.3 days or 2.36×10^6s to complete one orbit. Find (a)the magnitude of the position vector and (a)the magnitude of the velocity vector using the center of Earth as the origin.

At the right is a sketch of the moon orbiting Earth. The position and velocity vectors are shown at two times Δt apart during which the position and velocity vectors both rotate through an angle θ:



1. Draw the displacement vector $\Delta\vec{r}$. Label the triangle formed by the r vectors and Δr with an A.
2. Redraw the two velocity vectors on the coordinate systems at the right with their tails at the origin. Include the angle θ.
3. Draw the change in velocity vector $\Delta\vec{v}$. Label the triangle formed by the v vectors and Δv with a B.
4. Explain why A and B are similar triangles.
5. Find the ratio $\frac{\Delta v}{\Delta r}$ in terms of r and v. Solve for Δv.
6. Divide Δv by Δt to get the magnitude of the acceleration vector.
7. Show the result is, $a = \frac{v^2}{r}$



Example 2:A physics professor twirls a ball overhead in a circle of radius 50cm,The ball completes 5.0 revolutions per second. Find (a)the speed and (b)the acceleration of the ball.

Question: You come upon two friends arguing. The first one says that the moon orbits Earth at a constant velocity and therefore the moon is not accelerating. The second one says that since the moon in moving in a circle it must have a centripetal acceleration even though it has a constant velocity. Resolve their dispute.

Lecture 08 - Summary

Circular Motion - acceleration is directed toward the center.

Centripetal Acceleration $a_c = \frac{v^2}{r}$

Review for First Exam

Quantity	Definition	Mathematically
Position	The location of an object with respect to a coordinate system.	$\vec{r}$
Displacement	A change in position.	$\Delta\vec{r} \equiv \vec{r}_f - \vec{r}_i$ or $\Delta x \equiv x_f - x_i$ and $\Delta y \equiv y_f - y_i$
Average Velocity	The average rate of displacement.	$\vec{v} \equiv \frac{\Delta\vec{r}}{\Delta t}$ or $v_x = \frac{\Delta x}{\Delta t}$ and $v_y = \frac{\Delta y}{\Delta t}$
Speed	The magnitude of the velocity vector.	$v \equiv \lvert\vec{v}\rvert = \sqrt{v_x^2 + v_y^2}$
Average Acceleration	The rate of change of velocity.	$\vec{a} \equiv \frac{\Delta\vec{v}}{\Delta t}$ or $a_x = \frac{\Delta v_x}{\Delta t}$ and $a_y = \frac{\Delta v_y}{\Delta t}$

Kinematic equation	Missing variable
$v = v_o + at$	$x - x_o$
$x = x_o + v_o t + \frac{1}{2}at^2$	v
$v^2 = v_o^2 + 2a(x - x_o)$	t

Centripetal Acceleration $a_c = \frac{v^2}{r}$

Review for First Exam

Physics 202A Equation Sheet for Exam 1

Laws, Principles, Useful Relationships, and Other Information

The Definition of Velocity: $\vec{v} \equiv \frac{\Delta \vec{r}}{\Delta t}$

The Definition of Acceleration: $\vec{a} \equiv \frac{\Delta \vec{v}}{\Delta t}$

The Kinematic Equations:

$v = v_o + at$

$x = x_o + v_o t + \frac{1}{2} a t^2$

$v^2 = v_o^2 + 2a(x - x_o)$

Centripetal Acceleration: $a_c = \frac{v^2}{r}$

Acceleration due to gravity $g = 9.80\ m/s^2$

Earth - mass: 5.98×10^{24} kg radius: 6.38×10^6 m

Moon - mass: 7.36×10^{22} kg radius: 1.74×10^6 m

Sun - mass: 1.99×10^{30} kg radius: 6.96×10^8 m

Earth - moon distance: 3.82×10^8 m

Sun - Earth distance: 1.50×10^{11} m