PHYS 2211

Look over:
Chapter 4 Sections 1–7
Sample Problems 1, 5, 6, 7, 8, 9

PHYS 1111

Look over:
Chapters 3 Sections ~~5–7~~ -4
Examples ~~4, 5, 6, 7, 8 and 9~~
1, 2, 3, 4, 5, 6

Topics Covered

1) Kinematic Equations of Motion.
2) Projectile motion
3) Range Equation.
4) Shape of the Path taken during Projectile Motion.

3–D Motion

All objects have associated with them at any given moment in time a position ***r***, a velocity ***V***, and an acceleration ***a***.

These three properties themselves in general have three components in the ***x***, ***y***, and z directions.

Kinematic Equations

x-motion equation

$$v_x = v_{x_0} + a_x t$$

$$\Delta x = x - x_0 = \left(\frac{v_{x_0} + v_x}{2}\right) t$$

$$\Delta x = x - x_0 = v_{x_0} t + \tfrac{1}{2} a_x t^2$$

$$v_x^2 = v_{x_0}^2 + 2 a_x \Delta r_x$$

y-motion equation

$$v_y = v_{y_0} + a_y t$$

$$\Delta y = y - y_0 = \left(\frac{v_{y_0} + v_y}{2}\right) t$$

$$\Delta y = y - y_0 = v_{y_0} t + \tfrac{1}{2} a_y t^2$$

$$v_y^2 = v_{y_0}^2 + 2 a_y \Delta r_y$$

Vector Equations of Motion

$$\vec{v}_1 = \vec{v}_0 + \vec{a} t$$

$$\Delta \vec{r} = \vec{r}_1 - \vec{r}_0 = \tfrac{1}{2}(\vec{v}_0 + \vec{v}_1) t$$

$$\Delta \vec{r} = \vec{r}_1 - \vec{r} = \vec{v}_0 + \tfrac{1}{2} \vec{a} t^2$$

$$|\vec{v}_1|^2 = |\vec{v}_0|^2 + 2\vec{a} \bullet \Delta \vec{r}$$

The strategy for solving kinematic problems in two dimensions with constant acceleration is:

Resolve the vector displacements, velocities, and accelerations into components along the x and y axes and then use the separate components to help you find the thing you are looking for.

The link between theses equations is the common time (t).

If You Give an Object an Initial Horizontally Velocity

The Horizontal velocity will stay the same but the vertical velocity changes due to the acceleration of gravity.

Projectile Motion

On the surface of the Earth there is no acceleration in the horizontal direction so the equations of motion boil down to:

$$v_y = v_{y_0} + a_y t$$

$$\Delta y = \left(\frac{v_{y_0} + v_y}{2} \right) t$$

$$\Delta y = v_{y_0} t + \tfrac{1}{2} a_y t^2$$

$$v_y^2 = v_{y_0}^2 + 2 a_y \Delta y$$

$$\Delta x = v_x t$$

Example 1

1) In a local bar, a customer slides an empty beer mug down the counter for a refill. The bartender is momentarily distracted and does not see the mug, which slides off the counter and strikes the floor 1.40 m from base of the counter. If the height of the counter is 0.860 m, a) With what velocity did the mug leave the counter? b) What was the mug's velocity just before it hit the floor?

If You throw an object in to the air at an angle.

The path that the object will take is a **Parabola**.

Example 2

2)A long jumper leaves the ground at an angle of 20.0° above the horizontal and at a speed of 11.0 m/s.

a) How far does he jump in the horizontal direction?

b) What is the maximum height reached?

Example 3

3)A football is thrown from the top of a building upward at an angle of 30.0° to the horizontal and with an initial speed of 20.0 m/s. If the height of the building is 45.0 m

a) How long is it before the stone hits the ground?

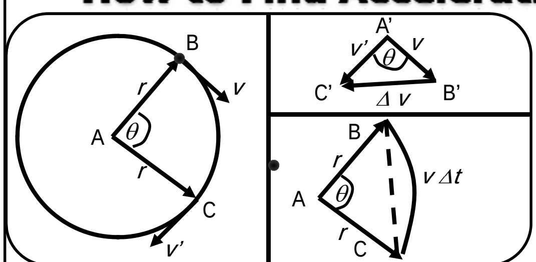
b) What is the velocity of the football just before it hits the ground?

c) How far from the building does it hit the ground?

Uniform Circular Motion

For an object moving in a circle with constant speed, called **Uniform Circular Motion**, the velocity changes continuously in direction but not in magnitude.

How to Find Acceleration



Comparing triangle ABC and A'B'C' we see that:

$$\frac{\Delta v}{v} \approx \frac{v\Delta t}{r} \Rightarrow \frac{\Delta v}{\Delta t} \approx \frac{v^2}{r}$$

$$a = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} = \frac{v^2}{r}$$

Example 4

4)A bicycle racer rides with a constant speed around a circular track *25 m* in diameter. What is the acceleration of the bicycle if its speed is *6.0 m/s*?

Summary of Chapter 4

- Projectile motion is the motion of an object near the Earth's surface under the influence of gravity.
- An object moving in a circle at constant speed is in uniform circular motion.
- It has a centripetal acceleration $a_R = \frac{v^2}{r}$