## Group Problem

You are at the Orange Bowl on January 8, 2009, where OU is playing USC for the 2008 National Championship. The score is OU 21, USC 20, and USC is lining up for a last second field goal to try to win the game. You watched the USC kicker warm up and you saw that he could kick the football with a maximum velocity of 21 m/s. He lines up for a 45-yard kick. You watch as he kicks the ball at an angle of 35° above the horizontal. Assuming he kicks the ball straight will the ball clear the 10-foot goal post, or will OU win the national championship?

Context-Rich Problems: Solutions Outline

<u>FOCUS the PROBLEM</u>
Draw a picture of the situation including ALL the information given in the problem.

$V_o = 21$ $^m/_s$

35°

$45 yd = 135 ft$

$10 ft$
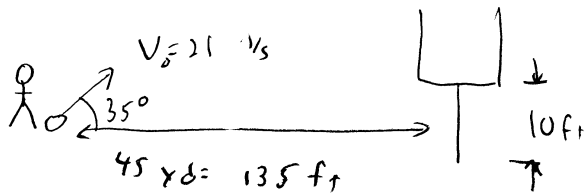
$21 ^m/_s \times \frac{100 cm}{m} \times \frac{1 in}{2.54 cm} \times \frac{1 ft}{12 in} = 68.9 \frac{ft}{sec}$

Question(s): What is the problem asking you to find?

Will the field goal be good?

Approach: Outline the approach you will use.

Use kinematic equations with $a_x = 0$, $a_y = -g$ to determine how high the ball will be when it goes 45 yds. (You could also figure out where the ball is horizontally when it is 10 ft high)

<u>DESCRIBE the PHYSICS</u>
Draw physics diagram(s) and define ALL quantities uniquely.

$+x$

$V_o = \frac{68.9 ft}{sec}$

$\theta = 35^o$

$t_o = 0$
$x_o = 0$, $y_o = 0$
$V_{ox} = V_o \cos \theta$, $V_{oy} = V_o \sin \theta$
$a_x = 0$ $a_y = -g$

$t_1 = ?$
$V_{1x} = V_{ox} = V_x$ $V_{1y} = ?$
$x_1 = 135 ft$ $y_1 = ?$

Which of your defined quantities is your Target variable(s)? $\boxed{y_1}$

Quantitative Relationships: Write equations you will use to solve this problem.

$$V_2^2 = V_1^2 + 2a(x_2 - x_1)$$

$$V_2 = V_1 + a(t_2 - t_1)$$

$$x_2 - x_1 = V_{ox}(t_2 - t_1) + \frac{1}{2}a(t_2 - t_1)^2$$

PLAN the SOLUTION
Construct Specific Equations (Same Number as Unknowns)

$$y_1 - y_0 = V_{oy}(t_1 - t_0) - \frac{1}{2}g(t_1 - t_0)^2$$

$$y_1 = V_{oy}t_1 - \frac{1}{2}g t_1^2 \qquad ① \qquad \underline{\text{Unknowns}}$$
$$y_1, t_1$$

$$X_1 - X_0 = V_x(t_1 - t_0)$$

$$X_1 = V_x t_1 = V_0 \cos\theta$$

$$t_1 = \frac{X_1}{V_0 \cos\theta} \qquad ②$$

Plug ② into ①

$$y_1 = V_0 \sin\theta\left(\frac{X_1}{V_0\cos\theta}\right) - \frac{1}{2}g\left(\frac{X_1}{V_0\cos\theta}\right)^2$$

$$= X_1 \tan\theta - \frac{1}{2}g\left(\frac{X_1}{V_0\cos\theta}\right)^2$$

Check Units

$$[L] = [L] + \frac{[L]}{[T]^2}\left\{\frac{[L]}{\frac{[L]}{[T]}}\right\}^2 = [L] \quad \text{ok}$$

EXECUTE the PLAN
Calculate Target Quantity(ies)

$$y_1 = (135 \text{ ft})(\tan 35°)$$
$$- \frac{1}{2}(32 \text{ ft/s}^2)\left(\frac{135 \text{ ft}}{68.9 \text{ ft/sec } \cos 35}\right)^2$$

$$= 3.0 \text{ ft}$$

EVALUATE the ANSWER
Is Answer Properly Stated?

Yes; in feet

Is Answer Unreasonable?

No, it is near the height of 10 ft

Is Answer Complete?

No, the kicker misses the field goal. It doesn't clear the cross-bar.   OU wins!

(extra space if needed)

Write your Group Number here and the names of the group members who are present.

Group Number:_____

Name:_____

Name:_____

Name:_____

Name:_____