# *PHYS 1307*

# SOLVING PHYSICS PROBLEMS

Many students, even if they are good at other sciences, math, or engineering, often find physics problems very difficult because they do not adopt the right approach for physics. Physics consists of a very small number of conceptually-deep basic laws that are combined with mathematical methods to solve problems in the real world; no other subject works like this. Physics problems are like mystery stories - you often don't know who dunnit until the very end.

**- Don't search for "the right equation".** You will not be able to solve a real physics problem by finding an appropriate equation and then plugging numbers into it. No self-respecting college-level teacher would assign such a problem.
**- Don't memorize.** In physics you should not need to memorize anything (equations for basic laws should be available in your book or on a formula sheet) and it will not help you solve problems. It is important you understand the meaning of equations that express basic laws, and memorization usually indicates a simple lack of this conceptual understanding.

Below is a more detailed format it is suggested you use when solving *all* physics problems, even if you are sure you know how to get the answer. This skill will help you to solve physics problems and also to explain your solution to a reader (who may be the grader, yourself 2 months later, or the Nobel Prize committee).

## D I A N A

**D**ESCRIPTION/ **D**IAGRAM – define unique symbols for unknowns sought and data given, label a diagram with your symbols, include a directed coordinate system, a few words to clarify perhaps.

**I**DEA – state the fundamental idea(s) or principle(s) of physics you will use. This can be expressed via a general equation chosen from the formula sheet. You should then write it out explicitly for the current problem using your symbols, setting to zero any symbols that vanish; do not write numbers yet!

**A**NALYSIS – Symbolically derive the unknown you want using algebra and calculus.

**N**UMBERS – now substitute data for the knowns and perform calculation of the unknown

**A**NSWER – check number makes sense, round to appropriate precision, put units

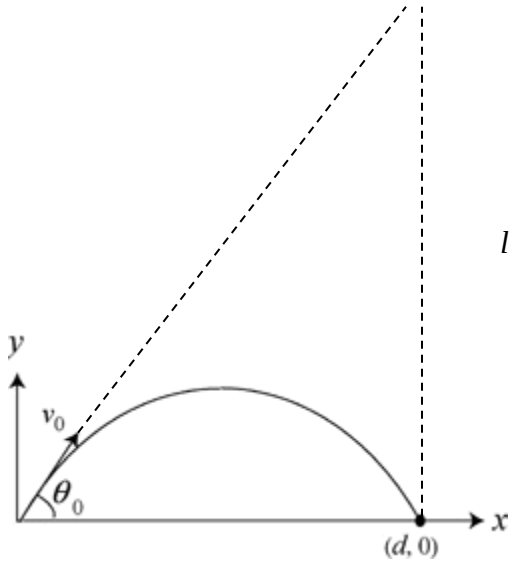
*For more detailed advice about how to approach physics problems, see Dan Styler's page* *http://www.oberlin.edu/physics/dstyer/SolvingProblems.html*

## Exemplary Solution

A rifle that shoots bullets at 460 m/s is to be aimed at a target 45.7 m away. If the center of the target is level with the rifle, how high above the target must the rifle barrel be pointed so that the bullet hits dead center? [2 sin $\theta$ cos $\theta$ = sin 2$\theta$ ]

### *Diagram/Description (2 points)*

$v_o$ = 460 m/s
$x - x_0 = d$ = 45.7 m
$a_x$ = 0 neglect drag
$a_y$ = - 9.80 m/s$^2$ free fall
$y - y_0$ = 0 (no change in $y$)




### *Idea (2 points)*

constant acceleration $\quad x - x_0 = v_{0x}\, t + \tfrac{1}{2}\, a_x\, t^2 \quad \rightarrow \quad d = v_0 \cos\theta_0\, t$
$\qquad\qquad\qquad\qquad\quad y - y_0 = v_{0y}\, t + \tfrac{1}{2}\, a_y\, t^2 \quad \rightarrow \quad 0 = v_0 \sin\theta_0\, t + \tfrac{1}{2}\, a_y\, t^2$

tan = opp/adj $\rightarrow$ $l = d \tan\theta_0$

### *Analysis (1 point)*

$x$ direction: $\quad t = d / v_0 \cos\theta_0$
$y$ direction: $\quad 0 = t\,(v_0 \sin\theta_0 + \tfrac{1}{2}\, a_y\, t\,)$ $\qquad$ cancel $t$ = 0 solution (launch time).

$v_0 \sin\theta_0 = -\tfrac{1}{2}\, a_y\, t$ $\qquad$ solve $y$ direction
$= -\tfrac{1}{2}\, a_y\, d / (\, v_0 \cos\theta_0\,)$ $\qquad$ substitute for $t$ from $x$ direction
$\sin\theta_0 \cos\theta_0 = -\tfrac{1}{2}\, a_y\, d / v_0^2$
$\theta_0 = \tfrac{1}{2} \sin^{-1} (\, - a_y\, d / v_0^2\,)$

### *Numbers (no points)*

$= \tfrac{1}{2} \sin^{-1} [\, 9.80 \text{ x } 45.7 / 4 \text{ x } 460^2\,] = 0.0606^o$
$l = 45.7 \tan 0.0606 = 0.484$

### *Answer (1 point)*

= <u>0.484 m</u> ( 3sf )