Generalized PROJECTILES

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Except for the first one (which is review), the projectile problems in this packet presented in **GENERAL FORM**. Particular numbers are not presented, although they might be included in certain answers. ***Your answers must be expressed as functions only of the variables presented in the problem and/or fundamental constants (such as "g").*** You can introduce other "dummy" variables for thought purposes, but they cannot be included in a final answer. Your final answer may well include fewer than all of the constants & variables given in the problem.

1) Numerical Projectile Review

A cannon is fired from ground level at an angle of 50° above the horizontal. The cannonball has an initial speed of 50 m/s.

Assuming the ground is level, how far from the cannon will the cannonball land?

2) The Arctan of Four

A projectile is fired from the ground at an initial speed of v_0.

At what angle should it be fired so that its horizontal "range" is precisely the same (number of meters or yards or whatever) as its peak height?

"Range" refers to the horizontal displacement traversed by the projectile by the time it has returned to the ground.

HINTs:

1. Derive an equation that expresses the dependent variable x ("range") as a function of the independent variable θ. This equation will also make reference to the constants g and v_0.

2. Independently, derive an equation that expresses the dependent variable y ("peak height") as a function of the independent variable θ. This equation will also make reference to the constants g and v_0. It might start off by having time as an independent variable, but you've got to get rid of that somehow. It's not given in the problem.

3. Set the two equal to each other and solve for θ.

3) Symmetry

A projectile is fired from the ground at an initial speed of v_0.

Prove that any projectile fired at an acute angle, θ, will experience precisely the same range as any projectile fired at an angle of $90° - \theta$ (the complement of θ).

By "prove," we mean derive: in other words, provide an algebraic demonstration. Showing that a projectile fired at angle, θ, will experience precisely the same range as any projectile fired at an angle of $90° - \theta$

How do you do that?

First, find (in general form) the range of a projectile fired at any angle θ.

Then find (in general form) the range of a projectile fired at angle $90° - \theta$.

Then show that the expressions for the two ranges are equivalent.

4) To the Max

A projectile is fired from the ground at an initial speed of v_0.

Use any combination of the result from problem 3, verbal reasoning and/or differential calculus to do the following:

Prove/argue/convince us that firing at an angle of **45°** will produce the maximum range.