

Kinematics Problem Set

Rajeev Atla

- Problem weights
 - Problem n is worth n points
 - So problem 1 is worth 1 point, problem 2 is worth 2 points, etc.
 - Total of 15 points
- Try to get as many points as you can!
- Don't forget to have fun!
- Feel free to reach out for hints
- There will be a leaderboard

§1 Problem 1

Using calculus and/or geometry, derive the equation

$$x(t) = x_0 + v_0 t + \frac{1}{2} a t^2$$

§2 Problem 2

For two vectors \mathbf{a} and \mathbf{b} , prove the following inequalities:

$$|\mathbf{a}| - |\mathbf{b}| \leq |\mathbf{a} + \mathbf{b}| \leq |\mathbf{a}| + |\mathbf{b}|$$

§3 Problem 3

A ball is thrown from the ground. The ball crosses the height h_1 twice, with T_1 seconds between crossings. Above, at a height of h_2 , the ball takes T_2 seconds between crossings. Derive an expression for g , the acceleration due to gravity, in terms of these variables.

§4 Problem 4

Bobby wants to swim across a river of width w . This river flows east to west with a velocity of v_r . In still water, Bobby can move in any direction with a speed of v_b . In what direction should Bobby move to minimize the total distance he travels. Hint: There are two cases, check both of them.

§5 Problem 5

A rabbit is at the origin and a fox is at $(0, -a)$. At $t = 0$, the rabbit begins moving with a velocity $\mathbf{v} = v\hat{x}$. Simultaneously, the fox begins running directly in the direction of the rabbit with speed v . After a long time, the distance between the two animals is d . Find d .