



ADVANCED PHYSICS CLUB

OCTOBER 1, 2023

USEFUL RESOURCES

The updates, homework assignments, and useful links for APC can be found on SchoolNova's web page:

https://schoolnova.org/nova/classinfo?class_id=adv_phy_club&sem_id=ay2023

The practical information about the club and contacts can be found on the same web page.

TODAY'S MEETING

Today we solved all the assigned problems on uniform motion. Our discussions led us to more open-ended questions continuing the story of problems 4,6 and 7. We invite you to think about these questions and play with them. Next time we are going to share the results.

FOLLOW-UP PROBLEMS

These questions are inspired by our discussions on problems 4, 6 and 7 of the previous assignment. They are less olympiad-style and more research-style - play with them and take them as far as you want!

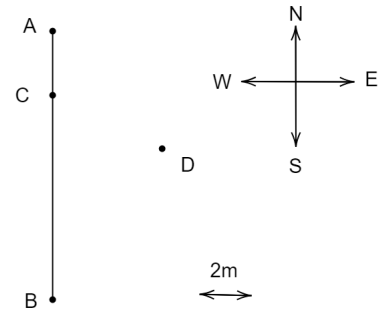
4. Modeling a human as a rectangle of some height and width, determine whether the best way to stay as dry as possible when going from a given point A to a given point B during rain is walking or running. Consider different limiting cases for the human height/width ratio.
6. Write a computer code with your favorite language/environment to visualize the trajectory of a turtle. Find numerically how many times does the distance to the center change with each full turn. Can you find the same ratio analytically to compare? Can you determine the whole trajectory analytically?
7. Take part c) of problem 7 as far as you can. Some steps you can take include finding the equation for position of the "refraction point", looking at various special cases to check that this equation reduces to something that you expect, solving the equation numerically, writing a code to visualize the optimal trajectory with the parameters that you input.

NEW HOMEWORK

Our next topic is linear motion with acceleration.

1. Imagine that you are watching a movie in reverse, so that people are walking backwards, spilled water goes back directly into the glass, etc. If you watch a scene with an accelerating car, how does velocity of the car compare to the velocity of the same car in the normal movie? How about the acceleration of the car?
To get an idea, you may check out the following Youtube channel:
<https://www.youtube.com/@moviesinreverse531/featured>
2. Upon entering an unpaved section of the road every car reduces its speed from v_1 to $v_2 < v_1$. the length of each car is l . What is the minimal distance between the cars that drivers should keep on the paved road to avoid collisions?
3. Two bodies start moving towards each other along a straight line with initial velocities v_1 and v_2 . They have accelerations a_1 and a_2 respectively and acceleration is in the opposite direction to velocity for both of them. What is the maximal initial distance between them l_{max} such that they will meet each other?
4. A bus moving on a straight road at initial speed 15 m/s is approaching a stop. It spends 20 seconds on traveling the last 350 meters before stopping. Prove that acceleration of the bus has changed direction during these 20 seconds.
5. After being released from the source, a charged particle moves distance L with constant velocity. Then it gets into a constant electric field providing the particle with deceleration a so that it eventually stops. Find the initial velocity of the particle such that the total time of its motion is minimal.

- *6. Two runners stand still at points A and B each holding one end of a long rubber cord. After a signal they start running: runner A runs with constant velocity 1 m/s to the east and runner B runs with constant acceleration to the south. An observer noticed that point C on the cord has passed through a particular point D shown on the figure. Using the scale provided on the figure, find the acceleration of runner B.



- *7. If acceleration changes, the rate of this change is called jerk: $j = \frac{\Delta a}{\Delta t}$ (acceleration changes by Δa in time Δt). For jerk 1 m/s³ what will speed be in 5 s if the initial speed was zero? What will be the distance traveled in the same amount of time? Could you think of practical situations in which it is important to consider jerk?

FOR THE NEXT MEETING

IMPORTANT: The next club's meeting is at 3:30pm, via Zoom, on Sunday, **October 15**.