PHY-101 : Assignment 1

Problem 1 (100 points) :
(a) Define distance and displacement. Differentiate between these two quantities.
(b) Define velocity and use it to define speed. Explain the difference between them.
(c) Provide examples of physical quantities that are scalars. Do the same for vector quantities (other than the ones mentioned above).
(d) What are the S.I. units for length, mass and time?
(e) State and describe the three basic equations of kinematics. What sort of acceleration is most fundamental and forms the core principle of these equations?

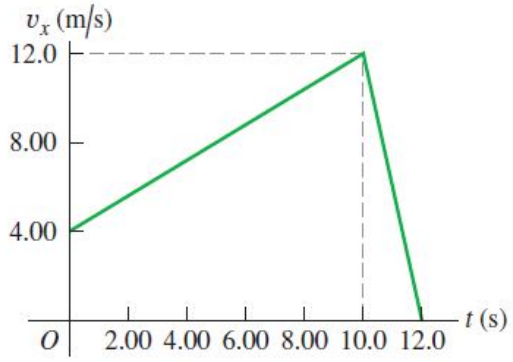
Problem 2 (10 points) : An automobile and a truck start from rest at the same instant, with the automobile initially at some distance behind the truck. The truck has a constant acceleration of 2.1 m/s^2, and the automobile an acceleration of 3.4 m/s^2. The automobile overtakes the truck after the truck has moved 40 m. (a) Calculate the time taken by the automobile to overtake the truck. (b) Calculate the initial distance between the automobile and the truck when they were at rest. (c) Compute the speed of each vehicle when they are abreast. (d) On a single graph, sketch the position of each vehicle as a function of time. Take $x = 0$ to be the initial location of the truck.

Problem 3 (10 points) : A sprinter can maintain maximum acceleration for 2 s and his maximum speed is 10 m/s. After reaching this maximum speed, his acceleration becomes zero,and then he runs at constant speed. Assume that his acceleration is constant during the first 2 s of the race, that he starts from rest, and that he runs in a straight line. (a) Calculate the distance run by the sprinter when he reaches his maximum speed. (b) Compute the magnitude of his average velocity for a race of the following lengths: (i) 50 m, (ii) 100 m, (iii) 200 m.

Problem 4 (10 points) : A jet fighter pilot wishes to accelerate from rest at a constant acceleration of $5g$ to reach Mach 3 (three times the speed of sound) as quickly as possible. Experimental tests reveal that he will black out if this acceleration lasts for more than 5 s. Use 331 m/s for the speed of sound. (a) Will the period of acceleration last long enough to cause him to black out? (b) What is the greatest speed he can achieve with an acceleration of $5g$ before blacking out?

Problem 5 (10 points) : An automobile speeding at 100 km/h passes a stationary police cruiser. The police officer starts to move her cruiser in pursuit 8 s after the automobile passes. She accelerates uniformly to 120 km/h in 10 s, and then continues at uniform speed until she catches the speeder. (a) Calculate the distance of the speeder from the cruiser when the latter starts. (b) Calculate the distance of the speeder from the cruiser when the latter reaches uniform speed of 120 km/h. (c) Determine the time taken by the cruiser take to catch the speeder. At this instant, compute their mutual distance from the starting position of the cruiser.

Problem 6 (10 points) : A deer runs along a straight line (the x-axis) with the velocity-time graph shown below:



(a) For the twelve seconds of its motion, compute the distance traveled by the deer and its displacement. (b) For the first ten seconds of motion, determine the velocity as a function of time. Do the same for the last two seconds of motion. (c) Using your results to (b), calculate the acceleration as a function of time and sketch its graph.

Problem 7 (50 points) : The following exercises from the attached file.

Section 14.2: Exercises 1-5, 9-12, 15-18, 36, 37 and 42.

Section 14.3: Exercises 1, 3, 4, 9, 11, 17-24.

Section 14.4: Exercises 4, 5, 6, 11-14.