

Name: _____ “Alphabetic” Student No.:

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HOMEWORK #1 Due on Tuesday, Sept. 6 by 5:30pm (NO LATE homework accepted!)

Please follow all of the homework formatting rules described in the syllabus (or you will lose points!)

Attach this cover sheet to your submitted homework and enter your “alphabetic” student number in the box above. This number will be given to you on Thursday (9/1).

Problem #1: Motion of Car with Different Constant Accelerations

While driving your car, you are merging onto a highway and at time $t = 0$ **speed up** from 10 m/s to 30 m/s over 10 s. You then **drive** for 20 s before encountering a construction zone. You then **slow down** at 1 m/s^2 until reaching the “safe speed” of 20 m/s.

- (a) Accurately draw the **position** (x), **velocity** (v), and **acceleration** (a) vs. time **graphs** for your car’s motion from the time you start speeding up until the time you reach the safe speed. Arrange the graphs vertically on the page with the position graph located at the top and the acceleration graph located at the bottom (see recitation sheet on 8/28 for an example). Graph paper is recommended.
- (b) Draw the corresponding **motion diagram** for your car’s motion with x -positions marked and labeled every 5 s. Label all average v vectors between the x -positions and the corresponding a vectors (see recitation sheet on 8/28 for an example).
- (c) Calculate the **total distance** x traveled from $t = 0$ when you started speeding to when you reached the “safe speed.” In your work, clearly show the distances (Δx_1 , Δx_2 , Δx_3) for each of the time periods (#1 = speed up, #2 = constant speed, #3 = slow down).

Problem #2: Motion of Two Cars

You and a friend are driving your cars along a straight road. You (car A) are traveling at a constant speed of 25 m/s. Your friend (car B) is 300 m behind you and starts to accelerate at 2 m/s^2 from a speed of 20 m/s.

- (a) Draw an initial “**picture**” of the problem with all the relevant variables and their numerical values indicated next to each car, e.g. accelerations a_A and a_B , initial velocities v_{A0} and v_{B0} , and initial locations x_{A0} and x_{B0} . Assume that you are located at the origin and your friend is at $x_{B0} = -300 \text{ m}$.
- (b) Draw a **motion diagram** of the problem from when your friend starts accelerating to when he catches up with you. Draw and label at least (5) x -position “dots” with TWO DIFFERENT colors for Car A and Car B. Draw and label the average velocity vectors between the x -positions and indicate the uniform acceleration for each car.
- (c) Sketch the **position** (x), **velocity** (v), and **acceleration** (a) vs. time **graphs** for both cars for the motion indicated in part (b). Arrange the three graphs vertically on the page with the position graph located at the top and the acceleration graph located at the bottom (see recitation sheet on 8/28 for an example).
- (d) Write the x -equations for you (car A) and your friend (car B) with the initial position and velocity values substituted.
- (e) Using the equations from part (d), find the time at which your friend “catches up” to you.

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Problem #3: Vertical Motion of a Thrown Object

At time $t = 0$, a ball is thrown upward from the ground with an initial velocity of 20 m/s.

- (a) Draw the motion diagram for the ball’s motion with at least (7) y -positions marked and labeled. Label all average v vectors between the x -positions and the corresponding a vectors (see p. 20 in book for an example)
- (b) Find the time t at which the ball reaches its apex (i.e., highest point). Show all work algebraically and then substitute numerical values at the end.
- (c) Find the largest height y_{\max} reached by the ball at its apex.
- (d) Find the time at which the ball reaches 4 m during its ascent.

Problem #4: Vertical Motion of Two Falling Objects

You drop two water balloons off the side of a building. Balloon A is simply “let go” and takes 4 s to hit the ground. Balloon B is launched downwards using a sling shot and takes only 3 s to hit the ground.

- (a) Draw the **motion diagrams** for Balloons A and B. The y -positions for each balloon should be marked every second and be consistent with each other. Label all average v vectors between the y -positions and the corresponding a vectors.
- (b) Find the **height h** of the building. Start from the y -equation of motion for Balloon A and assume that the **origin** is located on the **ground**. Remember to show all your work algebraically before substituting numerical values.
- (c) Find the initial velocity v_{B0} of the “launched” Balloon B.
- (d) Find the final velocity v_B of Balloon B when it reaches the ground.