Physics 8, Fall 2019, Homework #2.

Due at start of class on Friday, September 13, 2019

Problems marked with (*) must include your own drawing or graph representing the problem and at least one complete sentence describing your reasoning.

Remember **online response** at `positron.hep.upenn.edu/q008/?date=2019-09-13`

1. (§3.5) You start your car from rest and accelerate at a constant rate, heading east. Your speed is 22.5 m/s after 73.5 s. (a) What is your acceleration? (State both magnitude and direction.) (b) How far do you travel during these 73.5 s?

2. (§3.6) An astronaut is on a planet on which the acceleration due to gravity is unknown. To find this acceleration, she drops a rock, which falls 3.55 m in 2.25 s. What is the magnitude of acceleration due to gravity on this planet?

3. (§3.6) With what minimum speed must a ball be thrown straight up in order to reach a height of 23.5 m above the launch position? How many seconds does the ball take to reach this height? (Neglect air resistance.)

4*. (§3.6) On a top-secret mission, an espionage agent prepares to drop a canister of exposed film from a bridge railing 33.8 m to the deck of a speedboat approaching on the river. Channel markers are spaced regularly along the river (with one of them just below the drop position), and the boat is passing them at the rate of 1 marker every 0.875 s. How many markers away should the boat be when the agent drops the film?

5*. (§3.7) A woman steps outside one winter day to go to work. Her icy driveway is 12.5 m long from top to mailbox, and it slopes downward at 11.0° from the horizontal. She sets her briefcase on the ice at the top while opening the garage, and it slides down the driveway. (a) What is its acceleration? (b) How many seconds does it take to get halfway to the mailbox? (c) How many seconds (after setting it down) until it reaches the mailbox? (d) What is its speed at the instant it reaches the mailbox?

6. (§3.8) An object moves along the x axis according to the equation $x(t) = bt^3 + ct^2 + dt + e$, where $b = 2.75\,\mathrm{m/s^3}$, $c = -15.1\,\mathrm{m/s^2}$, $d = 21.3\,\mathrm{m/s}$, and $e = 25.2\,\mathrm{m}$. (a) What are its instantaneous velocity and instantaneous acceleration at t=2.2 s? (Either write as a vector or write components v_x and a_x.) (b) What are its average velocity and average acceleration during the interval from $t_i = 2.2\,\mathrm{s}$ to $t_f = 4.2\,\mathrm{s}$?

7*. During a blackout, you are trapped in a tall building. You want to call rescuers on your cell phone but can't remember which floor you're on. You pry open the doors to the elevator shaft, stoop down to floor level, drop your keys down the shaft, and hear them hit bottom at ground level 3.67 s later. (a) Making a simple calculation and remembering that the ground floor is numbered floor 1 (conventional in the USA), you determine which floor you're on. What floor is that? (Take the distance between flights to be 3.0 m.) (b) Before you make that phone call, however, you realize you've forgotten that the sound of the impact at the bottom travels up the shaft at 343 m/s, and so you redo your calculation. What floor number do you tell the rescuers? (The challenge here is explaining your reasoning for part (b)!)

8. A rock dropped from the top of a building travels 15.2 m in the last second before it hits the ground. How high is the building?

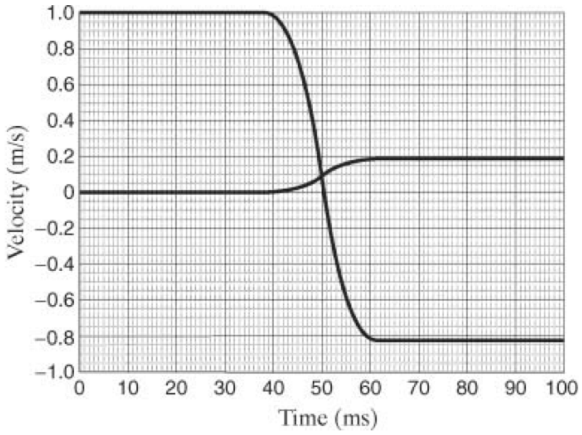
(Chapter 4 problems)

9*. Two male moose charge head-on at each other with the same speed and meet on an icy patch of tundra. As they collide, their antlers lock together and the two slide together with one-half of their original speed. (a) What is the ratio of their inertias (i.e. the ratio of their masses)? (b) In which direction do they slide after colliding?

10*. A load of coal is dropped vertically from a bunker into a railroad hopper car of inertia $8.7 \times 10^3\,\mathrm{kg}$ coasting at 0.35 m/s on a level track. The car's speed is 0.15 m/s after the coal falls. What is the inertia (i.e. the mass) of the load of coal? (Since we are analyzing only the horizontal motion, we can consider the coal+car system to be isolated.)

11. In some collisions, the velocity of one participant changes little while

that of the other changes a lot, as the figure below illustrates. (a) In which direction (positive or negative) are the objects moving before the collision? (b) After the collision? (c) What is the ratio of the inertia of the larger object to the inertia of the smaller object? (d) Does friction play an important role in this collision? (Explain what feature of the graph would indicate whether or not friction is negligible here. Hint: non-negligible friction would cause moving objects to slow down, before, during, and after the collision.)



12*. Draw diagrams that show the initial and final velocity vectors and initial and final momentum vectors when a rapidly moving golf ball hits (a) a golf ball at rest or (b) a basketball at rest. In each case, assume that the golf ball moves along the line connecting the centers of the two balls. (The mass of a basketball is about 14× the mass of a golf ball.)

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(Extra credit on next page, if you're intereseted.)

XC1*. Optional / extra-credit. (§3.5) Two cars are moving at 97.0 km/h, one behind the other, on a rural road. A deer jumps in front of the lead car, and its driver slams on the brakes and stops. What minimum initial distance between the rear of the lead car and the front of the second car is required if the second car is to stop before hitting the lead car? Assume that the acceleration is the same for both cars and that the driver of the second car begins braking 0.600 s after the lead car begins braking.

XC2*. Optional / extra-credit. (§3.7) You are playing table air hockey with a friend. The puck is sitting at rest in her goal when she suddenly lifts her end of the table by 0.567 m. The puck slides down the tilted surface into your goal, 3.52 m away. (a) What is the magnitude of the puck's acceleration as it slides? (b) How many seconds does it take the puck to reach your goal? (c) With what speed does the puck hit your goal?

XC3*. Optional / extra-credit. Hold a dollar bill with its short sides parallel to the floor, and have a friend hold the thumb and forefinger of one hand on either side of the bottom edge, with the thumb and finger slightly apart. Offer your friend the following deal: she can keep the dollar if she can catch it between her thumb and finger after you release it. Most people cannot catch the bill. Use this information (and your measurement of the length of the long side of a dollar bill) to calculate a typical minimum reaction time.

XC4*. Optional / extra-credit. From a promontory overhanging a lake, you throw a stone that enters the water vertically at 16.5 m/s. You hear the splash 2.75 s after you release the stone. (a) What was the stone's initial velocity? (b) Did you throw the stone downward or upward? (c) From what height above the lake surface did you release the stone?

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