

Physics 20 Problem Set 2

Harry Nelson

**due Monday, October 11, by 5pm
to the Physics 20 Boxes in Broida Hall's Lobby**

Course Info: The instructor is Harry Nelson, the TAs are Hyejin Ju and Yoni BenTov. A web page for the course is set up at <http://hep.ucsb.edu/courses/ph20>.

We meet MWF 10:00-10:50am in 1640 Broida. There are **three discussion sections**, and attendance at the one you've registered for is mandatory.

The text for the course is 'An Introduction to Mechanics' by Kleppner and Kolenkow. (KK). This is a hard textbook, but rewarding. Our plan is to cover much of the first five chapters of this text. The 4th edition of Resnick, Halliday, and Krane 'Physics' (RHK4) has more detailed explanations of many topics, so is a good reference. Both texts are available in the library under Physics 20 reserve.

Working problems is crucial to the understanding of physics. Expect to spend at least 12 hours a week outside of class studying and working problems. It is good to work with other students to understand how to solve problems, but **write up your solutions independently and originally; don't copy other work and use it as your own, from another student or off the web... that is, well, cheating, with potentially dramatic penalties.**

Please make your work neat, clear, and easy to follow. It is hard to grade sloppy work accurately. Generally, make a clear diagram, and label quantities. Derive symbolic answers, and then plug in numbers after a symbolic answer is available.

These problems pertain to the second three lectures, and the corresponding reading is really Chapter 2 of RHK4, which is an expanded version of pages 13-14 in KK.

1. For many months, a well-known high-energy physicist commuted weekly between Boston, Massachusetts and Geneva, Switzerland, the two cities being separated by a distance of 4000 miles. What was the physicist's average speed during this period? Do you need to know the speed of the airplane to solve this problem? (RHK4 2.5)
2. The position of a particle moving along the x axis is given in centimeters by $x = 9.75 + 1.50t^3$, where t is in seconds. Consider the time interval $t = 2$ to $t = 3$ s and calculate:
 - (a) the average velocity;
 - (b) the instantaneous velocity at $t = 2$ s;
 - (c) the instantaneous velocity at $t = 3$ s;
 - (d) the instantaneous velocity at $t = 2.5$ s;
 - (e) the instantaneous velocity when the particle is midway between its positions at $t = 2$ and $t = 3$ s. (RHK4 2.13)
3. How far does the runner whose velocity-time graph is shown in Fig. 1 travel in 16 s? (RHK4 2.14)
4. What is the acceleration of the runner in Fig 1 at $t = 11$ s?

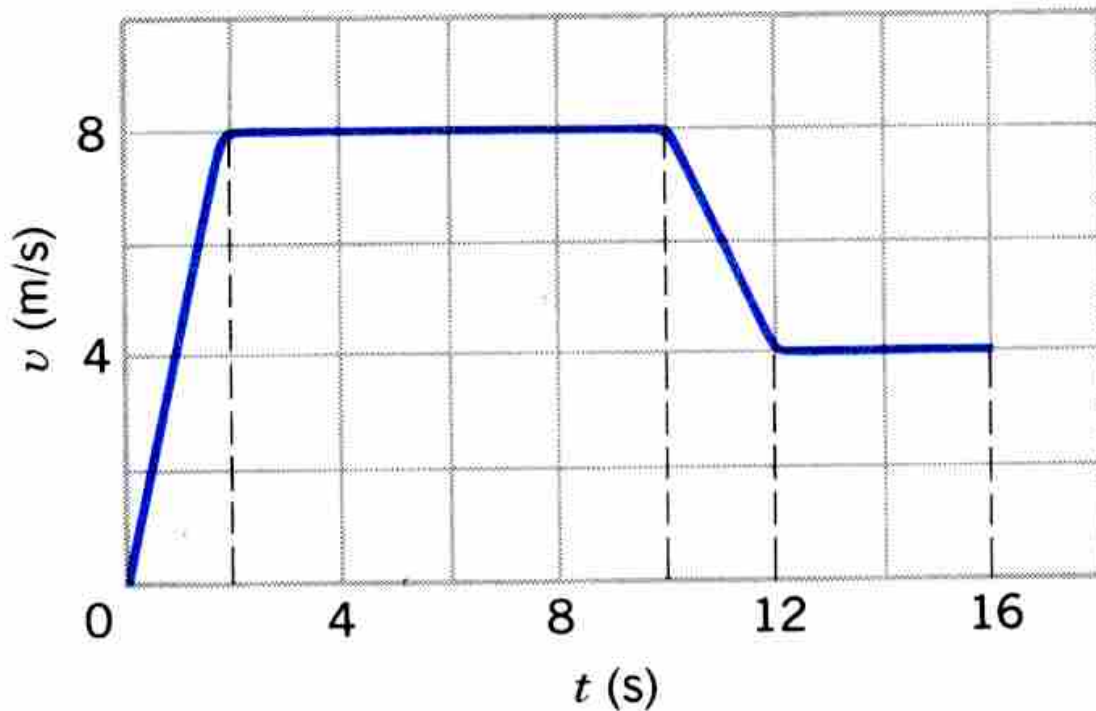


Figure 1: Problems 3 and 4.

5. In a video game, a spot is programmed to move across the screen according to $x = 9.00t - 0.750t^3$, where x is the distance in centimeters measured from the left edge of the screen and t is the time in seconds. When the spot reaches the screen edge, at $x = 0$ or $x = 15$ cm, it starts over.
- At what time after starting is the spot instantaneously at rest?
 - Where does this occur (give the x) ?
 - What is the acceleration when this occurs?
 - In which direction does it move in the next instant after coming to rest?
 - When does it move off the screen? (RHK 2.28)
6. A rocketship in free space moves with constant acceleration equal to 9.8 m/s^2 .
- If it starts from rest, how long will it take to acquire a speed one-tenth of the speed of light?
 - How far will it travel in so doing?
- The speed of light is $3.0 \times 10^8 \text{ m/s}$. (RHK 2.30)
7. You are called upon to give advice to a lawyer concerning the physics involved in one of their cases. The question is whether a driver was exceeding a 30-mile/hour speed limit before he made an emergency stop, brakes locked and wheels skidding. The length of the skid marks on the road was 19.2 ft. The police officer made the assumption that the maximum deceleration of the car would not exceed the acceleration of a freely falling body ($=32 \text{ ft/s}^2$) and did not give the driver a ticket. Was he speeding? Explain. (RHK4 2.38)