Name: SOLUTIONS

PHYS 1210-02 Quiz 1

You may use a 3"×5" note card written on both sides and a calculator. You have a maximum of 60 minutes.

Don't worry too much about the relative point values of questions; the points matter within standards, not overall.

Some equalities you may find useful are

1 hour = 60 min = 3600 s
1 mile = 5280 ft = 1609 meters = 8 furlongs
1 meter = 39.37 in = 3.281 ft
1 furlong = 660 feet

1. (4 points) The only stretch of Interstate 95 where the speed limit is 75 miles per hour is between Bangor, Maine and the Canadian border. What is 75 miles per hour in meters per second? Show your work.

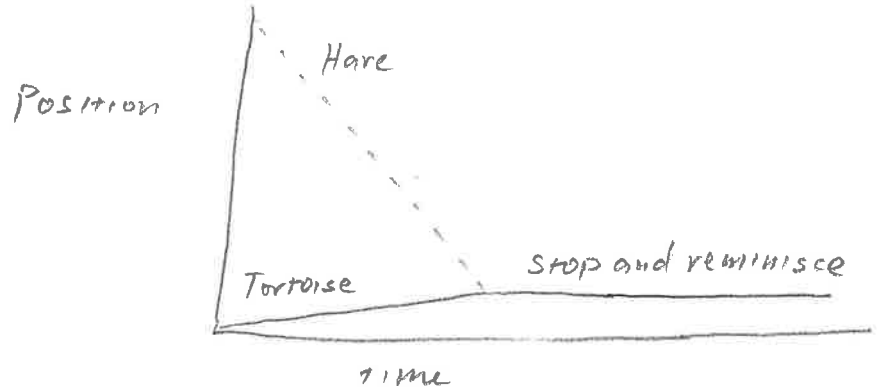
$$75\ \frac{\text{mi}}{\text{h}} \cdot \frac{1609\ \text{m}}{\text{mi}} \cdot \frac{1\ \text{h}}{3600\ \text{s}} = \boxed{33.52\ \text{m/s}}$$

2. (4 points) The **acre** is an Imperial unit of land area equivalent to 0.1 square furlongs. (I am not making this up.) In the USA, large volumes of water, such as in lakes, are counted in acre-feet, where one acre-foot is the volume enclosed in a box one acre in area and one foot thick. How many cubic meters are in one acre-foot? Show your work.

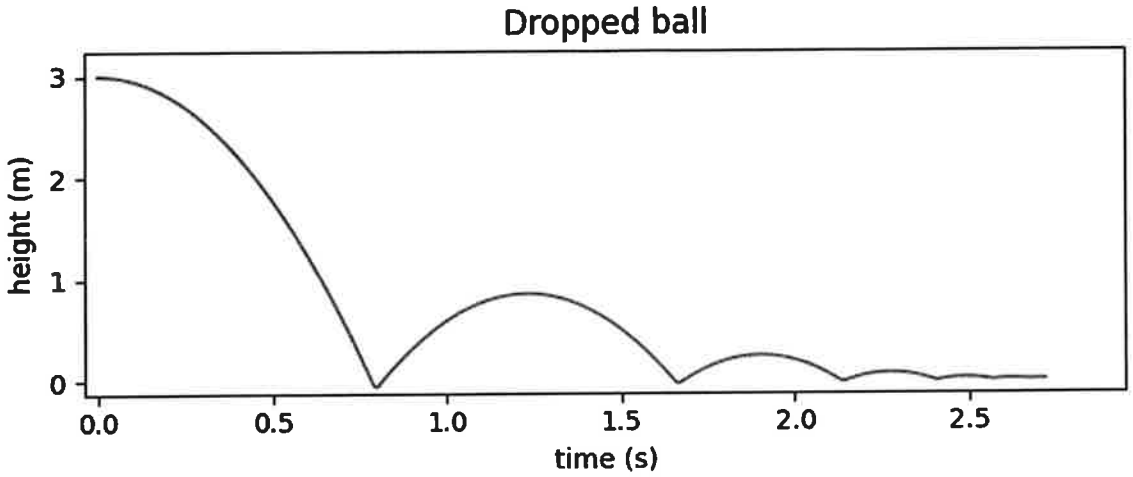
$$\text{acre}\cdot\text{ft} \cdot \frac{0.1\ \text{furlong}^2}{\text{acre}} \cdot \left(\frac{660\ \text{ft}}{\text{furlong}}\right)^2 \cdot \left(\frac{\text{m}}{3.281\ \text{ft}}\right)^3 = \boxed{1234\ \text{m}^3}$$

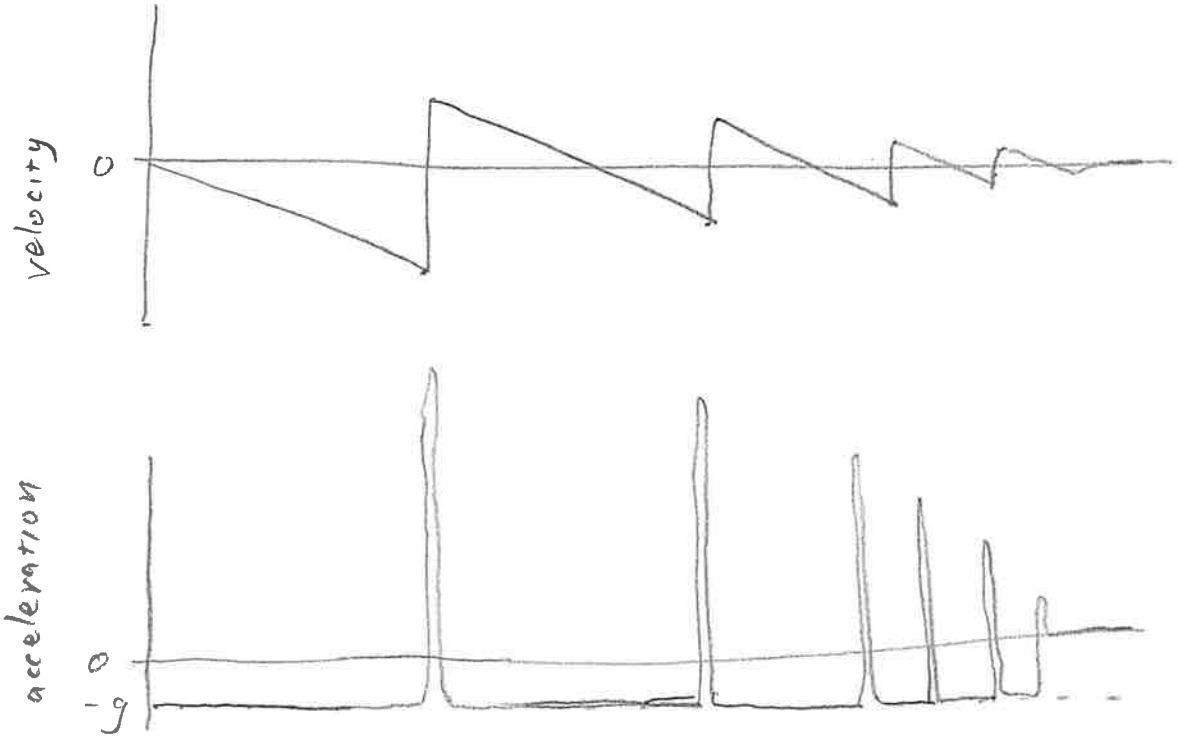
3. (2 points) Long after their famous race, the Tortoise and Hare spot each other across a field and "run" (The Tortoise can't run. Sad!) toward each other to shake hands (Neither of them has hands. Sad!). The Hare travels faster than the Tortoise. Make a position-time plot to describe their interaction.

Here's one possibility:



4. Below is a position-time graph. Underneath it,
   a. (2 points) Draw a velocity-time graph for the same motion,
   b. (2 points) Draw an acceleration-time graph for the same motion, and
   c. (2 points) Describe the motion in words.





The ball drops from rest at a height of 3m, accelerates downward and rebounds from the floor at 0m. After each rebound, it accelerates downward again. With each rebound, it bounces to a lower height than before.

5. Col. John Paul Stapp set a human land speed record on the Sonic Wind 1 rocket sled at the Holloman Air Force base on December 10, 1954. The sled accelerated from rest to a speed of 282 meters per second in 5.0 seconds, then slowed to a stop in 1.4 seconds.

   a. (2 points) What was the magnitude of the sled's acceleration as it was slowing to a stop?

$$a = \frac{\Delta v}{\Delta t} = \frac{-282\ m/s}{1.4\ s} = -201.4\ m/s^2$$

magnitude is absolute value = **201.4 m/s**

   b. (2 points) How far did the sled travel from start to stop?

$$\Delta x = \Delta x_1 + \Delta x_2 = \tfrac{1}{2}(0+v)\Delta t_1 + \tfrac{1}{2}(v+0)\Delta t_2 = \tfrac{1}{2}v(\Delta t_1 + \Delta t_2)$$

$$= \tfrac{1}{2}(282\ m/s)(5.0\ s + 1.4\ s) = \tfrac{1}{2}(282\ m/s)(6.4\ s) = \boxed{902.4\ m}$$

   c. (2 points) What was the sled's average speed from start to stop?

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{902.4\ m}{6.4\ s} = \boxed{141\ m/s}$$

6. A truck travels along a rocky road at an average speed of 15.0 mi/h for 20 minutes. Then it travels on a rural road for 26 minutes at an average speed of 70 mi/h. After that, it travels on a highway at an average speed of 80 mi/h for 30 minutes.

   a. (0 points) What is the total time of the truck's journey?

$$\Delta t = \Delta t_1 + \Delta t_2 + \Delta t_3 = 20\ min + 26\ min + 30\ min = \boxed{76\ min}$$

$76\ min \frac{1\ h}{60\ min} = 1.2\overline{6}\ h$; $20\ min = \frac{1}{3}\ h$; $26\ min = 0.4\overline{3}\ h$; $30\ min = \frac{1}{2}\ h$

   b. (2 points) How far does the truck travel?

$$\Delta x = \Delta x_1 + \Delta x_2 + \Delta x_3 = v_1 t_1 + v_2 t_2 + v_3 t_3$$

$$= (15\tfrac{mi}{h})(\tfrac{1}{3}h) + (70\tfrac{mi}{h})(0.4\overline{3}\ h) + (80\tfrac{mi}{h})(\tfrac{1}{2}h) = (5 + 30.\overline{3} + 40)\ mi = \boxed{75.\overline{3}\ mi}$$

   c. (2 points) What is the truck's average speed over its entire journey, in miles per hour?

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{75.3\ mi}{1.26\ h} = \boxed{59.4\ mi/h}$$