Phys 1100 Fall 2013 MW9 Exam #1 Name:_____

You may use your calculator. You may not consult books or notes. You must show your work. **Box or circle your answers**. No partial credit is given unless so indicated.

1. (20 points) Express the following in SI units, with appropriate notation and rounding. (1 cm = 0.010000 m; 1 in = 2.5400 cm; 1 km = 1,000.0 m)

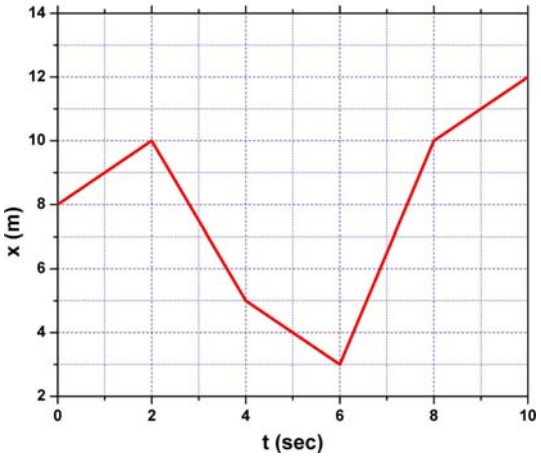
(a) $\dfrac{(4.78\times10^{-3}\,km^2)(8.5871\times10^{6}\,s^2)}{5.1\ (in/s)}=?$

$$=\frac{(4.78\times10^{-3}\,km^2)\left(\dfrac{1000\,m}{1km}\right)^2(8.5871\times10^{6}\,s^2)}{5.1\dfrac{in}{s}\left(\dfrac{2.54cm}{1in}\right)\left(\dfrac{1m}{100cm}\right)}=\boxed{3.2\times10^{11}\,m\,s^3}$$

(b) $24.00\,km+170.0\,m+3.32\,cm=?$

$$=2400\,m+170.0\,m+0.0332\,m=\boxed{2.417\times10^{4}\ m}$$

2. (30 points) From the figure depicting the position of an object in a one-dimensional motion along the x-axis, determine the following quantities. (Express your answers with two significant figures. Do not forget about units and signs.)



(a) The displacement for the interval t = 4 s to t = 8 s.

$\Delta x = x_{8s} - x_{4s} = 10m - 5m = 5.0\ m$

(b) The average velocity for the interval t = 4 s to t = 8 s.

$$\bar{v} = \frac{10\,m - 5m}{8s - 4s} = 1.3\ m/s$$

(c) The instantaneous velocity at t = 1s.

Use the range 0 - 2 s to find the slope:

$$v_{1s} = \frac{10m - 8m}{2s - 0s} = 1.0\,m/s$$

(d) The average acceleration for the interval t = 1s to t = 3s.

The instantaneous velocity at t=1s is already known to be 1.0 m/s from (c). Need to also find the instantaneous velocity at t = 3s.

$$v_{3s} = \frac{5m - 10m}{4s - 2s} = -2.5\,m/s$$

$$\bar{a} = \frac{v_{3s} - v_{1s}}{t_f - t_i} = \frac{-2.5m/s - 1.0m/s}{3s - 1s} = -1.8\ m/s^2$$

(e) The instantaneous acceleration at t= 3s.

$a_{7s} = 0\ m/s^2$, because the velocity is constant (-2.5m/s) in the range t=2 s to t=4 s.

3. (22 points, partial credit) A hot-air balloon has just lifted off and is rising at the constant rate of 1.5 m/s. Suddenly one of the passengers realizes she has left her camera on the ground . A friend picks it up and tosses it straight upward with an initial speed of 13 m/s, when the passenger is 2.5 m above her friend. The passenger misses the camera on its way up but catches it on the way down. How high is she when she catches the camera?

Solution (Problem 2-110)

Assume up is positive y, ground is at y=0, and the camera is tossed at t=0.
The position of the camera is

$$y = 0 + 13t - \tfrac{1}{2}9.8t^2 \qquad (1)$$

The position of the passenger is

$$y = 2.5 + 1.5t \qquad (2)$$

A catch is made when those two are the same,

$$13t - \tfrac{1}{2}9.8t^2 = 2.5 + 1.5t$$

$$4.9t^2 - 11.5t + 2.5 = 0$$

$$t = \frac{11.5 + \sqrt{11.5^2 - 4*2.5*4.9}}{9.8} = 2.1\,s\,,$$

where we have chosen the plus sign for the quadratic root. Plugging into Eq. (2) or (1) above, the passenger is at

$$\boxed{y = 2.5 + 1.5 \times 2.1 = 5.7\ m}$$

4. (28 points, partial credit) A cheetah can accelerate from rest to 25.0 m/s in 6.22 s. Assuming constant acceleration, (a) how far has the cheetah run in this time? (b) After sprinting for just 2.00 s, what is the cheeta's speed? (c) Calculate the distance covered by the cheetah in the first 2.00 s. (d) Calculate the distance covered by the cheetah in the next 4.22 s.

Solution: (Problem 2-48)

The constant acceleration of the cheetah is

$$a = \frac{25m/s - 0m/s}{6.22s} = 4.02m/s^2$$

(a) $\Delta x = \left(\frac{25m/s + 0m/s}{2} \right) \times 6.22s = 77.8m$

(b) $v_{2s} = 0 + a*2s = 4.02*2.00 = 8.04m/s$

(c) $\Delta x_{2s} = \frac{4.02}{2} \times 2^2 = 8.04m$

(d) 77.8 - 8.04 = 69.8m