PHY 131 Fall 2018

TEST #2

(100 points)

Name________________________________

$x = at^2/2 + v_i t$ $x = v_{avg}\, t$ $v_f^2 = v_i^2 + 2ax$ $v_f = v_i + at$

3.28 ft = 1m 1609 m = 1 mile 1 hr = 60 min = 3600 sec 5280 ft = 1 mile

Use g = 10 m/s². Ignore friction and air resistance for each of these problems.

SHOW YOUR WORK and BOX YOUR ANSWER!

1. (50 points) A ball is thrown straight up in the air from a height of 1.0 meter above the ground at a speed of 12 m/s. Defining the ground as $h = 0$, the release point is at $h = 1.0$ m. One second into its *descent*, the ball enters a net, which decelerates it at a constant rate of 25 m/sec each sec.
   a) What is the velocity of the ball when it *just* reaches the net?
   b) What is the maximum height (with respect to the ground, which is defined as h = 0 m) that the ball reaches?
   c) At what height above the ground does the ball come to a stop in the net?
   d) What is the acceleration of the ball at its peak?
   e) Sketch position-time, velocity-time, and acceleration-time graphs for the vertical travel of the ball on the graphs provided. The positive direction is upward. Clearly label relevant time, position, velocity, and acceleration values.

a) If it is 1.0 seconds into its decent, the velocity must be 10 m/sec downward.

b) During the upward flight, the average speed is 6 m/sec and it takes 1.2 seconds for gravity to stop it. The distance of the upward flight is

$$y = v_{avg}t = (6\ \text{m/sec})(1.2\ \text{seconds}) = 7.2\ \text{meters}$$

Add the 1.0 meters because it was released 1.0 meters above the ground gives 8.2 meters

c) The ball hits the net with a speed of 10 m/sec and is slowed down at 25 m/sec each second. The distance to stop can be determined with

$$v_f^2 = v_i^2 + 2ay = 0 = (10\ \text{m/sec})^2 + 2(-25\ \text{m/sec}^2)y$$

The stopping distance in the net is thus 2.0 meters.

So, the peak of the flight of the ball is 8.2 m above the ground and after falling for one second it hits the net. In this one second, it travels

$$y = v_{avg}t = (5\ \text{m/sec})(1\ \text{seconds}) = 5\ \text{meters}$$

Therefore, the ball stops 1.2 meters above the ground.

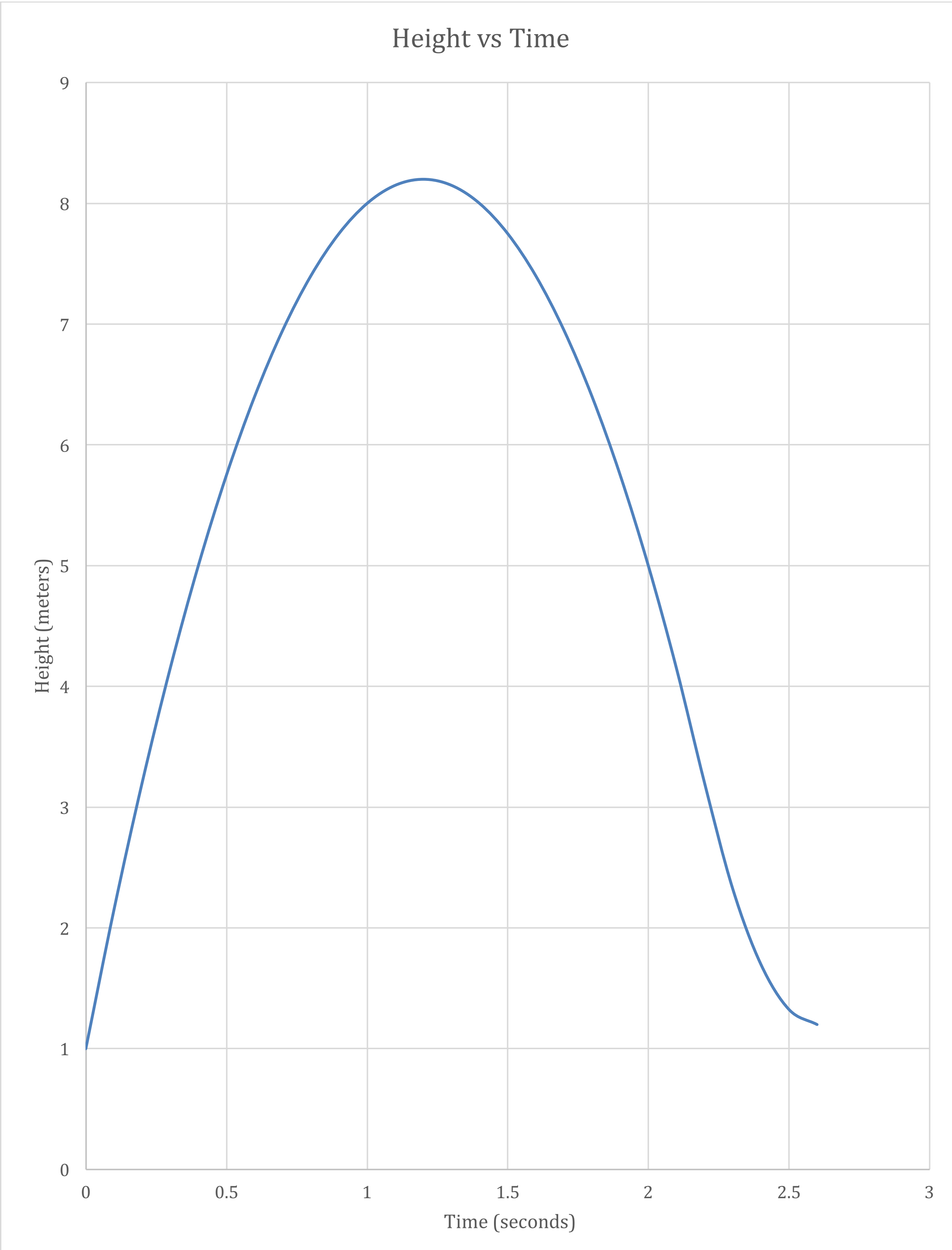
Answers with units:

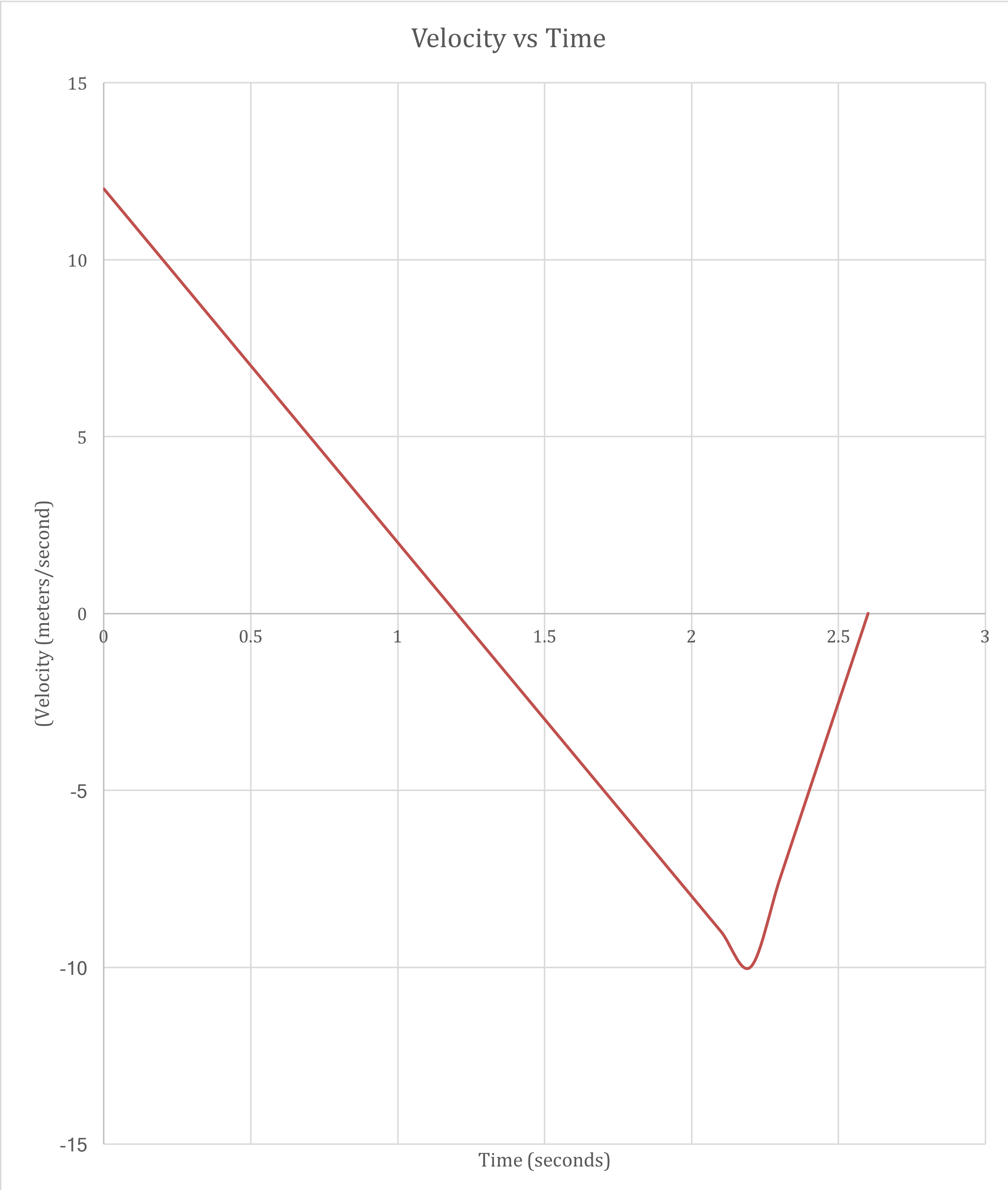
a) **10 m/sec downward**

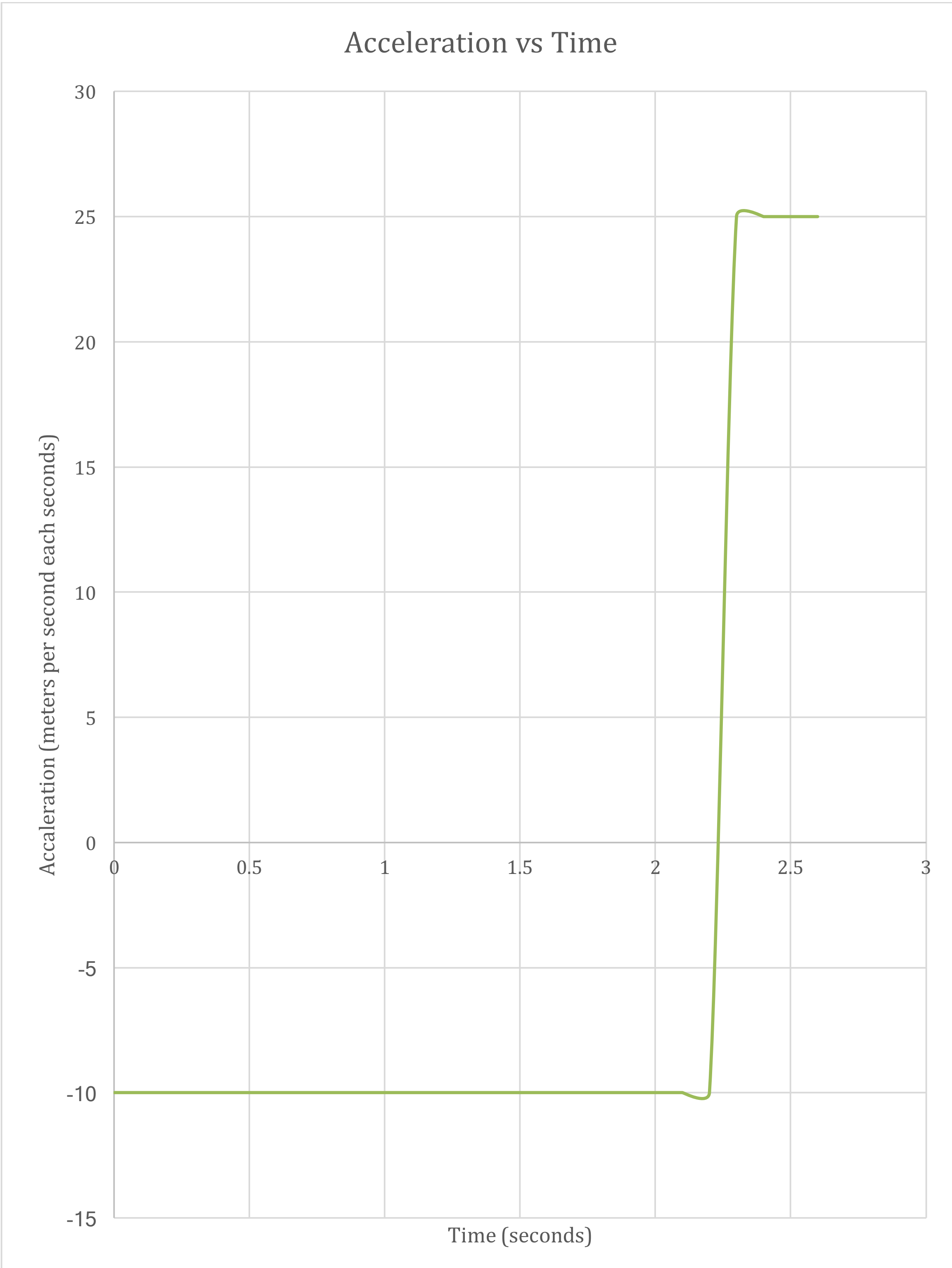
b) **8.2 meters**

c) **1.2 meters**

d) **10 m/sec² down**


Height vs Time
Height (meters)
Time (seconds)
0
1
2
3
4
5
6
7
8
9
0
0.5
1
1.5
2
2.5
3


Velocity vs Time
15
10
5
0
-5
-10
-15
(Velocity (meters/second)
0
0.5
1
1.5
2
2.5
3
Time (seconds)


Acceleration vs Time
30
25
20
15
10
5
0
-5
-10
-15
0
0.5
1
1.5
2
2.5
3
Accaleration (meters per second each seconds)
Time (seconds)

2. (25 points) In a 10-mile race Alice can beat Betty by 2 miles and Alice can beat Carol by 4 miles. By how many miles can Betty beat Carol in a 10-mile race?

Let's say Alice runs ten miles/hour. The first race will be over in one hour. So, Betty runs 8 miles per hour and Carol runs 6 miles per hour.

In a 10-mile race between Betty are Carol, Betty will finish in:

$$t_B = \frac{10\ miles}{8\ miles/hour} = 1.25\ hours.$$

In 1.25 hours, Carol runs

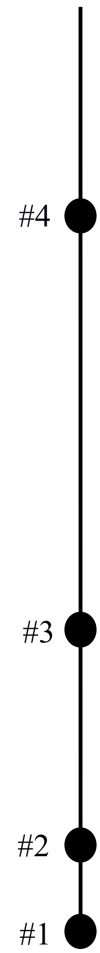
$$x_C = (6\text{ miles/hour})\times(1.25\text{ hours}) = 7.5\text{ miles}$$

Therefore, Betty will beat Carol by 2.5 miles.

Answer with units:

2.5 miles

3. (25 points) In physics lab, students attach lead weights to a string, spacing them so that, when dropped, the time interval between sequential weights hitting the ground is the same. The lead weights on the string, shown at right, are spaced to allow a time of 0.30 seconds between "plinks" on the ground when the first weight (#1) is right at ground level. One lab group accidentally drops the string upside down (so #4 is dropped first, right at ground level). What is the time between weights #4 and #3 hitting the ground?



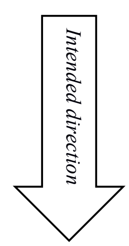
If the time between any two weights hitting is 0.3 seconds, the 3rd weight will hit at 0.6 seconds and thus be moving at 6 m/sec.

The distance between the 3rd and 4th weight must be:

$$x_{34} = \frac{1}{2}\left(10\,\frac{\text{m}}{\text{sec}^2}\right)(0.3\text{ seconds})^2 + \left(6\,\frac{\text{m}}{\text{sec}}\right)(0.3\text{ seconds}) = 2.25\text{ m}$$

When it is dropped upside-down, with the weight #4 at the ground, weight #3 must fall 2.25 meters from rest. To calculate this time, we can use

$$x = 2.25\text{ m} = \frac{1}{2}\left(10\,\frac{\text{m}}{\text{sec}^2}\right)\text{t}^2 + (0)\text{t} = 0.67\text{ seconds}$$



Answers with units:

0.67 seconds