General Physics I (PHYS 103) Fall 2006 **Name:**_____

Exam 1: September 21, 2006

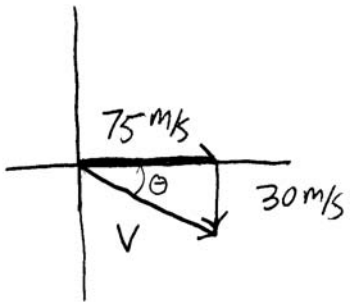
Questions and Problems: Provide clear and logical answers to each of the following questions. In question 1 answer 3 of the 4 parts (a-d). Where calculations are required, neatly show all work. Be sure that your answers have the correct units. If you continue your work on another sheet of paper, be sure that it is clearly labeled. Students may use the attached equation sheet and a calculator during this exam.

1a (10 points) A tennis ball approaches a player with a velocity of 43 m/s to the south. The player hits the ball and gives it a velocity of 51 m/s to the north. What was the average acceleration (magnitude and direction) of the ball during the 1.0×10^{-3} s when it was in contact with the racquet?

$$\vec{a}_{avg} = \frac{\Delta \vec{v}}{\Delta t} = \frac{51\ m/s\ \hat{i} - (-43\ m/s\ \hat{i})}{1 \times 10^{-3}\ s}$$

$$\vec{a}_{avg} = 94000\ m/s^2$$

1b (10 points) The velocity of an object is given by $\mathbf{v} = 75\ \mathbf{i} - 30\ \mathbf{j}$. Determine the speed of the object. Find the direction the object is traveling relative to the x axis.



$$V = (V_x^2 + V_y^2)^{1/2}$$

$$V = (75\ m/s^2 + 30\ m/s^2)^{1/2}$$

$$V = 80.8\ m/s$$

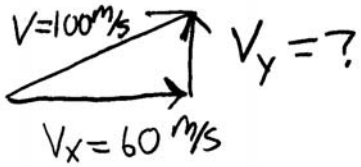
$$\theta = \tan^{-1}\left(\frac{30\ m/s}{75\ m/s}\right) = 21.8^\circ$$

1c (10 points) The velocity of an object subject to friction is given by $v_x(t) = 20 - 5\,t^2$. Estimate the acceleration at t = 2.

$$a = \frac{dv}{dt} = \frac{d}{dt}(20 - 5t^2) = -10t$$

$$a(t=2) = -10(2) = -20\ m/s^2$$

1d (10 points) A projectile is fired from a gun and has an initial speed of 100 m/s and a horizontal component of velocity equal to 60 m/s. Determine the vertical component of the velocity.

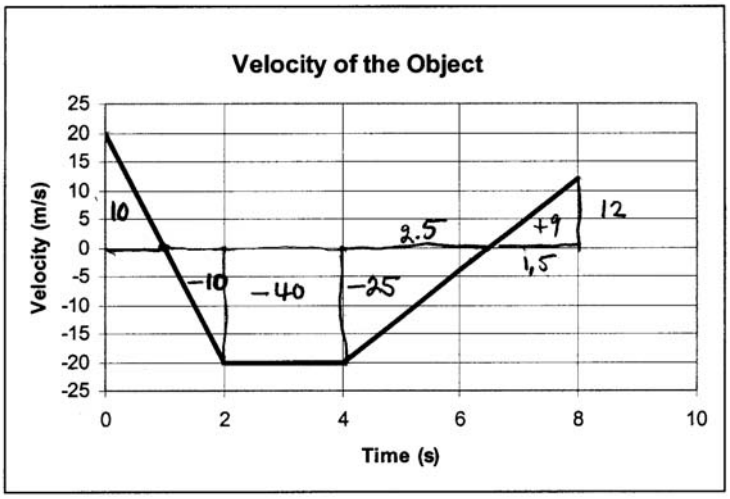


$$V_y = \left(V^2 - V_x^2\right)^{1/2}$$

$$V_y = \left(100\ m/s^2 - 60\ m/s^2\right)^{1/2}$$

$$V_y = 80\ m/s$$

2. The graph below shows the horizontal velocity of an object over an eight second period.

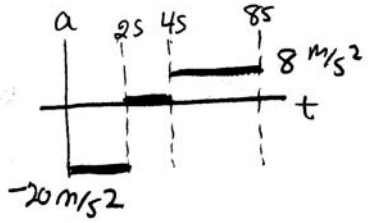


a (15 points) Using the data from the plot, construct a graph of the acceleration versus time. Clearly label the plot and indicate important values.
b (15 points) Using the data from the plot, construct a position versus time graph with appropriate labels. Clearly label the plot and indicate important values.

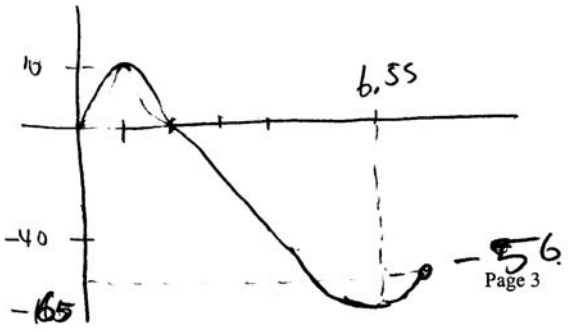
a) $a = \frac{\Delta v}{\Delta t} = \frac{-20\ m/s - 20\ m/s}{2\ s} = -20\ m/s^2$

$a = 0$

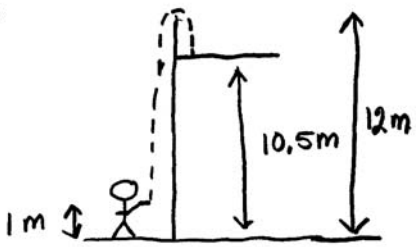
$a = \frac{12\ m/s - (-20\ m/s)}{4s} = 8\ m/s^2$



b) Area under curve



3 (20 points) A person on the ground wishes to throw a flashlight on to the roof of a building. To do this, the flashlight must clear a 12.0 m wall to land on the roof which is 1.5 m below the top of the wall. The person throwing the flashlight releases it at a height of 1.0 m (see figure to the right).



a) With what initial velocity must the person throw the flashlight upward so that it just clears the wall.
b) How long after the flashlight leaves the person's hand does it land on the roof?
c) Make a velocity versus time graph of the motion of the flashlight.

a) $V_i = ?$ $V_f = 0$ Top $y_i = 1$ $y_f = 12$ $a = -9.8\ m/s^2$ $t = ?$

8

$V_f^2 = V_i^2 + 2a(y_f - y_i)$

$V_i = \sqrt{-2a(y_f - y_i)}$

$V_i = \sqrt{-2(-9.8\ m/s^2)\ 11\ m} = 14.68\ m/s$

b) $V_i = 14.68$ $V_f = ?$ $y_i = 1$ $y_f = 10.5$ $a = -9.8\ m/s^2$ $t = ?$

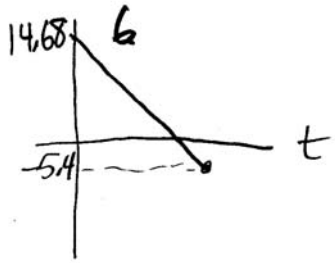
6

$V_f^2 = V_i^2 + 2a(y_f - y_i)$

$V_f^2 = (14.68\ m/s)^2 + 2(-9.8\ m/s^2)(9.5\ m)$

$V_f^2 = 29.30$

$V_f = \pm 5.4\ m/s$

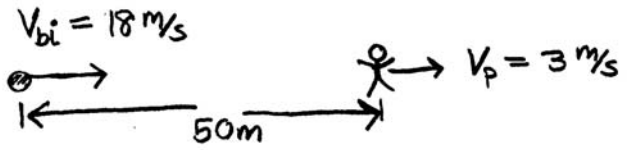


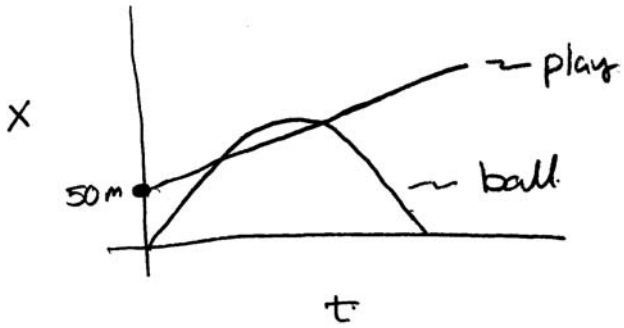
$t = \frac{\Delta V}{a} = \frac{-5.4\ m/s - 14.68\ m/s}{-9.8\ m/s^2}$

$t = 2.05\ m/s$

4 (20 points) A soccer ball is kicked to another player in a straight line along the ground with an initial velocity of 18 m/s as it roles along the ground it accelerates at -2.00 m/s^2. At the instant the ball is kicked the player is 50 m ahead and traveling at a constant velocity of 3 m/s (away from the ball)

a) On a position versus time graph, draw curves representing the motion of the ball and the player.
b) How long after the ball is kicked does it reach the player?
c) How far does the ball travel?





player
$V_p = 3$ m/s
$t = ?$
$x_{pf} = ?$
$x_{pi} = 50$ m

ball
$V_{bi} = 18$ m/s
$V_{bf} = ?$
$x_{bi} = 0$
$x_{bf} = ?$
$a_b = -2$ m/s^2
$t = ?$

$x_{pf} = x_{bf}$

$x_{pi} + V_p t = \cancel{x_{bi}}^{0} + V_{bi} t + \frac{1}{2} a_b t^2$

$-\frac{1}{2} a_b t^2 + (V_p - V_{bi}) t + x_{pi} = 0$

$t^2 - 15t + 50 = 0$

$t = \frac{+15 \pm \sqrt{(-15)^2 - 4(1)50}}{2(1)}$

$t = \frac{15 \pm 5}{2}$ s $= 5$s, 10s

$x_{pf} = x_{pi} + V_p t$

$x_{pf} = 50\text{m} + 3\ \text{m/s}\ 5\text{s} = 65\text{m}$