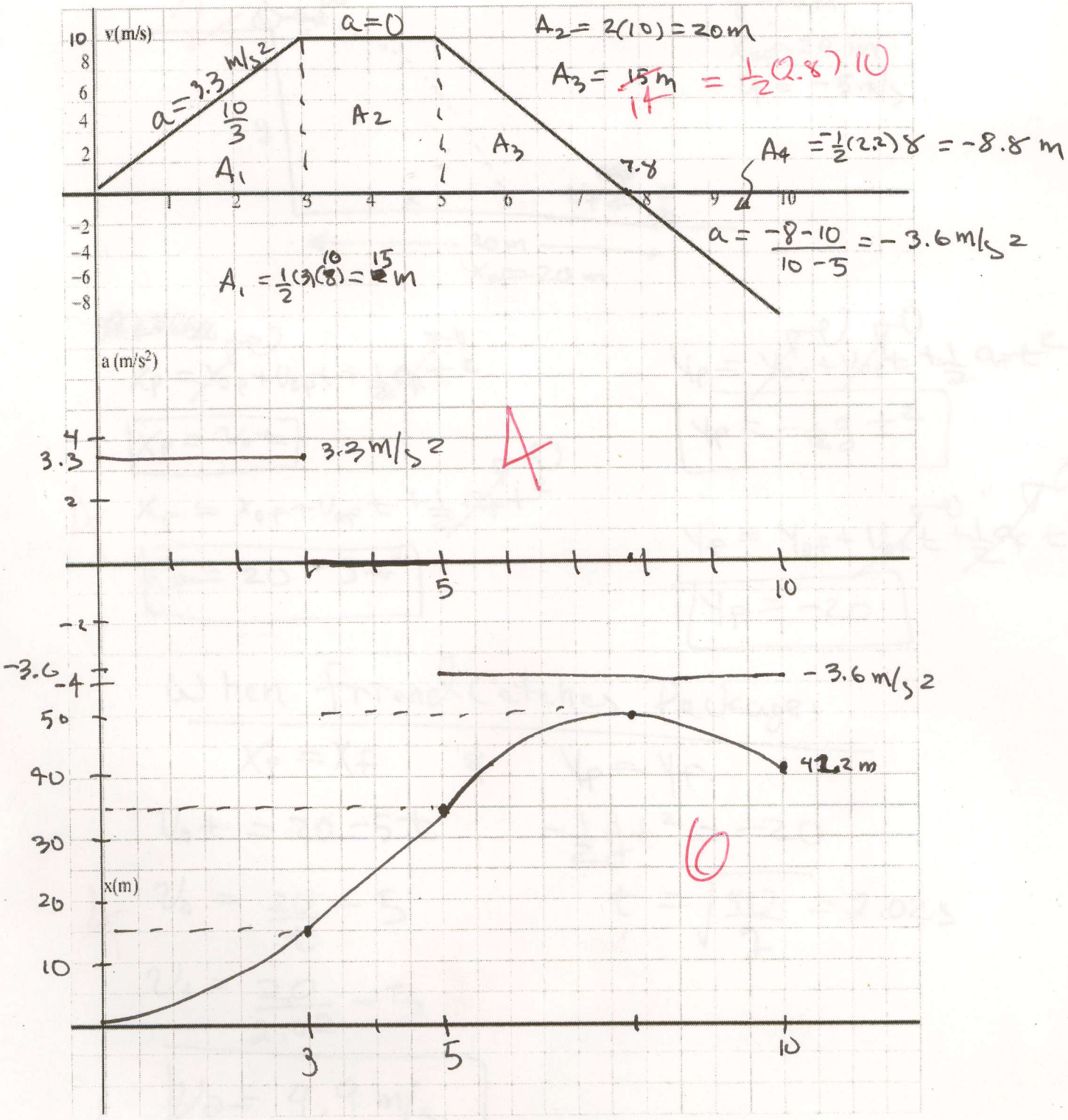
DO NOT TURN THIS PAGE!!!

NAME: KEY

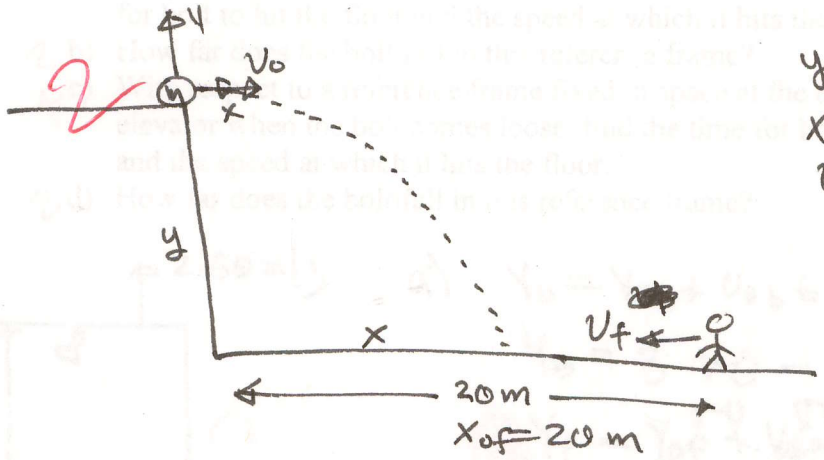
PHYSICS 4A
FALL 2005
EXAM 1

MAKE SURE TO SHOW ALL WORK IN COMPLETE DETAIL. NO CREDIT WILL BE GIVEN IF NO WORK IS SHOWN! THE POINT VALUE OF EACH PROBLEM IS AS INDICATED.

1. The initial velocity and initial position for a student riding his bike is zero at t = 0. The velocity vs. time graph for the student is shown below. Draw the corresponding a vs. t graph and x vs. t graph. (10 pts)



2. Just as you throw a package horizontally from a cliff 20.0 m high, your friend, who is running toward the cliff at 5.0 m/s, is 20 m away. With what velocity should you throw the package so that your friend can catch it? (10 pts)



$y = 20\ m$
$x_{of} = 20\ m$
$v_f = -5\ m/s$.

2

$x_p = x_{0p} + v_{0p}t + \frac{1}{2}a_p t^2$

$x_p = v_0 t$

$y_p = y_{0p} + v_{0p}t + \frac{1}{2}a_p t^2$

$y_p = -\frac{1}{2}g t^2$

4

$x_f = x_{0f} + v_{0f}t + \frac{1}{2}a_f t^2$

$x_f = 20 - 5t$

$y_f = y_{0f} + v_{0f}t + \frac{1}{2}a_f t^2$

$y_f = -20$

When friend catches Package:

$x_p = x_f$ & $y_p = y_f$.

$v_0 t = 20 - 5t$

$-\frac{1}{2}gt^2 = -20$

4

$v_0 = \frac{20}{t} - 5$

$t = \sqrt{\frac{40}{g}} = 2.02\ s$

$v_0 = \frac{20}{2.02} - 5$

$v_0 = 4.9\ m/s$

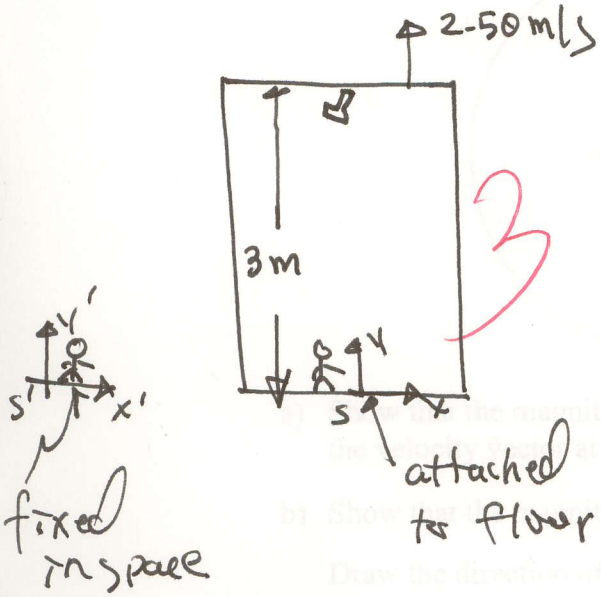
3. An elevator is moving upward at a constant speed of 2.50 m/s. A bolt in the elevator ceiling 3.0 m above the elevator floor comes loose and falls. (15 pts)

4 a) With respect to a reference frame fixed to the elevator floor, find the time for bolt to hit the floor and the speed at which it hits the floor.

2 b) How far does the bolt fall in this reference frame?

4 c) With respect to a reference frame fixed in space at the bottom of the elevator when the bolt comes loose, find the time for bolt to hit the floor and the speed at which it hits the floor.

2 d) How far does the bolt fall in this reference frame?



3

a) $y_b = y_{0b} + v_{0b}t + \frac{1}{2}a_b t^2$

$y_b = 3 + 0 - 4.9t^2$

$y_f = y_{0f} + v_{0f}t + \frac{1}{2}a_f t^2$

$y_f = 0$

$y_b = y_f$

$3 - 4.9t^2 = 0$

$t = \sqrt{\frac{3}{4.9}} = \boxed{0.78\text{ s}}$ 2

$v_b = \frac{dy_b}{dt} = -(9.8)t = (-9.8)(0.78)$

$\boxed{v_b = -7.64\text{ m/s}}$ 2

b) $\boxed{3\text{ m !}}$ 2

c) $y_b = 3 + 2.50t - 4.9t^2$

$y_f = 0 + 2.50t$

$y_b = y_f$

$3 + 2.50t - 4.9t^2 = 2.50t$

$\boxed{t = 0.78\text{ s}}$ 2

$v_b = \frac{dy_b}{dt} = 2.50 - 9.8t$

$\boxed{v_b = -5.14\text{ m/s}}$ 2

* At t > 0,

$v_{bs'} = v_{bs} + v_{s's'}$

$v_{bs'} = -7.64\frac{\text{m}}{\text{s}} + 2.50\text{ m/s}$

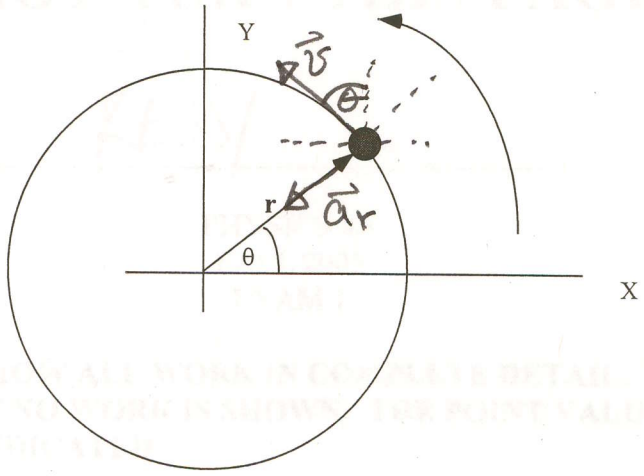
$\boxed{v_{bs'} = -5.14\text{ m/s}}$

d) $\Delta y_b = 2.50t - 4.9t^2$ 2

$= -1.03\text{ m}$

4. Consider a particle moving with constant speed 'v' in a circular path of radius 'r' in the counter clock-wise direction as shown below. At the given instant shown, the position vector of the particle is given by:
(10 pts)

$$\vec{r} = r(\cos\theta\,\hat{\mathbf{i}} + \sin\theta\,\hat{\mathbf{j}})$$



a) Show that the magnitude of the velocity vector of the particle is $v = r\omega$. Draw the velocity vector at the instant shown above.

b) Show that the magnitude of the acceleration of the particle is $a = r\omega^2 = \frac{v^2}{r}$. Draw the direction of the acceleration vector at the instant shown above.

a) $\vec{v} = \frac{d\vec{r}}{dt} = r\frac{d}{dt}(\cos\theta\,\vec{i} + \sin\theta\,\vec{j})$

$= r\left[-\sin\theta\left(\frac{d\theta}{dt}\right)\vec{i} + \cos\theta\left(\frac{d\theta}{dt}\right)\vec{j}\right]$

b) $\vec{v} = r\omega\left[-\sin\theta\,\vec{i} + \cos\theta\,\vec{j}\right]$

$\boxed{v = r\omega}$

b) $\vec{a} = \frac{d\vec{v}}{dt} = r\omega\frac{d}{dt}\left[-\sin\theta\,\vec{i} + \cos\theta\,\vec{j}\right]$

$\vec{a} = r\omega\left[-\cos\theta\left(\frac{d\theta}{dt}\right)\vec{i} - \sin\theta\left(\frac{d\theta}{dt}\right)\vec{j}\right]$

b $\vec{a} = r\omega^2\left[-\cos\theta\,\vec{i} - \sin\theta\,\vec{j}\right]$

$a = r\omega^2 = r\frac{v^2}{r^2} = \frac{v^2}{r}$ ✓