Physics 105 Sample Exam 1

Please write your CID_____

3 hour time limit. **No books or notes.**

$<v> = \frac{\Delta x}{\Delta t}$

$<a> = \frac{\Delta v}{\Delta t}$

$v = v_o + a\,t$

$x = x_o + \frac{1}{2}(v_o + v)\,t$

$x = x_o + v_o t + \frac{1}{2} a t^2$

$v^2 = v_o^2 + 2a\,(x - x_o)$

If $Ax^2 + bx + c = 0$, $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$g = 9.80\ m/s^2$

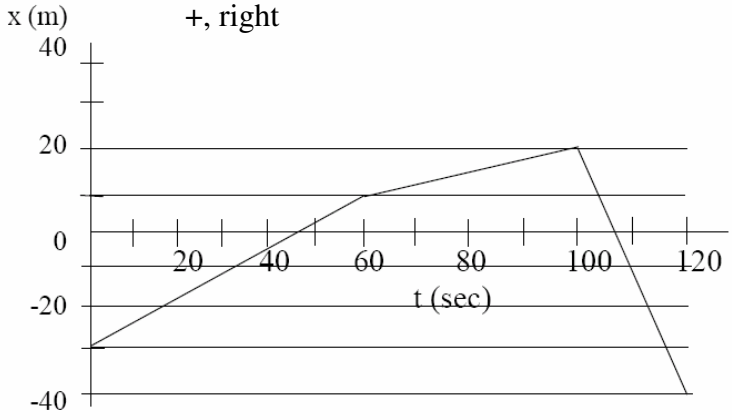
[?] with choices means simple multiple choice.

When a numerical answer is required [S] with no choices means supply the second significant digit. If the number itself is zero, mark 0. For answers 3.872, -0.003872, or 3.872×10^7 you would mark 8 if [S] (second digit) is displayed. For the answer 5.072, you would mark 0. Sometimes a range of answers is given (as in the homework). The correct answer is in that range. For example: {4.88, 6.48}m/s. If you got 6.275, you would mark 2 (the second digit) for your answer. If you got 3.823, try again (out of range).

Keep four significant digits throughout your calculations; do not round up to less than four. When data is given, assume it has at least four significant digits. For example "15 meters" means 15.00 meters.

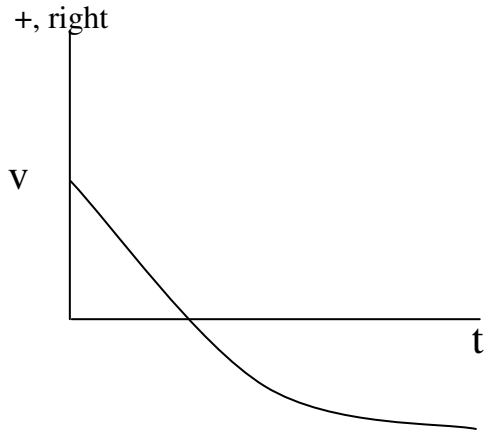
Write your CID on both places in your exam. Did you do this _____? Points deducted for failing to mark CID.

A bicycle has an x(t) curve given in the figure below. Positive x means to the right. The displacement between 0 and 60 seconds is [1S] _____ m. At the time t=20 seconds, the bicycle is [2?] _____ 1) moving to the right 2) moving to the left 3) not moving . The period of time with the greatest speed is [3?]_____1) 0-60 sec 2) 60-100 sec 3) 100-120 sec At t=80 seconds, the instantaneous velocity is [4S] _____ m/s. At. The average velocity between 60 and 120 seconds is [5S] _____ m/s and is [6S] _____ (1) to the right 2) to the left 3)neither (zero).



Δx= (-30-10)=-40 [1] 0 (because [S] was shown, you write 0, the second significant digit (see instructions above)
At 20, moving to right (positive slope)
[2] 1
Slope is greatest magnitude from 100- [3] 3
at 80, slope is (20-10)m / (40) sec = 0.25 m/s [4]: 5

From 60-120: <v>=Δx/Δt = (-40-10)m/(60)sec = -50/60 = -0.833 m/s [5] 3
direction to left [6] 2



The curve is velocity vs time for an object. Positive means to the right. The curve represents an object [7?] _____ 1) moving right 2) moving left 3) moving right then moving left 4) moving left then moving right 5) not moving. The *acceleration* of this object is [8?] _____ 1) to the right 2) to the left 3) to the right then to the left 4) to the left then to the right 5) zero. The magnitude of the acceleration of the object is [9?] _____ 1) increasing 2) decreasing 3) constant

pos v then neg v: moving right then left [7] 3
slope always negative: a is negative, left [8] 2
magnitude of slope is decreasing , so |a| is decreasing [9] 2

A jet fighter landing on an aircraft carrier is going very fast, and the hook catches a springy cable. The cable is so springy that it stops the jet and then the jet rolls backward, speeding up. Right after the hook pulls on the cable, while the jet is going forward, the acceleration of the jet is [10?] _____ 1) forward 2) backward 3) zero. At the instant the jet is stopped, just before it starts going backward the acceleration of the jet is [11?] _____ 1) forward 2) backward 3) zero

a is always in the direction of the force: [10] 2
[11] 2

Sally throws a rock at a slight angle *below* horizontal from a cliff. Bob throws his at a slight angle *above* horizontal. They throw the *same speed*. Which hits the ground first? [12?] _____ 1) Sally's 2) Bob's 3) same. Which rock has the greatest acceleration during its flight? [13?] _____ 1) Sally's 2) Bob's 3) same.

Bob throws his a little up. This takes longer to go up and stop and come back down [12] 1
Same acceleration due to gravity [13] 3

On a second throw, Sally *throws her rock straight up*. Bob throws his rock straight down. They throw the *same speed*. Which rock has the greatest speed at the bottom? [14?] _____ 1) Sally's 2) Bob's 3) same

Same speed because when Sally's rock passes her, going down, it's going as fast as Bob threw his down. [14] 3

A sprinter does the 80 meter dash in 15 sec starting from rest, with constant acceleration. Her average velocity was [15 S] _____ {4.88, 6.48}m/s. Her acceleration was [16S] _____ m/s^2.

$\langle v\rangle = \Delta x/\Delta t = 80/15 = 5.33$ m/s [15] 3 since "S" is shown, write the *second* significant figure

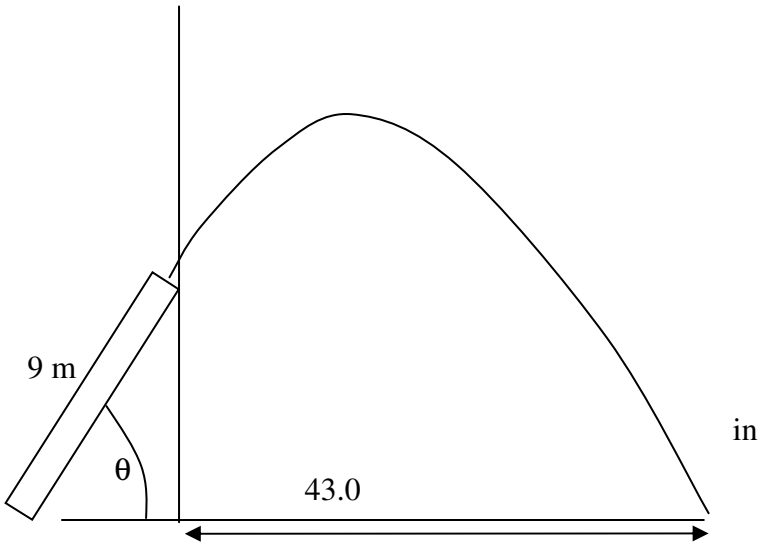
16: many ways to get acceleration. $x = x_o + v_o t + \frac{1}{2} a t^2$ solve for a (v_o=0). Or use $\langle v\rangle = 5.33 = (v_f + v_o)/2$, gives vf $= 2v_o = 10.66$m/s. a=10.66m/s/15 sec = 0.711 m/sec^2. [16] 1

A man jumps essentially straight upward at 3 m/s from a diving board 4 m above the water, and jumps into the water. When he hits the water, his speed will be [17S] _____ {8.61, 11.4} m/s. The total time he spends in the air is [18S]_____ sec.

I will take up as +. $v^2 = v_o^2 + 2a(y-y_o) = 3^2 + 2(-9.8)(-4m)$ then $v = \sqrt{87.4} = 9.35$ m/s [17] 3.

$v = v_o + a t$
$t = \Delta v/a = (-9.35-3)m/s/(-9.8)$m/s^2 = 1.26 sec [18] 2

After graduating, you are a circus performer and are shot out of a cannon. Having studied physics, you want to know all about the motion. So you take some measurements. The cannon is 9 m long. The angle of the gun is $\theta = 55^o$ above horizontal. What height above the ground do you start your journey through the air? [19S] _____ {6.33, 8.55}m You find that you end up hitting the ground a horizontal distance 43.0 m away from the end of the cannon, and that the flight took 3.75 seconds. From this, find the speed you left the cannon. [20S] _____ {14.8, 20.8}m/s From this information, find the highest distance *above the ground* that you reached in your flight. [21S] _____ {16.7, 23.1}m



h=9m sin(55) = 7.37 m. [19] 3 Since "S" is shown, write the *second* significant figure (because a range is given).

Since we know time, we can use either x or y motion to find v_o:
x motion: $\Delta x = v_{ox} t$. $v_{ox} = \Delta x/t = 43.0/3.75 = 11.5$ m/s. So $v_o = v_{ox}/\cos(55) = 20.0$ m/s.
<u>Or</u> y motion: $\Delta y = -7.37 = v_{oy} t - 1/2\ gt^2$. Solve for $v_{oy} = 16.4$ m/s $v_o = v_{ox}/\sin(55) = 20.0$ m/s.
Since "S" is shown, mark [0], the second digit of 20.00
NOTE: this exam was really written before we used the second digit notion, so **you may get 19.95** or something like that. On the real exam, I always choose the numbers so you won't get answers these problems so there is never any question about the 2nd digit.

You can find the max height two ways:

1) find t to come to peak of motion (to stop), and then find Δy it traveled in this time:

$0 = v_{oy} + a t$
$t = -v_{oy}/a = v_{oy}/g = 16.4/9.8 = 1.67$ sec.

$y_f = y_o + v_{oy} t - \frac{1}{2} g t^2 = 7.37$ m + 16.4*1.67 –1/2 * 9.8*(1.67)^2 = 21.1 m.

OR 2) Use **$v_{fy}^2 = v_{oy}^2 + 2a(y-y_o)$. $0 = v_{oy}^2 - 2g(y-y_o)$.**
$y = y_o + v_{oy}^2/2g = 7.37$ m + $16.4^2/2g = 7.37$m+13.7m = 21.1 m

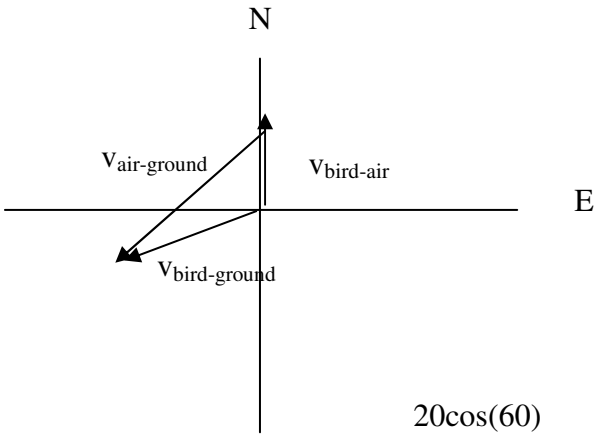
Since "S" is shown, mark [1], the second digit of 21.1 m [21] 1

Written problem Please write your **CID**_____

To get credit, show all your work as carefully and as neatly as possible.

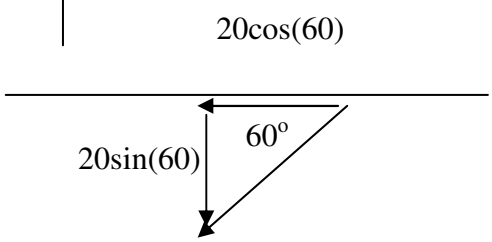
2. A bird flies north with respect to the air at 10 m/s. The air is moving with a wind of 20 m/s in a direction 60 degrees south of west.

a. **(3 pts)**Draw a vector diagram showing the bird's velocity vs. air, the air's velocity vs. ground, and the velocity of the bird relative to the ground. **Label each vector clearly**, and draw them close to scale.



$\mathbf{v}_{bird\text{-}ground} = \mathbf{v}_{bird\text{-}air} + \mathbf{v}_{air\text{-}ground}$

b. **(7 pts)** How fast is the bird going relative to the ground?



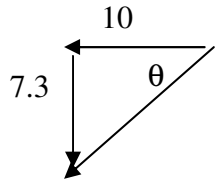
$\mathbf{v}_{bird\text{-}ground} = \mathbf{v}_{bird\text{-}air} + \mathbf{v}_{air\text{-}ground}$ **=(0,10) + (-20cos60, -20sin60) =(0,10) + (-10, -17.32)=(-10,-7.32)**

speed $|\mathbf{v}_{bird\text{-}ground}| = \sqrt{10^2 + 7.32^2}$ =12.4 m/s

This all agrees with the diagram.

c. **(3 pts)** What is the angle of the bird's velocity with respect to the ground? Specify the angle relative to some direction (N,S,E,W) (example: "60 degrees south of east")

$\theta = \tan^{-1}(7.3/10) = 36.1$ degrees South of W or 53.9 degrees west of south



d. **(3 pts)**If in the *same wind* the bird wants to fly directly north with *respect to the ground* at 10 m/s, show the vector $v_{bird\text{-}air}$ that it must instead have. Draw a vector diagram showing the bird's velocity vs. air, the air's velocity vs. ground, and the velocity of the bird relative to the ground. **Label each vector clearly**, and draw them close to scale. This is a graphical solution; you don't need to work out numbers. $\mathbf{v}_{bird\text{-}ground} = \mathbf{v}_{bird\text{-}air} + \mathbf{v}_{air\text{-}ground}$