Fall 2007 Please write your CID_____

Physics 105 Exam 1

Hess & Colton

3 hour time limit.

Constants: $g = 9.80\ m/s^2$

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.

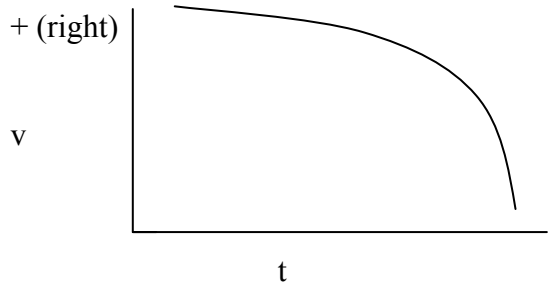
The problems are labeled with a question mark in brackets; [1?] means the answer goes in bubble sheet #1.

You are **encouraged to write your work and full answers on the exam pages** (but of course also record your final answers on the bubble sheet).

Make sure your calculator is in DEGREES, not radians.

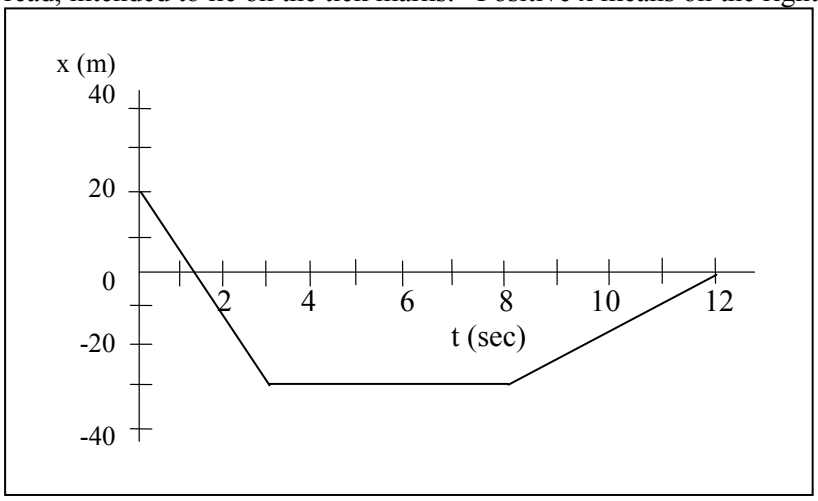
→Write your CID above upper right corner. Did you do this _____? You won't get your exam back without writing your CID.

The following graph is of velocity vs time v(t) of a car moving along a road, and right is positive. The graph shows that the car is [1?] ____ a) speeding up b) slowing down c) staying at constant speed, and moving to the [2?] ____ a) right b) left, with acceleration to the [3?] ____ a) right b) left, and the acceleration is [4?] ____ a) increasing in magnitude b) decreasing in magnitude c) constant.



1. **Slowing down (v decreasing)**
2. **v to the right (v is +)**
3. **slope is negative …a is to left (brakes are on)**
4. **increasing magnitude of a (brakes are put on more and more strongly) (slope of v is increasing).**

A bus has a x(t) curve given in the figure below. All numbers you take from the plot are nice round numbers easily read, intended to lie on the tick marks. Positive x means on the right.



The displacement between 0 and 3 seconds is: [5?] _____ a) less than -85 m b) between -85 and -75 m c) between -75 and –65 m d) between -65 and -55 m e) between -55 and -45 m f) between -45 and -35 m g) greater than -35 m.

At the time t=2 seconds, the bus is [6?] _____ a) moving to the right b) moving to the left c) not moving

At t=6 seconds, the instantaneous velocity is [?7] _____ a) less than -14 m/s b) between -14 and -11 m/s c) between -11 and -8 m/s d) between -8 and -5 m/s e) between -5 and -2 m/s f) between -2 and 1 m/s g) between 1 and 4 m/s h) between 4 and 7 m/s i) greater than 7 m/s.

At 10 seconds the instantaneous velocity is [8?] _____ a) less than -14 m/s b) between -14 and -11 m/s c) between -11 and -8 m/s d) between -8 and -5 m/s e) between -5 and -2 m/s f) between -2 and 1 m/s g) between 1 and 4 m/s h) between 4 and 7 m/s i) greater than 7 m/s.

The average velocity between 5 and 12 seconds is [9?] _____ a) less than -14 m/s b) between -14 and -11 m/s c) between -11 and -8 m/s d) between -8 and -5 m/s e) between -5 and -2 m/s f) between -2 and 1 m/s g) between 1 and 4 m/s h) between 4 and 7 m/s i) greater than 7 m/s and is [10?] _____ (a) to the right b) to the left .

5. Δx = -30m-20m = -50m
6. to the left
7. v = 0
8. slope: $\Delta x/\Delta t$ = [0-(-30)]m/(12-8) sec = 30/4 = 7.5 m/s
9. <v>= $\Delta x/\Delta t$ = [0-(-30)]m/(12-5) sec = 30/7 =4.28 m/s
10 positive slope, right

A jet plane lands with a speed of 50 m/s and can decelerate (slow down) at a maximum acceleration magnitude of 7 m/s^2 as it comes to rest. From the instant the plane touches the runway, what is the minimum time needed before it can come to rest? [11?] _____ a) less than 7.0 s b) between 7.0 and 7.1 s c) between 7.1 and 7.2 s d) between 7.2 and 7.3 s e) between 7.3 and 7.4 s f) between 7.4 and 7.5 s g) between 7.5 and 7.6 s h) more than 7.6 s

The minimum distance needed to stop is [12?]_____ a) less than 140 m b) between 140 and 160 m c) between 160 and 180 m d) between 180 and 200 m e) between 200 and 220 m f) between 220 and 240 m g) longer than 240 m.

11. $v = v_o + at \quad t = \dfrac{v - v_o}{a} = \dfrac{(0-50)m/s}{-7m/s^2} = 7.142s$

12. Many ways to find x: one is $v^2 = v_o{}^2 + 2a(x - x_o)$

$$x = x_o + \frac{v^2 - v_o{}^2}{2a} = 0 + \frac{0 - (50m/s)^2}{-2 \times 7m/s^2} = 178.6m$$

A car is moving to the left at constant speed. The acceleration is [13?]_____ a) to the right b) to the left c) zero. It now puts on its brakes (still moving left). The acceleration is [14?]_____ a) to the right b) to the left c) zero.

13. c 14. a (think direction of force)

A stone is thrown upward. At the peak of its motion, the acceleration is [15?] _____ a) up b) down c) zero. A stone is thrown upward and forward from a cliff. Neglect air friction. While the stone is still rising, the acceleration is [16?] _____ a) up b) down c) up and forward d) up and backward e) down and forward f) down and backward g) zero.

[15?] b [16?] b

Fans claim that Michael Jordan can stay in the air for 2.5 seconds. To do this he would need to jump to a height of [17?] _____ a) less than 7.0 m b) between 7.0 and 7.1 m c) between 7.1 and 7.2 m d) between 7.2 and 7.3 m e) between 7.3 and 7.4 m f) between 7.4 and 7.5 m g) between 7.5 and 7.6 m h) higher than 7.6 m

Hint: he's going up for half that time, then he falls half the time. How far does he fall?

17. If he's in the air 2.5 seconds, he's going up 1.25 seconds and falling for 1.25 seconds. How far would he fall in 1.25 seconds (to get back to the ground)? . So take t=0 and v_o= 0 at the top. Falling: 0= y_o □□ + v_ot - ½ g t^2 = 0+ 0 - ½(9.8m/s^2) (1.25s)^2 . y_o = 7.656 m or about 25 feet! So no, he can't stay in the air for 3 seconds!

A bullet is fired straight through a 0.05m thick board with constant acceleration while in the board. It strikes the board at 750 m/s, and emerges from the board at 300 m/s. The average velocity of the bullet while in the board was [18?] _____ a) less than 400 m/s b) between 400 and 440 m/s c) between 440 and 480 m/s d) between 480 and 520 m/s e) between 520 and 560 m/s f) greater than 560 m/s

The magnitude of the acceleration of the bullet while the bullet was in the board was
[19?] _____ a) less than 3.3E6 m/s^2 b) between 3.3E6 and 3.5E6 m/s^2 c) between 3.5E6 and 3.7E6 m/s^2
d) between 3.7E6 and 3.9E6 m/s^2 e) between 3.9E6 and 4.1E6 m/s^2 f) between 4.1 and 4.3 m/s^2 g) between 4.3 and 4.5 m/s^2 h) between 4.5 and 4.7E6 m/s^2 i) greater than 4.7E6 m/s^2.

18. <v> = ½ (v_o + v) = ½(1050 m/s) = 525 m/s Can also find from t and Δx.
19. More than one way: most direct: $v^2 = v_o{}^2 + 2a(x-x_o)$, or a = [$v^2$-$v_o{}^2$]/ [2 (x-x_o)] = [300^2 – 750^2]m^2/s^2/[2 *0.05m] = - 4.725 x10^6 m/s^2 (or you can find the time from the average velocity, and get a from that)

A hiker follows his compass due north for 3 miles. He then follows a direction 60° W of N (or 30° N of W) for 7 miles. He is now how far from where he started? [20?]_____ a) less than 8.2 mi b) between 8.2 and 8.3 mi c) between 8.3 and 8.4 mi d) between 8.4 and 8.5 mi e) between 8.5 and 8.6 mi f) between 8.6 and 8.7 mi g) between 8.7 and 8.8 mi h) more than 8.8 mi.

20. A_x=0, Ay = 3. B_x=7cos (30)=6.06, B_y = 7sin(30)=3.50. C_x= 0 + 6.06, C_y = 3+3.50 = 6.50. |C| = sqrt(6.06^2+ 6.5^2) = 8.86 mi

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A rock is shot with a speed of 40 m/s from a slingshot at a building 50 m away. The shot is at 21 degrees above the horizontal. It takes how long for the rock to hit the building? [21?] _____ a) less than 1.1 s b) between 1.1 and 1.2 s c) between 1.2 and 1.3 s d) between 1.3 and 14 s e) between 1.4 and 1.5 s f) between 1.5 and 1.6 s g) between 1.6 and 1.7 s h) between 1.7 and 1.8 s i) between 1.8 and 1.9 s j) longer than 1.9 s.

The rock hits the building how much higher than where it was released? [22?] _____ a) less than 11 m b) between 11 and 12 m c) between 12 and 13 m d) between 13 and 14 m e) between 14 and 15 m f) between 15 and 16 m g) between 16 and 17 m h) greater than 17 m.

21. $t = \Delta x/v_{ox}$ = 50m/(40cos21)m/s = 1.338 sec
22. $\Delta y = v_{oy}t - ½ g t^2$ = 40sin21 m/s * 1.338 s– ½ 9.8 $(1.338)^2$ = 10.4 m

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A bullet shot from a horizontally pointed gun takes [23?]_____ a) less b) the same c) more time to hit the ground than a bullet accidentally dropped from the same gun. A bullet shot from a gun pointed a little upward takes [24?]_____ a) less b) the same c) more time to hit the ground than a bullet shot horizontally from the same gun. Assume flat ground in all cases.

23, same (2) (same v_{oy}=0; same time to fall same distance. x motion doesn't affect it).
24. more (3) (it's going up at first…takes more time to fall to the ground).

You enter the freeway and travel at a constant speed of 55 mi/hr to drive to a concert in Logan. Your roommate enters the freeway a half hour later traveling at a constant speed of 75 mi/hr going to the same concert. When your roommate passes you, you both have traveled how far on the freeway [25?]_____ a) less than 85 mi b) between 85 and 90 mi c) between 90 and 95 mi d) between 95 and 100 mi e) between 100 and 105 mi f) between 105 and 110 mi g) more than 110 mi.

25. You are a distance 55mi/hr*0.5hr = 27.5 mi ahead. Relative velocity is 20 mi/hr. So the time is 27.5 mi /20mi/hr= 1.375 hrs to catch up. Your roommate has gone 1.375 hrs*75 mi/hr=103.1 mi. Or, you can find it from your speed: you have traveled 0.5 + 1.375 hrs = 1.875 hrs. Distance is 1.875 hrs*55 mi/hr =103.1 mi

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A bird flies with 10 m/s airspeed. It is flying in a wind of 5 m/s pointing east. It is flying due north with respect to the ground. The direction it points its head to fly is [26?]_____ a) N b) N and E c) N and W.

Its speed with respect to the ground is [27?] ____ a) less than 7.5 m/s b) between 7.5 and 8 m/s c) between 8 and 8.5 m/s d) between 8.5 and 9.0 m/s e) between 9.0 and 9.5 m/s f) between 9.5 and 10.0 m/s g) between 10.0 and 10.5 m/s h) between 10.5 and 11.0 m/s i) more than 11.0 m/s

26. N and W to cancel the vector of the wind, so its total goes N.

27. v_{bg} = sqrt(10^2 – 5^^2) = 8.66