Name _____

Physics 1210 Exam 1
28 September 2017

This test is closed-note and closed-book. No written, printed, or recorded material is permitted. Calculators are permitted but computers are not. No collaboration, consultation, or communication with other people (other than the administrator) is allowed by any means, including but not limited to verbal, written, or electronic methods. Sharing of calculators is prohibited. If you have a question about the test, please raise your hand. For multiple choice, you may choose two answers, and if one is correct, receive half credit, etc. For full credit on written problems, show the full thought process from basic equations to final results including a diagram and basic starting equations.

$$V_{avg}=\frac{x_2-x_1}{t_2-t_1}=\frac{\Delta x}{\Delta t} \quad a_{avg}=\frac{v_2-v_1}{t_2-t_1}=\frac{\Delta v}{\Delta t} \quad a_{rad}=\frac{v^2}{R}=\frac{4\pi^2 R}{T^2}$$

$$x_1=x_0+v_0 t+\frac{1}{2}at^2 \quad v_1=v_0+at \quad v_1^2=v_0^2+2a(x_1-x_0) \quad \Sigma \bar{F}=m\bar{a}$$

$$x_{quadratic}=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$

$$1mi=5280\,ft=1609\,m$$

$$2.2\,lbs=1\,kg \quad 1\,Ton=2000\,lbs$$

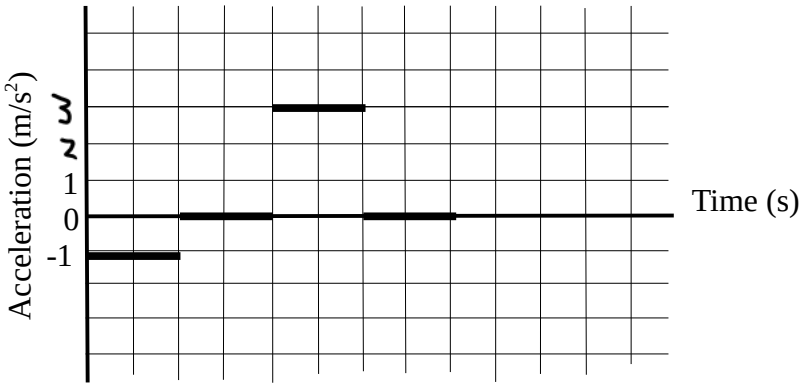
1. (20 pts) Write a few lines of Matlab code that would calculate the final velocity of a spacecraft that starts at zero velocity at the origin and travels a distance of 5000 km with an acceleration of 3.5 m/s^2. Include also Matlab commands that would plot final velocity as a function of final position (that is, v(x) versus x) for several different values of x.

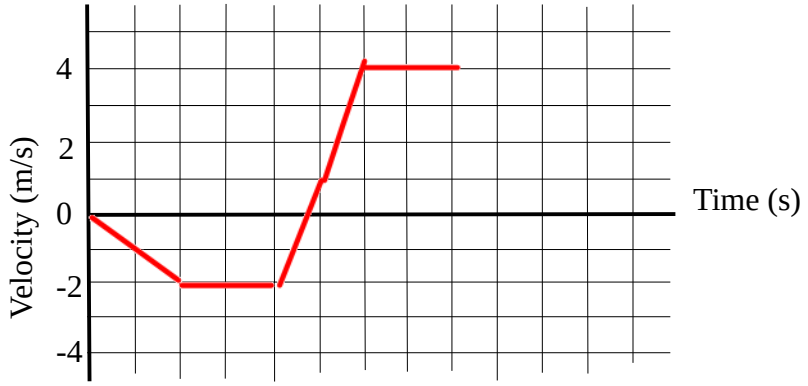
2. (10 pts) An explorer in the wilderness starts at the origin and travels three legs of a journey described by vectors $\vec{A}=3\hat{i}+4\hat{j}$ $\vec{B}=-2\hat{i}+3\hat{j}$ $\vec{C}=-4\hat{i}-5\hat{j}$
Their final angle from the origin, as measured in the usual way counterclockwise from the x axis, is closest to
A. 30 degrees B. 60 degrees C. 120 degrees D. 150 degrees E. 210 degrees

3. (10 pts) A train that starts from rest at the origin with uniform acceleration travels 500 m in 20 sec. If the engineer decides to travel an additional 20 seconds, the train goes an additional
A. 250 m B. 500 m C. 1000 m D. 1500 m E. 2000 m

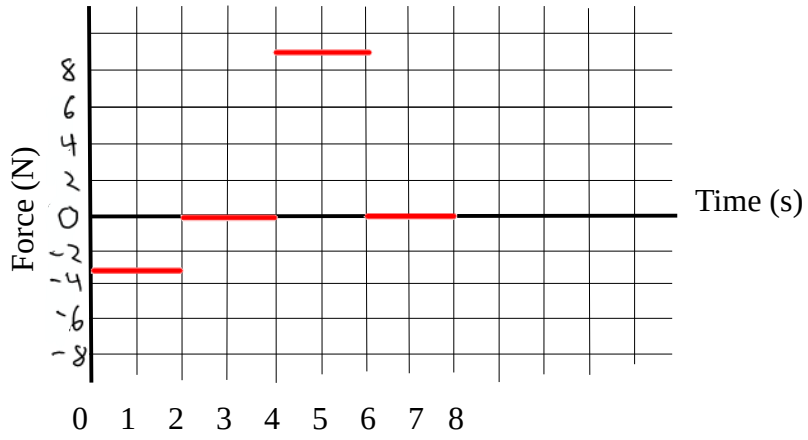
4. (10 pts) For a stone undergoing projectile motion with -Y direction defined to be in the direction of gravity
A. The acceleration in the X direction is zero and the acceleration in the Y direction is negative.
B. The acceleration in the X direction is zero and the acceleration in the Y direction is positive.
C. The acceleration in the X direction is positive and the acceleration in the Y direction is zero.
D. The acceleration in the X direction is negative and the acceleration in the Y direction is negative.
E. The acceleration in the X direction is positive and the acceleration in the Y direction is positive.

5. (30 pts) Given the indicated acceleration-time graph of a 3 kg object that starts at the origin at rest, draw quantitatively (meaning, number the axes) the corresponding force-time, velocity-time, and position-time graphs.





t	x
1	$-\frac{1}{2}$
2	-2
3	-4
4	-6
5	$-6\frac{1}{2}$
6	-4
7	0
8	4



6. (10 pts) The instantaneous velocity of a car in motion can be determined from

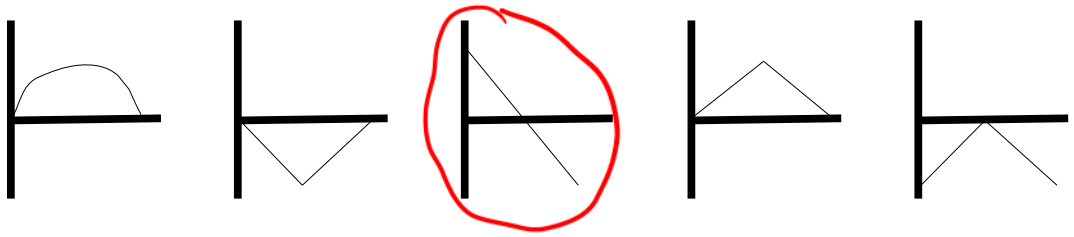
A. The derivative of the position-time curve.
B. The integral of the position-time curve.
C. The derivative of the acceleration-time curve.
D. The integral of the acceleration-time curve.
E. The square root of the second derivative of the stock market on the summer solstice.

7. (10 pts) The following graph gives the X position of a hummingbird as a function of time. From this you can conclude all of the following EXCEPT

t (s)	x (m)
1	2
2	5
3	8
4	11

A. Its average acceleration is zero
B. Its average velocity is constant
C. Its average velocity is greater than zero
D. Its average velocity is 3 m/s
E. It was at X<0 at t=0

8. (10 pts) A ball rolls up a ramp and rolls back down to the same position. Which graph best represents the velocity-time plot?
Circle one.



9. (10 pts) A train car is rolling to the right and experiences a net force that is always to the right. The magnitude of the net force is decreasing with time. The speed of the train car is

A. Increasing B. Constant C. Decreasing D. Zero E. Unreal

10. (10 pts) A 500 kg car collides with a 1000 kg truck going the opposite direction. During the collision

A. The force the car exerts on the truck is equal to the force the truck exerts on the car.
B. The force that the car exerts on the truck is slightly more than the force the truck exerts on the car.
C. The force the car exerts on the truck is slightly less than the force the truck exerts on the car.
D. The force the car exerts on the truck is much less than the force the truck exerts on the car.
E. The force that the car exerts on the truck would be greater than the force exerted by the truck on the car if the car were moving faster than the truck.

11. (10 pts) A ball is tossed vertically upward. When it reaches its highest point (before falling back downward),

A. its velocity and acceleration both reverse direction but the force of gravity remains downward.
B. its velocity is zero, its acceleration is zero, and the force of gravity is downward.
C. its velocity is zero, its acceleration is directed downward, and the force of gravity is momentarily zero.
D. its velocity is zero, its acceleration is zero, and the force of gravity is zero.
E. none of the above

12. (10 pts) You are coasting in a lazy circle to the left on your bike as you are applying the brake.

A. The centripetal acceleration vector points to the left and the tangential acceleration points behind you.
B. The centripetal acceleration vector points to the left and the tangential acceleration points forward.
C. The centripetal acceleration vector is zero and the tangential acceleration points behind you.
D. The centripetal acceleration vector points to the right and the tangential acceleration points behind you.
E. The centripetal acceleration vector points to the left and the tangential acceleration is zero.

13. (10 pts) Below is a picture of a ball rolling to the right along the X axis. Each picture is taken 1 second apart. From the sequence of pictures you can conclude:

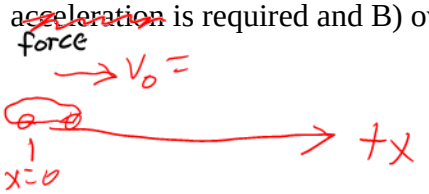
A. Its acceleration is zero and its velocity is positive.
B. Its acceleration is zero and its velocity is zero.
C. Its acceleration is negative and its velocity is zero.
D. Its acceleration is negative and its velocity is positive.
E. Its acceleration is negative and its velocity is negative.

14. (30 pts) A cat of mass M kg jumps vertically upward from the floor to reach a tabletop which is H meters above the floor in the shortest possible time, t. The acceleration from gravity is "g". The cat jumps with velocity V. If it wishes to reach a tabletop of height 3H its minimum speed is

A) 1/3 V B) 3V C) 3/2 V D) sqrt(2) V E) sqrt(3) V

For worked problems, be sure to make a complete solution including a picture with labeled variables and a symbolic answer, and a numerical answer, if required.

15. (50 pts) If you want your M=2000 kg truck to stop in 3.6 seconds from an initial speed of 70 km/hr, A) what acceleration is required and B) over what distance does the truck stop?



$t = 3.6\,s$
$x_0 = 0$
$x_f = ?$
$v_0 = 19.4\,m/s$
$v_f = 0$
$a = ?$

$70\ km/hr = 19.4\ m/s$
put in cgs units

A) $v_f = v_0 + at$

$a = \frac{v_f - v_0}{t} = \frac{0 - 19.4}{3.6} = -5.4\ m/s^2$

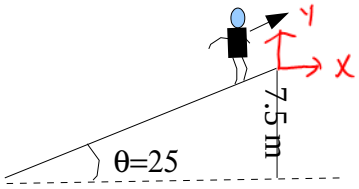
so $F = ma = 2000 \cdot (-5.4) = -10,800\ N$

B) $v_f^2 = v_0^2 + 2a(x_f - x_0)$

solve for x_f

$\frac{v_f^2 - v_0^2}{2a} = x_f - x_0 = x_f = \frac{0^2 - 19.4^2}{2(-5.4)} = 34.8\ m$

16. (70 pts) A skiier leaves a 25 degree ramp at the top of the ramp, 7.5 m above the level ground at a speed of 10 m/s. A) How high does the skiier reach above the ground? B) How far does the skiier travel horizontally before touching the ground again?



A) Y

Part A involves y motion only

y_0	y_f	v_{0y}	v_{fy}	a_y	t
7.5	?	$10\sin 25$	0	-9.8	?

Try $v_f^2 = v_0^2 + 2a(y_f - y_0)$

$$\frac{v_f^2 - v_0^2}{2a} + y_0 = y_f = \frac{0 - (10\sin 25)^2}{2(-9.8)} + 7.5 = 8.4 \text{ m}$$

B). First find how long skiier is in air.

$$y_f = y_0 + v_{0y}t + \frac{1}{2}at^2$$

$$0 = \underbrace{7.5}_{c} + \underbrace{10\sin 25}_{b=4.2}\,t + \underbrace{\frac{1}{2}(-9.8)}_{a=-4.9}t^2$$

$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$= \frac{-4.2 \pm \sqrt{4.2^2 - 4(-4.9)7.5}}{2(-4.9)}$$

$$= \frac{-4.2 \pm 12.83}{-9.8} = 1.74 \text{ s}$$

X-motion

x_0	x_f	v_{0x}	v_{fx}	a_x	t
0	?	$10\cos 25$	$10\cos 25$	0	1.74

So $x_f = x_0 + v_{0x}t + \frac{1}{2}\cancel{a_x}^{0}t^2$

$$= 0 + 10\cos 25(1.74)$$

$$x_f = 15.7 \text{ m}$$