Name _____

Physics 1210 Exam 1
27 September 2018

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.

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

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

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

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

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

1. (10 pts) Write a few lines of Matlab code that would calculate the position of a blood cell flowing through a vein. It starts at X=-0.5 m with a velocity of +0.4 m/s and has an acceleration of -0.3 m/s$^2$. Write code that would calculate and plot the position each half second from 0 to 3 seconds.

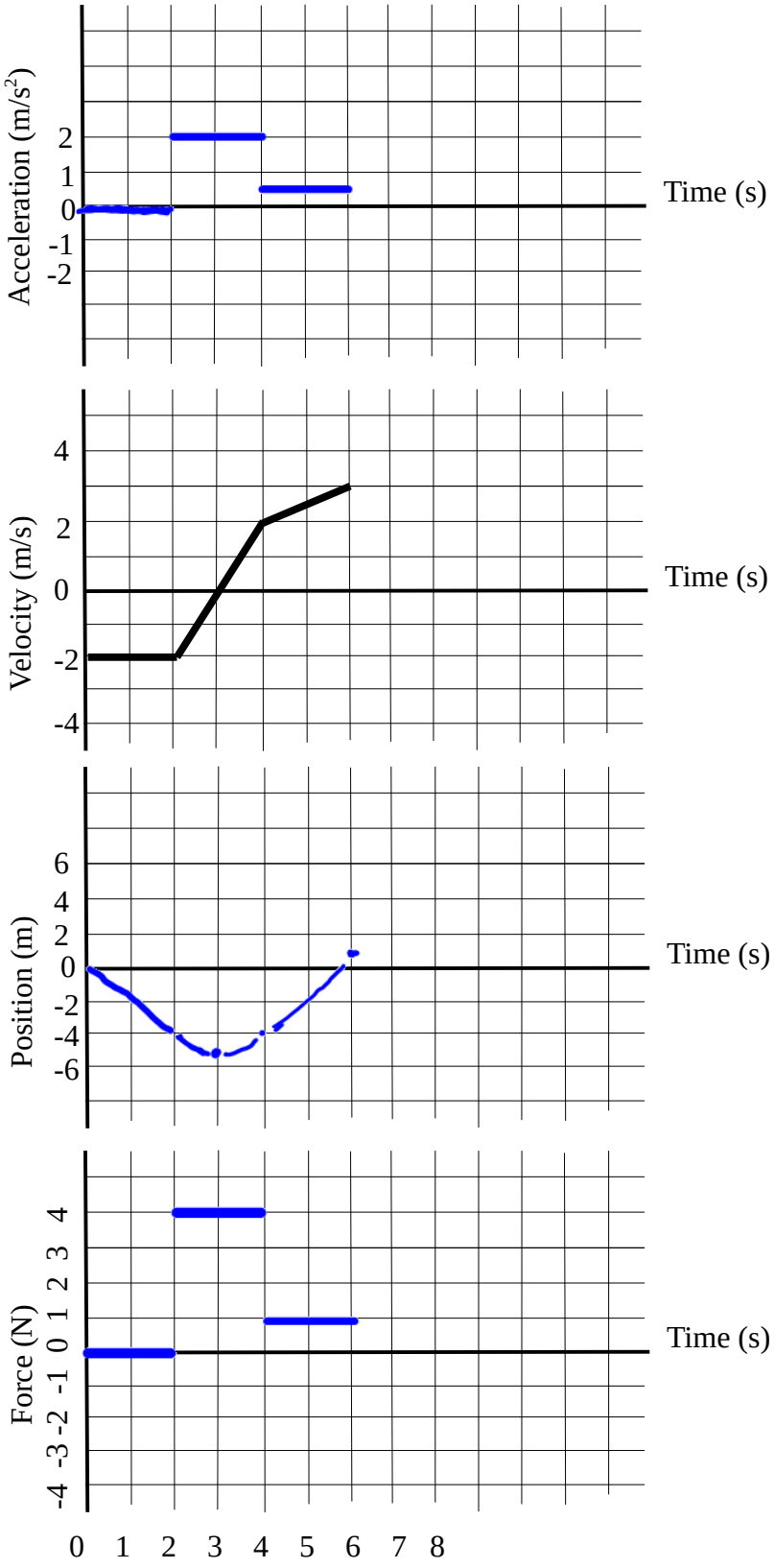
```
a=-0.3
v0=+0.4
x0=-0.5
t=0:0.5:3 (or t=[0,0.5,1.0,1.5,2.0,2.5,3.0]
xf=X0+v0*t + 0.5*a*t.^2
plot(t,x,'somesymbol')
```

2. (10 pts) In this table of four measurements of distance and the weight for each measurement, the weighted mean distance would be: A. 3.0 B. 3.5 C. 4.0 D. <3.5 E. >3.5

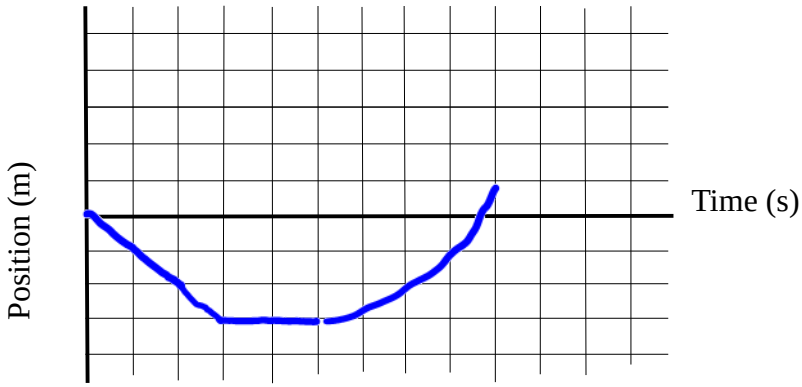
| Distance (m) | weight |
|---|---|
| 3.0 | 4 |
| 3.0 | 5 |
| 4.0 | 1 |
| 4.0 | 2 |

3. (10 pts) A mouse makes a journey consisting of one segment 12 meters in a direction 30 degrees south of east followed by a segment of 15 meters 45 degrees south of west. The final displacement from its starting point is: A. 16.6 m B. 19.2 m C. 22.5 m D. 24.7 m E. 26.7 m

4. (30 pts) Given the indicated velocity-time graph of a 2 kg object that starts at the origin, draw quantitatively (meaning, number the axes) the corresponding force-time, acceleration-time, and position-time graphs.



5. (10 pts) Draw a qualitative (no Y-axis numerals required) position-time graph for a person who starts at the origin, jogs at a constant speed in the negative direction for 3 seconds, rests for 2 seconds, and runs with increasing speed in the opposite direction for 4 seconds.




6. (10 pts) Suppose an object is moving with constant non-zero acceleration.

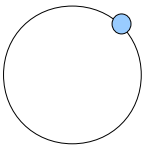
A. In equal times it moves equal distances
B. In equal times its velocity changes by equal amounts.
C. A graph of its position versus time has a constant slope.
D. In equal times its speed changes by equal amounts.
E. A graph of velocity as a function of time is a horizontal line.

7. (10 pts) Jan and Len throw rocks from a tall building. The ground near the building is flat. Jan throws her rock straight downward. Len throws his rock down and outward (at an angle of 60 degrees below the horizontal) with the same speed as Jan's. Which rock hits the ground first (air resistance is negligible)?

A. They hit at the same time B. Jan's hits first C. Len's hits first D. Not enough information is given to know

8. (10 pts) An astronaut is training in a centrifuge that spins at constant speed in a clockwise horizontal circle as shown. Which arrow best represents the direction of her instantaneous acceleration at the location shown?

A. ↘ B. ↗ C. ↙ D. ↖ E. zero length vector



9. (10 pts) A stalled car is being pushed uphill at constant velocity by three people. The net force on the car is

A. down the hill and greater than the weight of the car B. up the hill and greater than the weight of the car
C. down the hill and equal to the weight of the car D. up the hill and greater than the weight of the car
E. zero

10. (10 pts) A stone dropped from the top of a building hits the ground in t seconds. If you double the height of the building a dropped stone will hit the ground in

A. sqrt(2)t B. 2t C. 3t D. 4t E. sqrt(3)t

$$x_f = x_0^{\,0} + v_0^{\,0} t + \frac{1}{2} a t^2$$

$$x_f = \frac{1}{2} a t^2 \rightarrow t = \sqrt{\frac{2x_f}{a}}$$

11. (10 pts) A broken down car is being pulled back to town by a truck attached to the truck by a short chain.

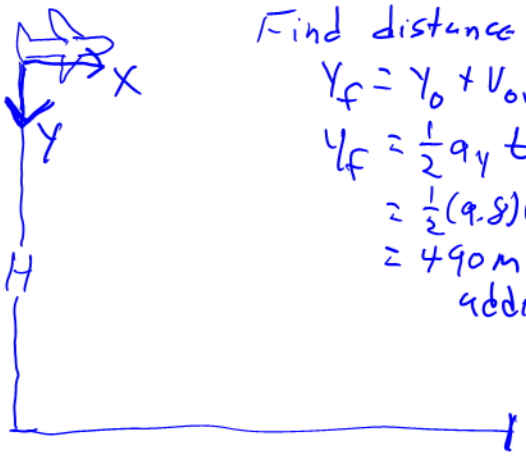
A. The force the car exerts on the truck is greater than the force the truck exerts on the car.
B. The force the car exerts on the truck is less than the force the truck exerts on the car.
C. The force the car exerts on the truck is equal to the force the truck exerts on the car.
D. The force the car exerts on the truck is less than the force the truck exerts on the car only if the truck is accelerating.
E. The force the car exerts on the truck is less than the force the truck exerts on the car only if the truck is decelerating.

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.

East (or full credit for any assumed direction)

12. (30 pts) A parachute jumper leaps from a plane flying at constant altitude H=3 km at an airspeed of $V_p$=30 m/s while there is a wind blowing east at $V_w$=5 m/s. For the first ten seconds she is in free fall (assume no air resistance so that she is a ballistic projectile). At $t_1$=10 sec the parachute opens and she falls with a constant speed of $V_1$=8 m/s downwards and drifts horizontally at the same speed as the wind. Compute a numerical value for

A. The time, $t_f$, when she hits the ground (after leaving the plane).




Find distance dropped in first 10 sec.

$Y_f = Y_0 + V_{oy}t + \frac{1}{2}a_y t^2$ $Y_0 = 0$ at plane

$V_{oy} = 0$ let $a = +9.8\ m/s$

$Y_f = \frac{1}{2}a_y t^2$

$= \frac{1}{2}(9.8)(10)^2$

$= 490\ m$ now find how long it takes to fall an additional $3000 - 490 = 2510\ m$

$Y_2 = Y_1 + V_{oy}t + \frac{1}{2}a_y t^2$ now $a_y = 0$

$V_{oy} = 8\ m/s$

$Y_2 = V_{oy}t$ let $Y_1 = 0\ m$

$Y_2 = 2510\ m$

$t = \frac{Y_2}{V_{oy}} = \frac{2510}{8} = 313\ s$

So total time $313 + 10 = 323$ sec

B. The horizontal distance, D, (eastward!) that she travels after leaving the plane until she hits the ground.

Break into 2 parts

For first 10 s horizontal speed is $30 + 5 = 35\ m/s$

$X_1 = X_0 + V_{ox}t + \frac{1}{2}a_x t^2$ $a_x = 0$

$X_0 = 0$

$X_1 = V_{ox}t$

$= 35(10)$

$= 350\ m$

For next 313 sec horizontal speed is $5\ m/s$ $a_x = 0$

$X_2 = V_{2x}t$

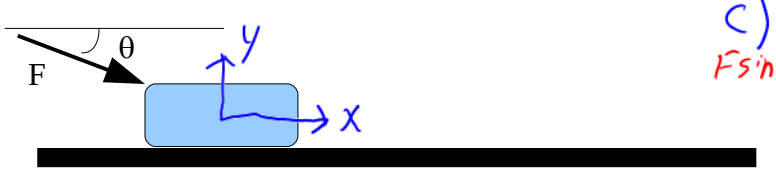
$= 5(313)$

$= 1565\ m$

Total distance $= 1565 + 350 = 1915\ m$

13. (40 pts) An olympic four-man bobsled team pushes a M=110 kg sled with a force of F=1500 N at an angle θ=30 degrees below the horizontal as shown. The sled starts at rest. They can push it a maximum distance of D=12 meters before they jump in. (The sled is on level frictionless ice).

A) Give a numerical value and an analytical expression for the speed of the sled when they enter it.
B) Give an expression for the time it takes them to travel that D=12 meter distance.
C) Draw a free body diagram for the sled
D) Give an expression for the normal force that the ice exerts on the sled.




C) $F$, $F_n$, $F\sin\theta$, $\theta$, $F\cos\theta$, $w$

A). Sum all forces in X direction to find accel. then use kinematics

X-motion

$\Sigma F_x = ma_x$

$F\cos\theta = ma_x$

$\frac{F\cos\theta}{m} = a_x = 11.8\ \frac{m}{s^2}$

we know $X_0 = 0$, $X_f = 12\ m$

and $a_x = 11.8\ m/s$

Try $v_1^2 = v_0^2 + 2a(X_1 - X_0)$

$v_1^2 = 0 + 2\left(\frac{F\cos\theta}{m}\right)X_1$

$v_1 = \sqrt{\frac{2F\cos\theta\, X_1}{m}} = 16.8\ m/s$

B). Try $X_f = X_0 + v_{0x}t + \frac{1}{2}a_x t^2$ $X_0 = 0$, $v_{0x} = 0$, $a_x = \frac{F\cos\theta}{m}$

$X_f = 0 + 0 + \frac{1}{2}a_x t^2$

$t = \sqrt{\frac{2X_f}{a_x}} = \sqrt{\frac{2X_f}{\frac{F\cos\theta}{m}}} = 1.4\ s$

D) $\Sigma \vec{F}_y = m\vec{a}_y$ $a_y = 0$

$F_n - w - F\sin\theta = 0$

$F_n = w + F\sin\theta$

$\boxed{F_n = mg + F\sin\theta}$

$= 1828\ N$