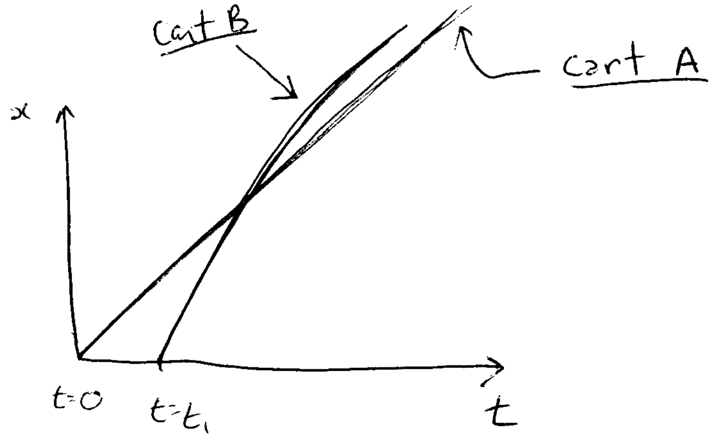
Physics 120 Term Test 1

I

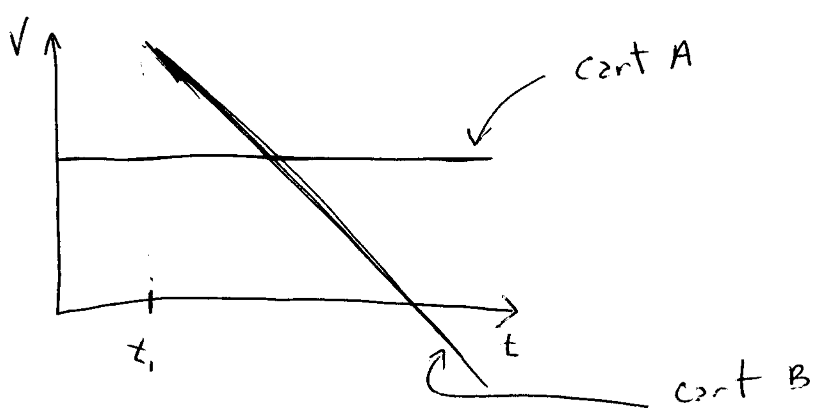
1a)



Note: For part a, b, c Carts DO NOT have to cross.

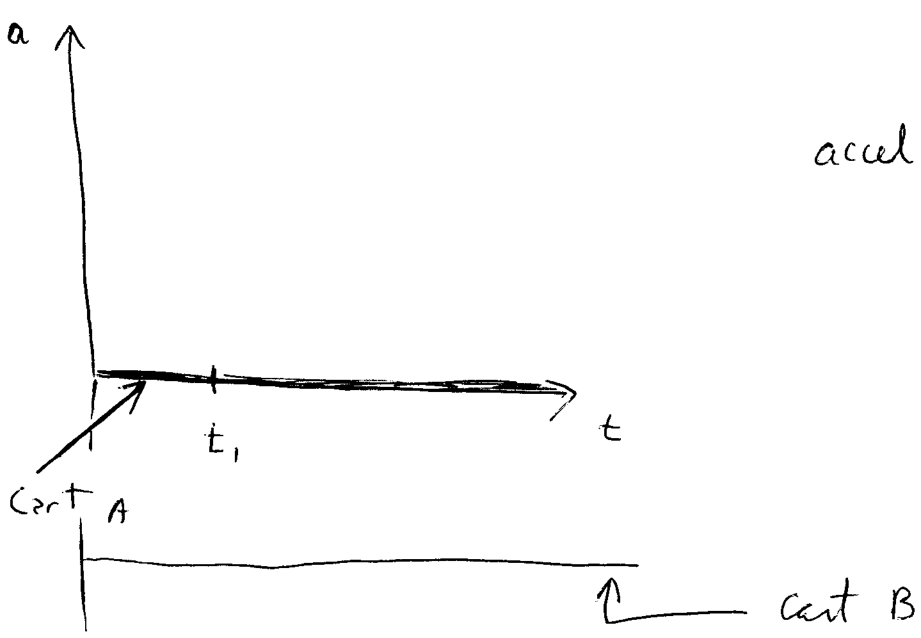
Position – time

b)



V vs t

c)



accel vs t

(II)

d) First, set the positions of the carts equal to determine the <u>crossing time</u>

$$\Delta x_A = \Delta x_B$$

$$V_{Ai}\,\Delta t_A = V_{Bi}\,\Delta t_B - \frac{1}{2}\frac{F_o}{m_c}(\Delta t_B)^2 \quad (*)$$

$\Delta t_A = t$

$\Delta t_B = t - t_1$] use this in (*) and solve for V_{Bi}

$$V_{Bi} = \frac{V_{Ai}\,\Delta t_A}{\Delta t_B} + \frac{1}{2}\frac{F_o}{m_c}\frac{(\Delta t_B)^{\cancel{2}}}{\cancel{\Delta t_B}} \quad (**)$$

we now want to find the time at which the velocity of cart B is V_o, this is the time we use in (**) (as Peter said, V_o is <u>NOT</u> initial velocity)

$$V_o = V_{Bi} - \frac{F_o}{m_c}\Delta t_B$$

so $$\Delta t_B = -[V_o - V_{Bi}]\frac{m_c}{F_o}$$
$$= t - t_1$$

Put this in (**) & simplify to get (check)

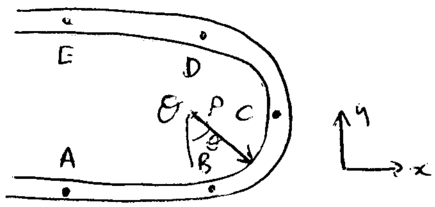
$$-\frac{1}{2}V_{Bi}^2 + V_{Bi}V_{Ai} + \left[\frac{1}{2}V_o^2 + V_{Ai}t_1\frac{F_o}{m} - V_{Ai}V_o\right] = 0$$

This is quadratic in V_{Bi} with $A = -\frac{1}{2}$, $B = V_{Ai}$, $C = \frac{1}{2}V_o^2 + V_{Ai}t_1\frac{F_o}{m} - V_{Ai}V_o$

Put in Quadratic Eqn And you're done.

III

2)



a) at A accel is zero

at C accel is $-\dfrac{V_{car}^2}{\rho}\hat{r}$

at E accel is zero

b) Position as a function of θ: The position vector points from the origin to where the car is located.

x - position of car is $x = \rho \sin\theta$

y - position of car is $y = -\rho\cos\theta$

so $\vec{r} = \rho\sin\theta\,\hat{\imath} - \rho\cos\theta\,\hat{\jmath}$

velocity is time derivative of position so (ρ is constant)

$$\vec{V} = \frac{d\vec{r}}{dt} = \rho(\cos\theta)\frac{d\theta}{dt}\hat{\imath} + \rho(\sin\theta)\frac{d\theta}{dt}\hat{\jmath}$$

If you want to get fancy you can calc. θ as a function of t & put it into your expression but the problem only asked for $\vec{r}$ & $\vec{V}$ as functions of θ.

c) Average velocity is $\dfrac{\Delta\vec{r}}{\Delta t} = \dfrac{\vec{r}_D - \vec{r}_B}{t_2 - t_1}$

Again, taking θ as the origin:

$\vec{r}_D = \rho\sin 180^\circ\,\hat{\imath} - \rho\cos 180^\circ\,\hat{\jmath} = 0\hat{\imath} + \rho\hat{\jmath}$

$\vec{r}_B = \rho\sin 0\,\hat{\imath} - \rho\cos 0\,\hat{\jmath} = 0\hat{\imath} - \rho\hat{\jmath}$

$\Delta t = 2t_0$ (There was a type-o on the exam so you can use t_0 or $2t_0$)

$$\vec{V}_{ave} = \frac{2\rho}{2t_0}\hat{\jmath} = \frac{\rho}{t_0}\hat{\jmath} \quad \left(\text{or } \frac{2\rho}{t_0}\hat{\jmath}\right)$$

d) At the point C the car is undergoing uniform circular motion. The position vector points from the origin (O) to C. The velocity vector points straight up (or down depending on the direction the car is moving)

$$\vec{r} = \rho\,\hat{i} + 0\,\hat{j}$$

$$\vec{v} = V_{or}\,\hat{j}$$

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3) See your notes (we did a similar problem in class)

PART B

4) $v = At^3 + \frac{B}{t}x + C\sin(\omega t)$

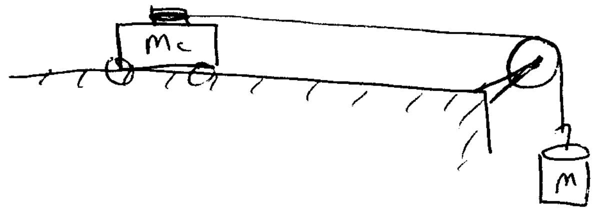
$[A] = \frac{m}{s^2}$, $[B] = \text{unitless}$, $[C] = \frac{m}{s}$, $[\omega] = \frac{1}{s}$

5) The speeds are the same whenever the magnitudes of the slopes are equal.
The particle is at rest (temporarily) at all maxima, minima, flat parts of the graph.
The particle is going fastest where the magnitude of the slope is greatest (steepest slope)

V

6)

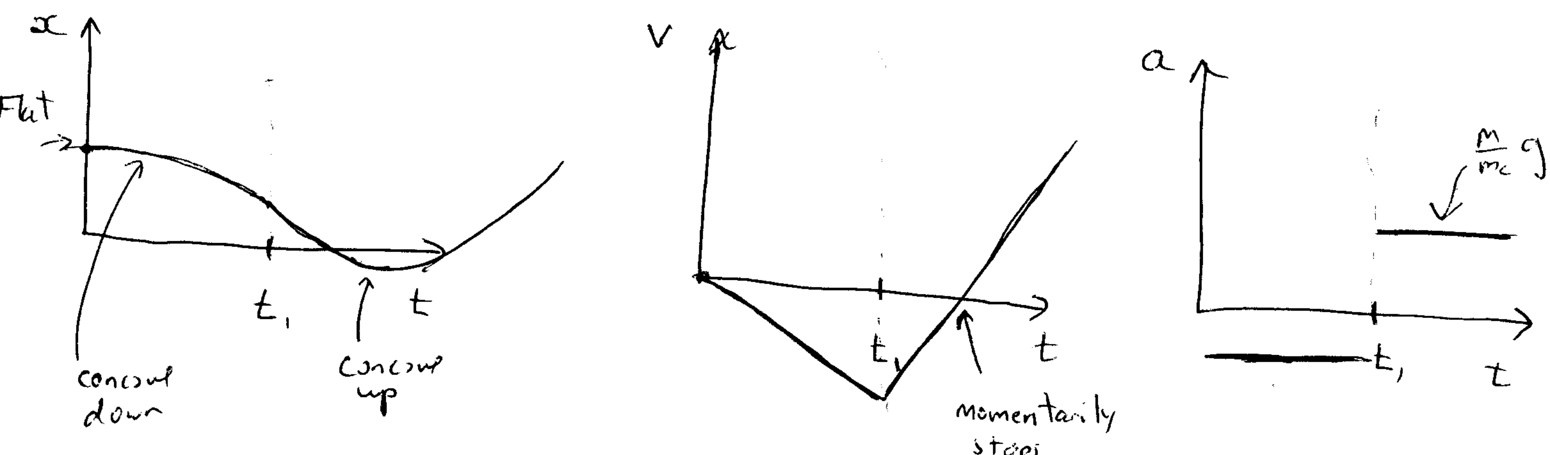
a)



No friction

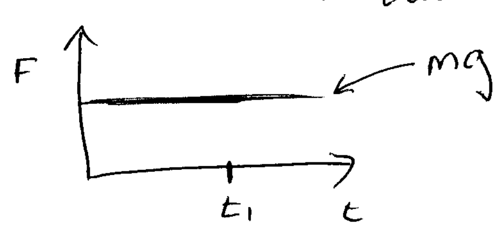
•) while being pushed to the left, the net horizontal force on the cart is $-F_o + mg = m_c a$ (m_c = mass of cart) so the acceleration is to the left ($F_o > mg$)

•) when you let go of the cart, $F_o = 0$ so the acceleration is to the right of magnitude $\frac{m}{m_c} g$.

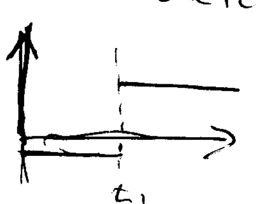


Only the general shape of these graphs is important.

b) The force sensor only detects the force due to the weight for part b

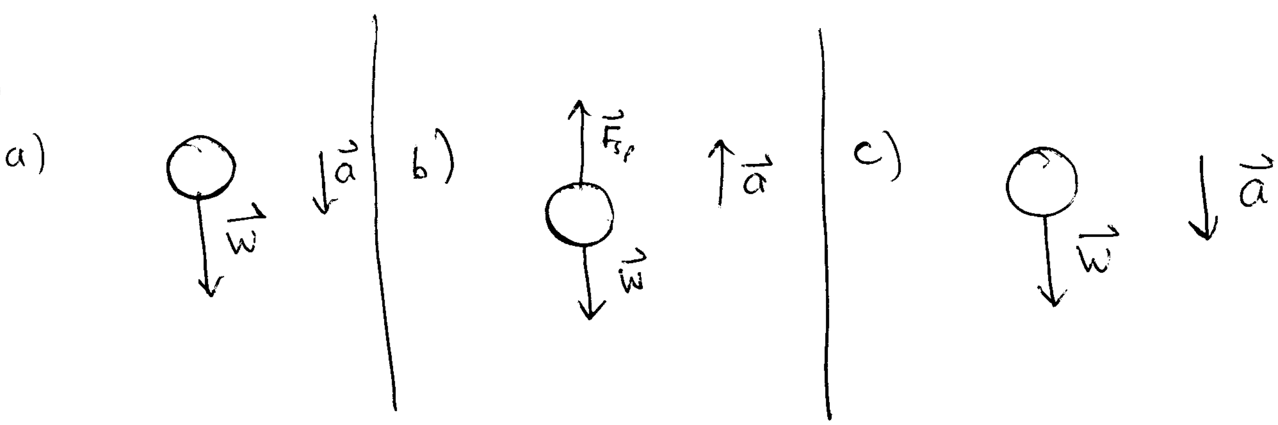


c) Now the force sensor detects the Net Force



VI

7)



8) The y-velocity is zero.
The x-acceleration is zero.] at max height (Projectile)