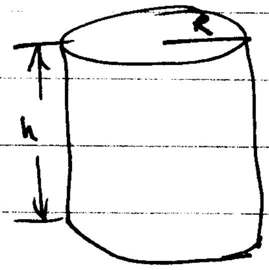
Physics 151 Practice Exam #1 Sol^{n}s

1) The Volume of the cylinder is given by $V = \pi R^2 h$



this can be used to find mass

$m = \rho V$

$\rho = 1 \frac{g}{cm^3} \times \left(\frac{100cm}{1m}\right)^3 \times \frac{1kg}{1000g}$

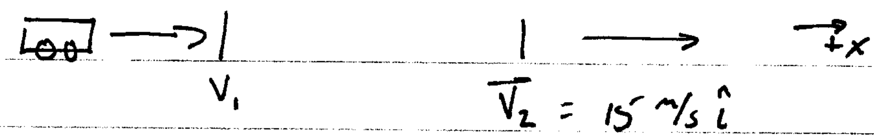
$= 1000 \frac{kg}{m^3}$

$V = \pi \left(\frac{39.3m}{2}\right)^2 (41.4m)$

$= 5 \times 10^4 m^3$

so $M = \rho V = 5 \times 10^7 kg$

2) with constant acceleration we can use the kinematic relations



$V = V_0 + at$

so $V_1 = V_0 + at_1$

$V_2 = V_0 + at_2$

and $V_2 - V_1 = a(t_2 - t_1)$

$X_1 = X_0 + V_0 t + \frac{1}{2} a t^2$

$X_2 = X_0 + V_0 t + \frac{1}{2} a t^2$

$X_2 - X_1 = V_0 t_2 + \frac{1}{2} a t^2 - V_0 t_1 - \frac{1}{2} a t_1^2$

$X_2 - X_1 = V_0 (t_2 - t_1) + \frac{1}{2} a (t_2^2 - t_1^2)$

And $V_1 = V_0 + at_1$

$\rightarrow V_0 = V_1 - at_1$

so

$\cancel{X_2 - X_1 = (V_1 - at_1)(t_2 - t_1)}$

$\cancel{+ \frac{1}{2} a}$

$$x_2 - x_1 = (v_1 - a t_1)(t_2 - t_1) + \tfrac{1}{2} a (t_2^2 - t_1^2)$$
$$= v_1 (t_2 - t_1) - a t_1 t_2 + a t_1^2 + \tfrac{1}{2} a (t_2^2 - t_1^2)$$
$$= v_1 (t_2 - t_1) + \tfrac{1}{2} a (t_2^2 + t_1^2 - t_1 t_2)$$
$$= v_1 (t_2 - t_1) + \tfrac{1}{2} a (t_2 - t_1)^2$$

OR simply

$$\Delta x = v_1 \Delta t + \tfrac{1}{2} a \Delta t^2 \quad \text{AND} \quad v_2 = v_1 + a \Delta t$$

we don't know a so ~~this~~

$$a \Delta t = v_2 - v_1$$
$$a = \frac{v_2 - v_1}{\Delta t}$$

and

$$\Delta x = v_1 \Delta t + \tfrac{1}{2} \frac{(v_2 - v_1)}{\cancel{\Delta t}} \Delta t^{\cancel{2}} = v_1 \Delta t + \tfrac{1}{2} v_2 \Delta t - \tfrac{1}{2} v_1 \Delta t$$
$$= \tfrac{1}{2} v_2 \Delta t + \tfrac{1}{2} v_1 \Delta t$$
$$\Rightarrow$$
$$\frac{2 \Delta x}{\Delta t} = v_2 + v_1$$

so

$$v_1 = \frac{2 \Delta x}{\Delta t} - v_2$$
$$= \frac{2 \times 60\,m}{6\,s} - 15\,m/s$$
$$= 20\,m/s - 15\,m/s = 5\,m/s$$

b) $$a = \frac{v_2 - v_1}{\Delta t} = \frac{15\,m/s - 5\,m/s}{6\,s} = \frac{10\,m/s}{6\,s} = 1.67\,m/s^2$$

c) if we make $t = 0$ when $v = 0$

$$v = \cancel{v_0}^{\,0} + at$$

then the car is ~~moving~~ at $5\,m/s$

at $$5\,m/s = 5/3\,m/s^2\, t$$
$$t = 3\,s$$

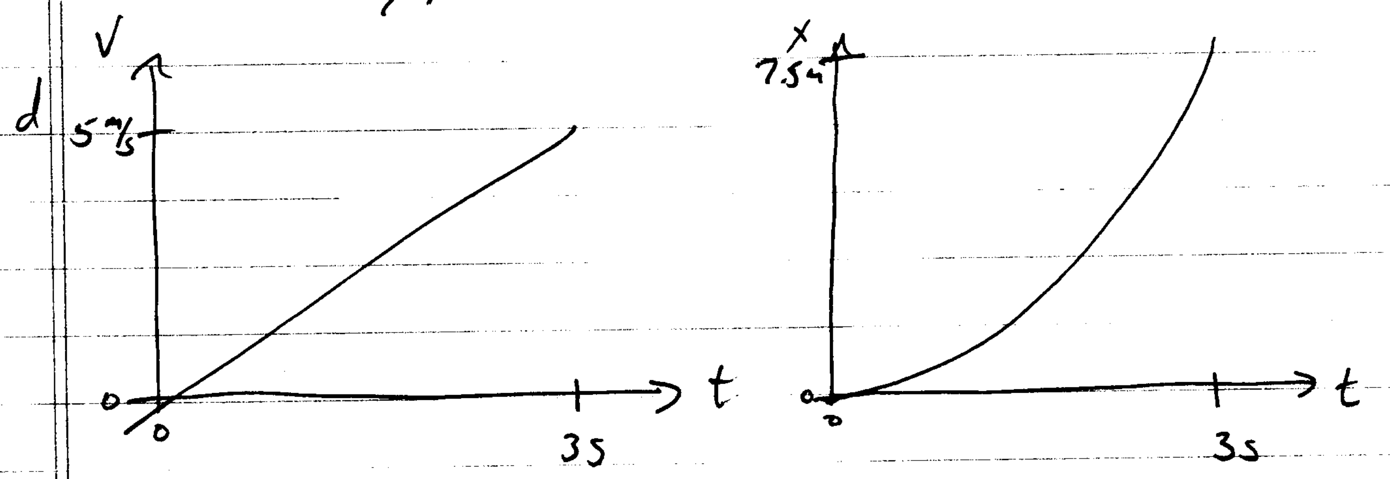
And if we make $x = 0$ @ $t = 0$

$$x = \cancel{v_0 t}^{\,0} + \tfrac{1}{2} a t^2$$

the car will be at position 1 @ 3 s

$$x = \tfrac{1}{2}\, \tfrac{5}{3}\ m/s^2\ (3s)^2 = 7.5\,m$$

so at $t=0$ the car is 7.5 m to the left of position 1.

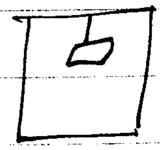


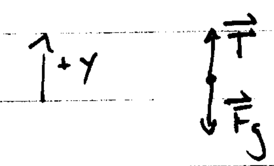
3 a) $D = \dfrac{x}{\sqrt{t}}$ so D has units of $m/\sqrt{s}$

b) $v = \dfrac{dx}{dt} = D\,\tfrac{1}{2}\, t^{-1/2}$

c) $a = \dfrac{dv}{dt} = \dfrac{-D}{4}\, t^{-3/2}$

d) Assuming that $D > 0$ The molecule will be slowing Down.

4) 



Free Body diagram for lamp.

$$\vec{a} = \frac{\Sigma \vec{F}}{m} = \frac{T\hat{j} - mg\hat{j}}{m}$$

$$a\hat{j} = \frac{T\hat{j} - mg\hat{j}}{m}$$

$$T = ma + mg$$

$$m(a+g) = T$$

$$m = \frac{T}{a+g} = \frac{89\,N}{2.4\,m/s^2 + 9.8\,m/s^2}$$

note a is in $+\hat{j}$ direction for a descending, slowing elevator.

$$m = 7.3\text{ kg}$$

b) This is exactly the same situation as before (part a) $\vec{a} = 2.4\,m/s^2\,\hat{j}$

c) Now $\vec{a} = -2.4\,m/s^2\,\hat{j}$ so

$$T = m(a+g) = 7.3\,kg(-2.4\,m/s^2 + 9.8\,m/s^2)$$
$$= 54\,N.$$