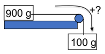
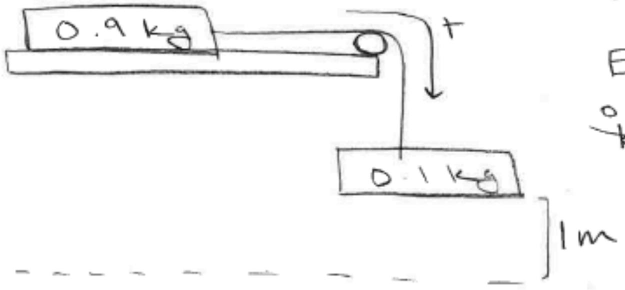
Big Exam #5:



1) In the diagram at right, a 900 g mass on a low friction surface is attached to a freely falling 100 g mass 1 m above the floor. The system is started from rest.
a) How would you find the maximum speed of the 900 g mass?
b) How long would this take?
c) Can you calculate the acceleration?
d) Can you think of another way to find the acceleration of the system?

I show a few good energy lens approaches, and one dynamics lens.



$V_0 = 0\ m/s$

Energy Lens

$\overset{0}{\cancel{KE}} + \underline{PE \Rightarrow KE + \overset{0}{\cancel{PE}}}$

a) Set: $PE = KE + PE$

$mgh = 1/2\, m_s v^2 + \cancel{mgh}$

$(0.1\ kg)(10\ m/s^2)(1\ m) = 1/2\,(0.9\ kg + 0.1\ kg)\, v^2$

$1\ J = 1/2\,(1\ kg)\, v^2$

$1\ J = 0.5\ kg\, v^2$

$v^2 = 2\ m^2/s^2$

$\boxed{V_{max} = \sqrt{2}\ m/s}$

b) $\Delta x = v \Delta t$

$\Delta t = \Delta x / V_{ave}$

$= 1m / (\sqrt{2}\ m/s - 0\ m/s / 2)$

$= 1m / \sqrt{2}\ m/s / 2$

$= 2m / \sqrt{2}\ m/s$

$= \boxed{2/\sqrt{2}\ s}$

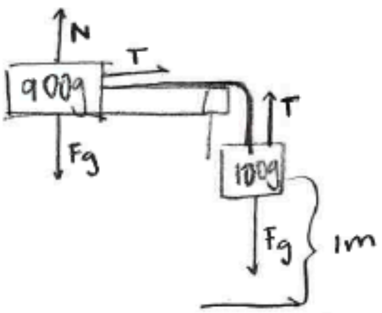
c) $a = \Delta v / \Delta t$

$= \dfrac{\sqrt{2}\ m/s - \cancel{0\ m/s}}{(2/\sqrt{2}\ s - \cancel{0\ s})}$

$= \dfrac{\sqrt{2}\ m/s}{2/\sqrt{2}\ s}$

$= \sqrt{2}\ m/s \cdot \sqrt{2}/2\ s$

$= \boxed{1\ m/s^2}$



A

a) Lense: Energy b/c transferring potential energy into kinetic energy.

$PE \Rightarrow KE \Longrightarrow m_1 g \overset{0}{\cancel{h_1}} + m_2 g h_2 = \frac{1}{2} m_1 v^2 + \frac{1}{2} m_2 v^2$

$100(10)(1) = \frac{1}{2}(1000) v_f^2$

$(2)\cancel{1000} = \overset{(2)}{\cancel{\frac{1}{2}}}\cancel{(1000)} v_f^2$

$\boxed{v_f = \sqrt{2}\, m/s}$

b) Lense: Kinematics b/c looking at speed as a function of time

$V_{avg} = \frac{\Delta x}{\Delta t} \Longrightarrow \frac{\sqrt{2}}{2} \overset{(t)}{=} \frac{1-0}{\Delta t}(t) \rightarrow \boxed{t = \frac{2}{\sqrt{2}} s}$

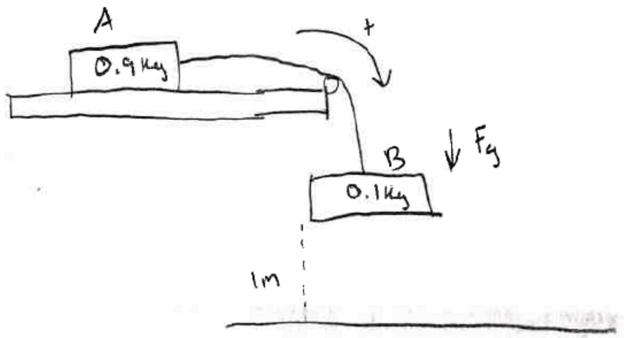
c) Kinematics

$a = \frac{\Delta v_f}{\Delta t} = \frac{\sqrt{2}-0}{\frac{2}{\sqrt{2}}\cancel{\left(\frac{\sqrt{2}}{1}\right)}} \Longrightarrow \boxed{1 m/s^2}$

d) can calculate acceleration through dynamics lense b/c forces cause acceleration

$\Sigma \vec{F} = m_s \vec{a}$

$a = \frac{\Sigma F}{m} = \frac{mg}{(10)\cancel{m}} = 1 m/s^2$



a) I will use an energy lens because energy changes forms. $PE_B \Rightarrow KE_{A+B}$

$(0.1kg)(10 m/s^2)(1m) = \frac{1}{2}(1kg)(v^2)$ $\quad v = \sqrt{2(0.1)(10 m/s^2)(1m)} = \sqrt{2}\, m/s$

b) kinematics because I have motion as explicit f(t).

$V_{ave} = \frac{\Delta x}{\Delta t} \Rightarrow \Delta t = \frac{\Delta x}{V_{ave}} \Rightarrow \Delta t = \frac{1m}{\sqrt{2}/2\, m/sec} \Rightarrow \Delta t = \sqrt{2}\, sec$

c) Dynamics because forces cause acceleration

$\Sigma F = m_s a_s \Rightarrow F_g = (1kg)a_s \Rightarrow (0.1kg)(10 m/s^2) = (1kg)a_s \Rightarrow a_s = 1 m/s^2$

d) Kinematics because I have motion as an explicit f(t).

$a = \frac{\Delta v}{\Delta t} \Rightarrow a = \frac{\sqrt{2}\, m/sec}{\sqrt{2}\, sec} \Rightarrow a = 1 m/s^2$

A great

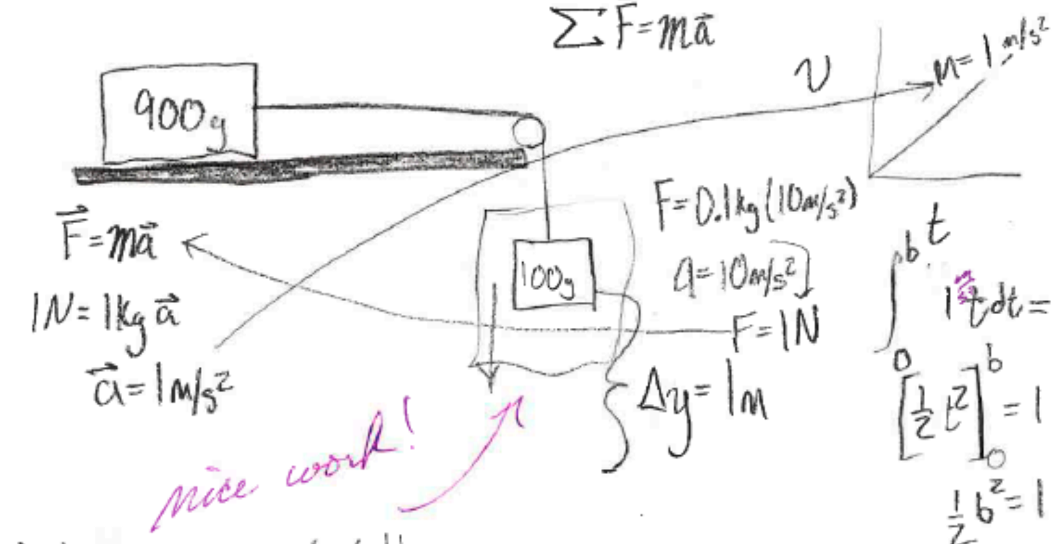
b) How long would this take?

c) Can you calculate the acceleration?

d) Can you think of another way to find the acceleration of the system?

$v(t) = 1\frac{m}{s^2}(t)$

$\sum \vec{F} = m\vec{a}$



$\vec{F} = m\vec{a}$

$1N = 1kg\,\vec{a}$

$\vec{a} = 1 m/s^2$

$F = 0.1kg(10 m/s^2)$

$a = 10 m/s^2$

$F = 1N$

$\Delta y = 1m$

nice work!

$\int_0^b 1\frac{m}{s^2}t\,dt = 1m$

$\left[\frac{1}{2}t^2\right]_0^b = 1$

$\frac{1}{2}b^2 = 1$

$b = \sqrt{2}\,sec$

a) The maximum speed of the 900g mass would occur just as the 100g mass hits the floor. We would need to find the acceleration on the system to find this.

b) This would take $\sqrt{2}$ seconds using kinematics

c) Yes I can calculate the acceleration. $\vec{a} = \frac{\sum \vec{F}}{m}$, and because the only force (1N) is from the falling 100g mass. The $a = 1 m/s^2$

d) I could use the energy laws to find the v_f of the system, and find a by using $\frac{v_f - v_0}{\Delta t}$

Name ____