Lab schedule
Learn

ECE105 - Introduction

Sep 8/2017

Practice:

$V_1 = 23 m/s \quad \vec{a} = -9.8 m/s^2 \quad V_2 = 0$

$d = V_2^2 - V_1^2 / 2a = 27.0 m$

$\vec{V_f}^2 - \vec{V_0}^2 = 2\vec{a}\Delta\vec{y}$

$0 - (23)^2 = 2|\vec{a}||\Delta\vec{y}| \cos 180 \quad -1$ this is where the - sign comes from (a is ~~not~~ -9.8)

$\Delta y = \frac{-23^2}{-2(9.8)}$

Definitions:

$\vec{V}_{avg} = \frac{\Delta\vec{x}}{\Delta t} \Big\} \lim_{\Delta t \to 0} \vec{V}_{avg} = \lim_{\Delta t \to 0} \frac{\Delta\vec{x}}{\Delta t} = \text{inst. } \vec{V} \Big\} \frac{d\vec{x}}{dt}$

$\vec{a}_{avg} = \frac{\Delta\vec{V}}{\Delta t} \Big\} \lim_{\Delta t \to 0} \vec{a}_{avg} = \lim_{\Delta t \to 0} \frac{\Delta\vec{V}}{\Delta t} = \text{inst. } \vec{a} \Big\} \frac{d\vec{v}}{dt}$

$\Delta\vec{x} = \frac{1}{2}\vec{a}t^2 + \vec{V}_0 t$

$\hookrightarrow \vec{x}(t) = \frac{1}{2}\vec{a}t^2 + \vec{V}_0 t + \vec{x}_0$ (just made it Δd)

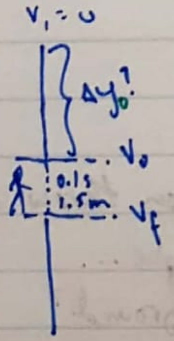
assuming constant $\vec{a}$

$x(t) = t^3$
$V(t) = 3t^2$
$a = 6t$

$X(t) = \int V dt + C$
$= t^3 + C \leftarrow$ or x_0
$V(t) = \int a dt + V_0 \leftarrow$ need const for initial values

Example:

You are sitting in your room. Stone dropped from top of building, you see it from window for 0.1s. From what height above ⊞ was dropped if ⊞ 1.5m



$V_1 = 0 \quad a = +9.8$

$\Delta\vec{y} = \frac{1}{2}\vec{a}t^2 + \vec{V}_0 t$

$1.5 = \frac{1}{2}(+9.8)(0.1)^2 + \vec{V}_0(0.1)$

$\vec{V}_0 = 14.51 m/s$

$V_f^2 - V_0^2 = 2(9.8)\Delta y$

$14.51^2 - 0 = 19.6\Delta y$

$\Delta y =$

Lecture 2 - Relative Motion Sep 11/2017

Example:

1) You throw 2 balls simultaneously. one ↑ 30 m/s one ↓ 15 m/s. Distance between them 3 seconds later?

Ball 1 Δd: $\frac{1}{2}\vec{a}t^2 + V_0 t$
$= -\frac{1}{2}(9.8)(3)^2 + (30)(3)$
$= 45.9\,m$

Ball 2 Δd: $\frac{1}{2}\vec{a}t^2 + V_0 t$
$= -\frac{1}{2}\vec{a}t^2 + V_0 t$
$= -\frac{1}{2}(9.8)(3)^2 + (-15)(3) = -89.1$

$|\Delta d_2 - \Delta d_1| = 135\,m$

Best way ⇒ $\vec{V}_{12} = 45$ $\vec{V}_{12} \times t = \Delta d = 135$

2) You let go of a ball and 0.5 seconds later you throw another straight down at 9.8 m/s. $\vec{V}_{12}$ after 3 seconds?

ball 1 is going 4.9 m/s

4.9 m/s, no matter what t is.

Relative Motion:

$\vec{V}_{12} = \vec{V}_1 - \vec{V}_2$

$\Delta\vec{x}_{12} = \Delta\vec{x}_1 - \Delta\vec{x}_2$

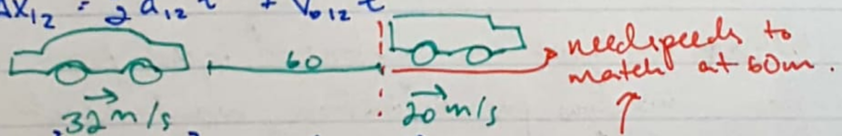
$\vec{a}_{12} = \vec{a}_1 - \vec{a}_2$

Example:

1) You are driving at 32 m/s, 60 m behind a truck moving at 20 m/s. Truck brakes at 4 m/s². What must be your $\vec{a}$ for no collision?

* Can't assume truck stops before you hit it.

$\Delta\vec{x}_{12} = \frac{1}{2}\vec{a}_{12}t^2 + V_{0\,12}t$



match $\cancel{V_{12f}^2} - V_{12_0}^2 = 2\vec{a}_{12}\cdot\Delta\vec{x}_{12}$

$-(V_{1_0} - V_{2_0})^2 = 2(\vec{a}_1 - \vec{a}_2)\cdot(\vec{x}_2 - \vec{x}_1)\cdot(-1)$

$-(12)^2 = -2(\vec{a}_1 - 4)(60)$

Find $\vec{a}_1$

2) You are in an elevator moving up at 6 m/s (open roof), you throw an apple straight up at 25 m/s (rel. to you). Max height of apple...

a) rel to you? b) rel to original height above ground?

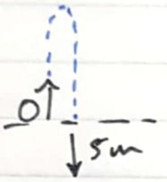
Scanned by CamScanner

Projectile Motion:

Sep 13, 2017

Example:

1) $v = 20\,m/s$



$v_f = ?$

$\Delta d_v = -5\,m$

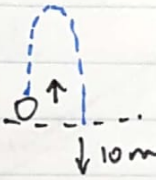
$\Delta d_v = \frac{v_f^2 - v_0^2}{2a}$

$-5 = \frac{v_f^2 - 20^2}{-2(9.8)}$

$v_f = 22.3\,m/s$ (down)

$\left\{ v_f^2 - v_0^2 = 2|\vec{a}||\Delta \vec{d}|(\cos\theta) \right.$ — $|\Delta\vec{d}|$: +ve, $\cos\theta$: +1

2) $v = 30\,m/s$



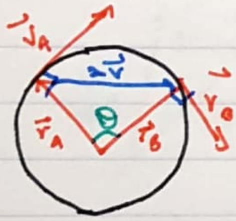
$t = ?$

$\Delta d_v = \frac{1}{2}\vec{a}t^2 + \vec{v}_0 t$

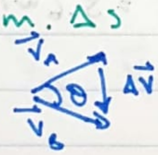
$-10 = \frac{1}{2}(-9.8)t^2 + (30)t$

$t =$

Circular Motion:



Sim. Δs



$\Delta\vec{v} \perp \Delta\vec{r}$ + $\parallel \Delta\vec{a}$

$a_r = \frac{v^2}{r}$

$s = \theta r$

$v = \omega r$

$a = \alpha r$

Example:

1) An object moves around a vertical circle starting at $\theta = 0$, $t = 0$, its speed is $10\,m/s$ 2 seconds later. What is the total $\vec{a}$ at $t = 2$?

Not constant $\vec{a}$. $\vec{a}_t$ $\vec{a}_r$ *Forgot to give $r = 7\,m$

Tangential $\vec{a}_t$: Use kin. equations to find $\vec{a}_t = 5\,m/s^2$

$\left\{ \vec{a}_c + \vec{a}_t = \vec{a} \right.$ ↑ perpendicular.

$\vec{a}_c = \frac{v^2}{r} = \frac{100}{7}$

$|\vec{a}| = \sqrt{a_t^2 + a_c^2}$

$= \sqrt{25 + \left(\frac{100}{7}\right)^2}$

Albert Wasef

ECE 105 Lab Introduction — Sep 14, 2017

Review guidlines on learn.

Read lab manual before lab

Submit on learn dropbox

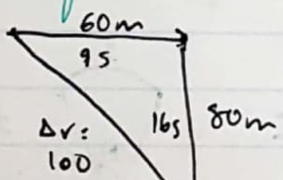
- ↳ prelab1, data1, report1, lab1
- ↳ Same file renamed.

Lab 1 on 28th

Error Analysis - read on learn.

Example: — Sep 15, 2017

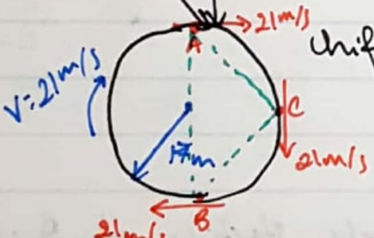
1)



$\vec{V}_{avg} = \frac{100}{25} = 4 m/s$

$V_{avg}\text{(speed)} = \frac{140}{25} = 5.6 m/s$

2)



Uniform.

Find: $\vec{V}_{avg_{AB}} = ?$ $\vec{a}_{avg_{AB}} = ?$

$\vec{V}_{avg_{AC}} = ?$ $\vec{a}_{avg_{AC}} = ?$

$V_{avg}\text{(speed)} = ?$

$\vec{A} \to \vec{B}$:

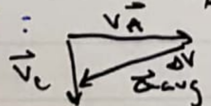
$\vec{V}_{avg} = \frac{2(17)}{(\pi r/21)}$ ← $\Delta d/\Delta t$, so $\Delta t = (\Delta d)(\vec{V})$ $= \frac{34}{(\pi r)(1/21)} (-\hat{j})$

$\vec{A} \to \vec{C}$:

$\vec{V}_{avg} = \left[\frac{(\sqrt{2})(17)}{(\pi r/(2)(21))}\right]\cos 45°\,\hat{i} + \left[\frac{(\sqrt{2})(17)}{(\pi r/(2)(21))}\right]\sin 45°\,\hat{j}$

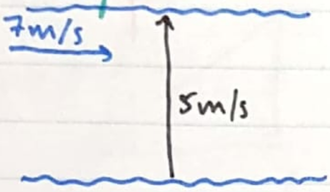
$\vec{a}_{avg}$ $\vec{A} \to \vec{B}$ $= \frac{42(-\hat{i})}{(\pi r/21)}$ $\xrightarrow{v_A}$ $\xleftarrow{v_B}$ $\therefore \vec{a} \leftarrow$

$\vec{a}_{avg}$ $\vec{A} \to \vec{C}$:



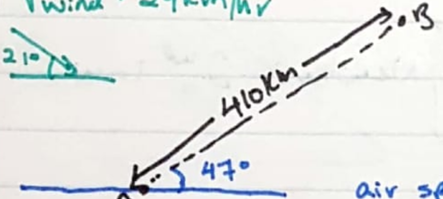
$= \frac{\Delta \vec{V}}{\Delta t} = \frac{\vec{V}_C - \vec{V}_A}{\Delta t} = \frac{\quad}{(\pi r/(2)(21))}$

Example..?

1)


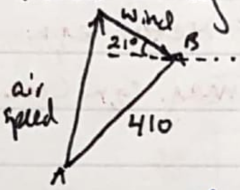
Must aim straight across to cross in fastest time.

Bearing: where you aim
Heading: where you end up.

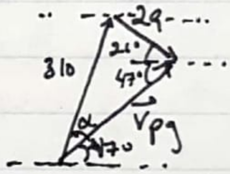
2) $V_{wind} = 29 km/hr$


air speed = 310km/hr

a) How long does trip take?



$\vec{V}_{pg} = \vec{V}_{pa} + \vec{V}_{ag}$



$\frac{\sin 68}{310} = \frac{\sin \alpha}{29}$

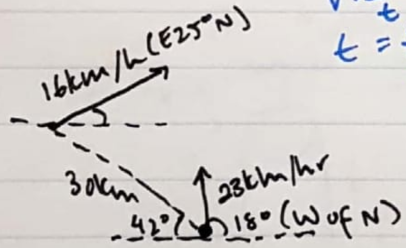
$\alpha = 4.98°$

$\frac{\sin 107°}{\vec{V}_{pg}} = \frac{\sin 68}{310}$

$V = \frac{d}{t}$

$t = \frac{d}{V} = \frac{410}{319.7} = 1.28 hr$ bearing: 51.98°

$\vec{V}_{pg} = 319.7 m/s$

3)


what is closest distance of approach?

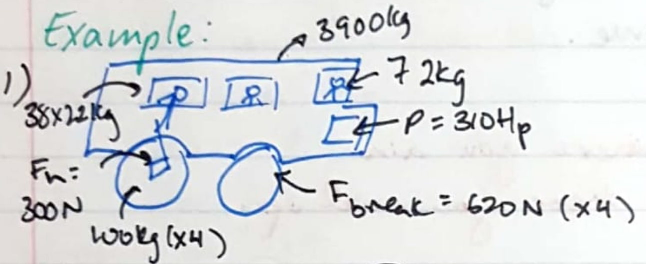
Find relative V rel to time. Derive for rel. Δd.

Sep 18, 2017

Forces:

Example:

1)

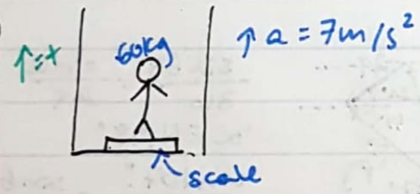


F_{net} = wheel?

$F_{net} = ma$
$= (100)(3.2)$
$= 320\,N$

} Newton's 2^{nd} law

2)



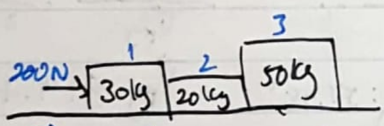
$\Sigma \vec{F}_y = m\vec{a}$

$\vec{N} + m\vec{g} = m\vec{a}$ ← vector eqn

$N - mg = ma$ ← mag. eqn (cos θ makes −)

$N = 1008\,N$

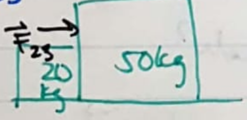
3)



$\Sigma F = ma = 200$

$a = 2\,m/s^2$

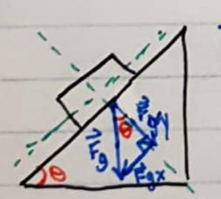
$\vec{F}_{23}$ = look at 3 in isolation



$\Sigma F = ma$
$= (2)(50)$
$= 100\,N$

Sep 20, 2017

*Grl2 physwals?
axis in direction of $\vec{a}$

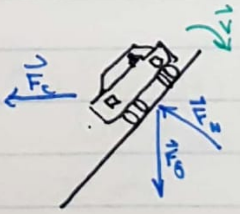


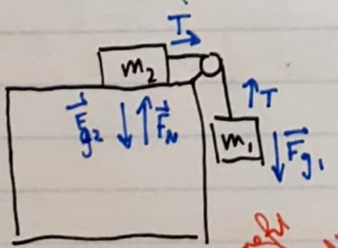
$\vec{F}_{gy} = -\vec{F}_N = \vec{F}_g \cos\theta$

Not a law!

$\vec{F}_{gx} = \vec{F}_g \sin\theta$

$\vec{F}_c$ ←





*be careful w/ a direction

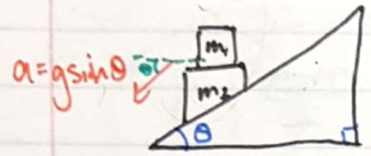
$\vec{F}_N = \vec{F}_{g2}$

$\Sigma \vec{F}_x = ma$

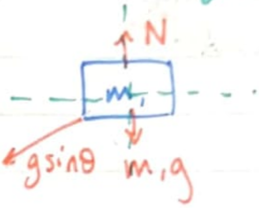
$T = m_2 a$ or $m_1 a = F_{g1} - T$ (depends on $\vec{a}$)

$a = \frac{m_1 g}{m_1 + m_2}$ $\quad T =$

Find the $\vec{N}$ between m_1 and m_2.



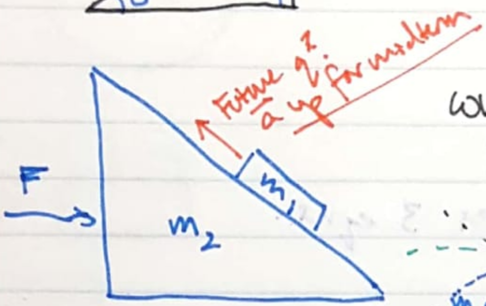
break up $\vec{a}$ into components



$\vec{N} + m_1\vec{g} = m\vec{a}_y$

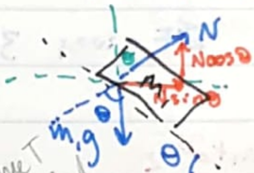
$N = m_1 g - m_1 g\sin^2\theta$

$= m_1 g\cos\theta$



What does F = ? so m_1 does not slide on m_2

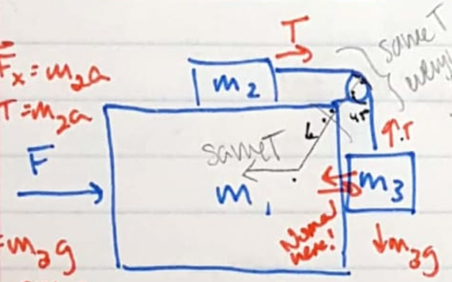
$F = (m_1 + m_2)a$



~~$N = mg\cos\theta$~~ more $\vec{F}$ applied

$\Sigma \vec{F}_y = m\vec{a}_y$ $\Sigma F_x = m\vec{a}_x = 0$

$\boxed{N\sin\theta = m_1 a}$ $\boxed{N\cos\theta = m_1 g}$ $\boxed{a = g\tan\theta}$



$\Sigma \vec{F}_x = m_2 a$

$T = m_2 a$

$T = m_3 g$

$m_3 g = m_2 a$

$a = \left(\frac{m_3}{m_2}\right) g$

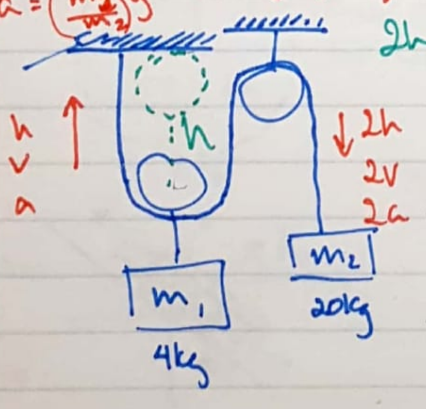
1) What force do you have to push m_1 w. so m_3 does not slide on m_1?

2) You let system go. Find $\vec{a}$ of m_1 ←.

m_1 feels tension ← since pulley is part of mass.

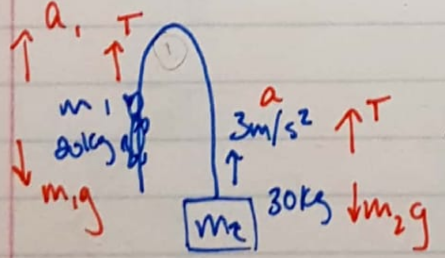
$\therefore F = (m_1 + m_2 + m_3)\left(\frac{m_3}{m_2}\right) g$

2h slack avail, so $m_2 \downarrow 2h$.



☆ Review

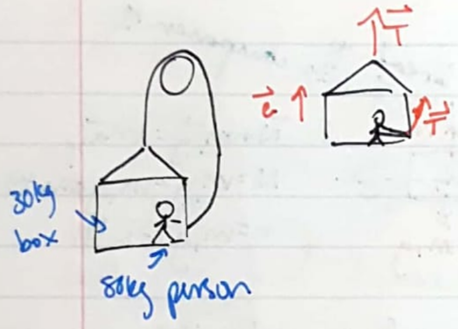
grid notes ☆



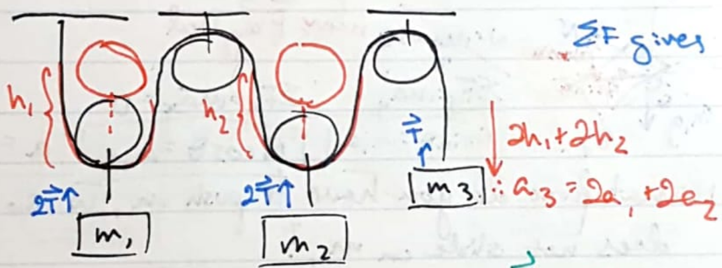
$\Sigma_{m_2} \vec{F}_y = m_2\vec{a}_y = \vec{T} + m_2\vec{g} = m_2\vec{a}_2$

$\Sigma_{m_1} F_y = m_1\vec{a}_y = \vec{T} + m_1\vec{g} = m_1 a_2$

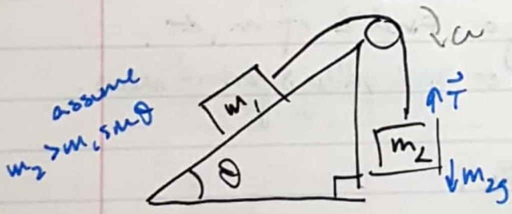
$a_1 = \dfrac{m_2 g - m_1 g + m_2 g}{m_1}$



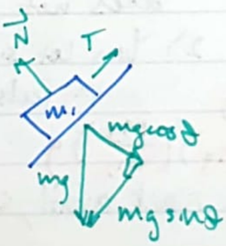
$$\sum \vec{F}_y = m\vec{a}_y$$
$$2\vec{T} + m_T\vec{g} = m_T\vec{a}$$
$$T = \frac{m_T g + m_T a}{2} = \frac{m_T g}{2}$$

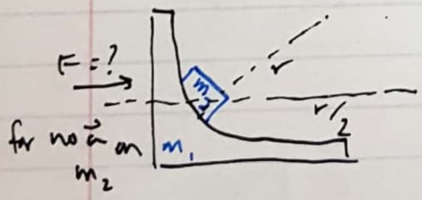


ΣF gives 3 eqns.



$a = ?$

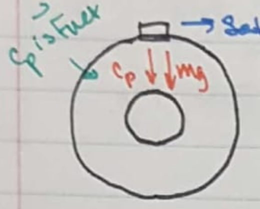


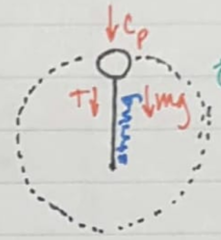


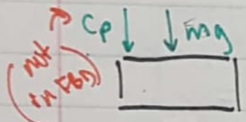
$(m_1+m_2)g\tan\theta$

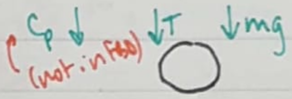
Satellite Motion:

Sep 25, 2017

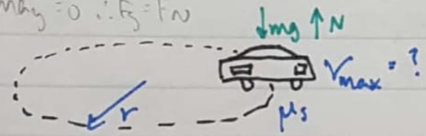








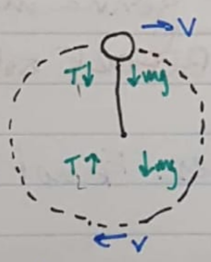
$\sum \vec{F_y} = m\vec{a_y} = 0 \therefore F_g = F_N$



$\sum \vec{F_r} = \frac{mv^2}{r} = \mu_s F_N = \mu_s F_g = \mu_s m g$

$\frac{mv^2}{r} = \mu_s mg$

$v = \sqrt{\mu_s r g}$



vertical ○. Find ΔT from top and bottom.

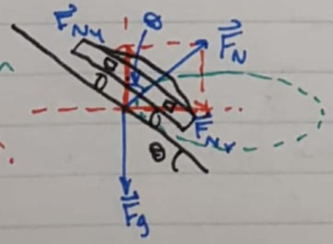
Top: $\sum \vec{F_r} = \frac{mv^2}{r} = T_1 + mg$ $T_1 = \frac{mv^2}{r} - mg$

Bottom: $\sum \vec{F_r} = \frac{mv^2}{r} = T_2 - mg$ $T_2 = \frac{mv^2}{r} + mg$

$\Delta T = T_1 - T_2$
$= \frac{mv^2}{r} - mg - \left(\frac{mv^2}{r} + mg\right)$
$= -2mg$

no friction v = ?

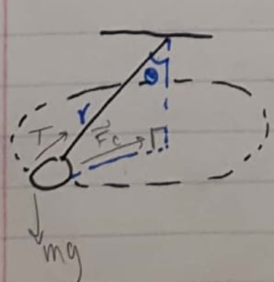
$\vec{N} \neq mg\cos\theta$!

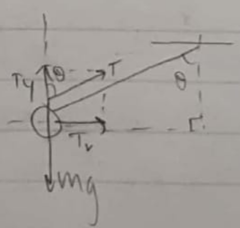


$\sum \vec{F_y} = \vec{F_{N_y}} + \vec{F_g}$
$\therefore \vec{F_{N_y}} = \vec{F_g} = mg$
$F_N\cos\theta = mg$

$\sum \vec{F_r} = m\vec{a_r}$
$\vec{F_{N_r}} = m\frac{v^2}{r}$
$F_N\sin\theta = \frac{mv^2}{r}$

$\tan\theta = \frac{v^2}{rg}$

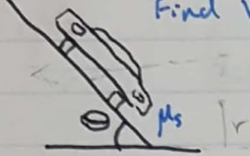


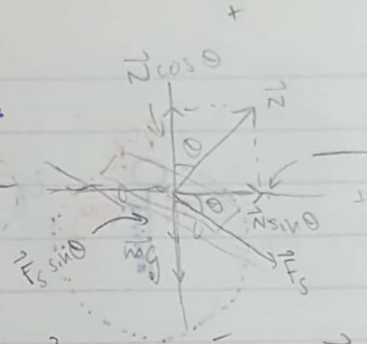


$\sum \vec{F_y} = 0$
$\vec{T_y} + m\vec{g} = 0$, so ② $T\cos\theta = mg$
$\sum \vec{F_r} = m\vec{a_r}$
$\vec{T_r} = m\frac{v^2}{r}$
① $T\sin\theta = \frac{mv^2}{r}$

$\tan\theta = \frac{v^2}{rg}$

Find V_{max}





$\vec{F}_s = \vec{F}_{s\,max} = \mu_s F_N$

$\sum \vec{F}_x = m\vec{a}_x = m\frac{v^2}{r}$

$\vec{F}_N \sin\theta + \vec{F}_s \cos\theta = \frac{mv^2}{r}$

$\vec{F}_N \sin\theta + \mu_s \vec{F}_N \cos\theta = \frac{mv^2}{r}$

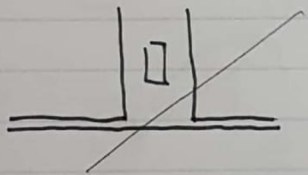
$\div$ $F_N \cos\theta - \mu_s F_N \sin\theta = mg$

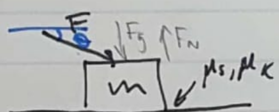
$\frac{\sin\theta + \mu_s \cos\theta}{\cos\theta - \mu_s \sin\theta} = \frac{v^2}{rg}$

$\sum \vec{F}_y = m\vec{a}_y = 0$

$\vec{F}_N \cos\theta + \vec{F}_s \sin\theta + \vec{F}_g = 0$

$F_N \cos\theta - \mu_s F_N \sin\theta = mg$





*Don't assume this object is gonna move! Need to establish this BEFORE solving.

$f_{s\,max} = F_N \mu_s = (mg + F\sin\theta)\mu_s$

$F\cos\theta \geq F_{s\,max}$ $\therefore$ object moves. F_K not F_s

$\sum \vec{F}_x = m\vec{a}_x = \vec{F}\cos\theta + \vec{F}_K$

$= \vec{F}\cos\theta + \vec{F}_N \mu_K$

$m\vec{a}_x = F\cos\theta - F_N \mu_K$

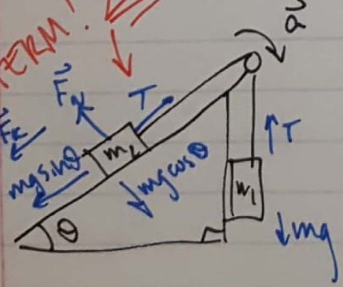
$\sum \vec{F}_y = m\vec{a}_y = 0 = \vec{F}\sin\theta + \vec{F}_N + \vec{F}_g$

$\vec{F}_N = \vec{F}\sin\theta + mg$

$m\vec{a}_x = F\cos\theta - (\vec{F}\sin\theta + mg)\mu_K$

$= F\cos\theta - F\sin\theta\,\mu_K - mg\mu_K$

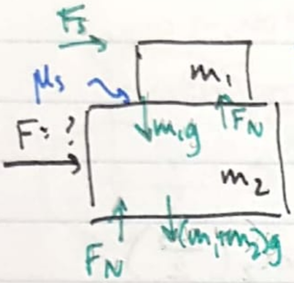
*MIDTERM! Δ moves!



$T - m_2 g\sin\theta - f_K = m_2 a$

$f_K = F_N \mu_K = mg\cos\theta\,\mu_K$

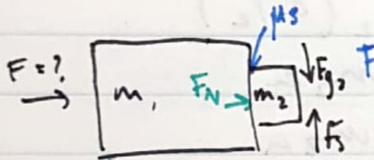
$T - m_1 g = -m_1 a$



$F_{max} = ?$ So m_1 doesn't slide on m_2

Sep 29, 2017

$$F_s = ma$$
$$F_N \mu_s = ma$$
$$mg\mu_s = ma$$
$$a = g\mu_s \quad \therefore \quad F = (m_1+m_2)g\mu_s$$

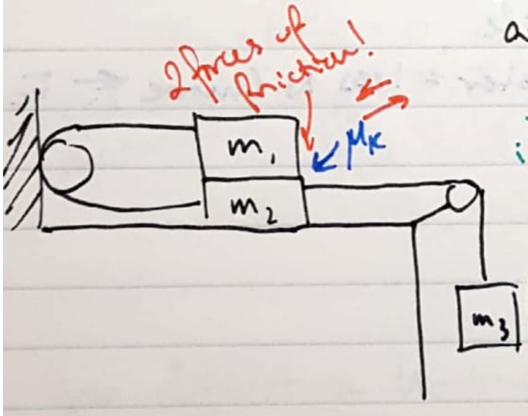


$F_{min} = ?$ so m_2 doesn't move ↑↓?

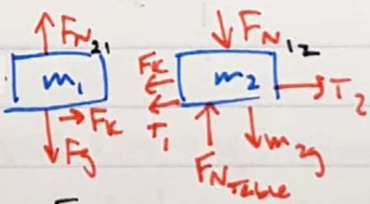
$$\Sigma \vec{F}_x = m_2 a$$
$$F_N = m_2 a$$

$$F_s = F_{g_2}$$
$$F_N \mu_s = F_{g_2} = m_2 g$$
$$m_2 a \mu_s = m_2 g$$
$$a = g/\mu_s$$

$$F = (m_1+m_2)a = \frac{g(m_1+m_2)}{\mu_s}$$



$$\text{i)}\ m_3 g - 2m_1 g\mu_K = (m_1+m_2+m_3)a$$



$$F_{N_{12}} = F_{N_{21}} = m_1 g$$

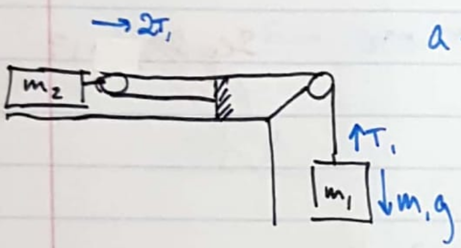
m_1)
$$\Sigma \vec{F}_y = 0 \Rightarrow \vec{F}_{N_{21}} = m_1 g$$
$$\Sigma \vec{F}_x = m_1 \vec{a}_x$$
$$\vec{T}_1 + \vec{F}_K = m_1 \vec{a}$$
$$T - m_1 g \mu_K = m_1 a \quad (1)$$

m_2)
$$\Sigma \vec{F}_x = m_2 \vec{a}_x$$
$$\vec{T}_2 + \vec{T}_1 + \vec{F}_K = m_2 \vec{a}$$
$$T_2 - T_1 - F_K = m_2 a$$
$$T_2 - T_1 - m_1 g \mu_K = m_2 a$$

m_3)
$$\Sigma \vec{F}_y = m_3 \vec{a}_y$$
$$\vec{T}_2 + m_3 \vec{g} = m_3 \vec{a}_y$$
$$m_3 g - T_2 = m_3 a \quad (3)$$

Now, add all 3 eqns to get i).

Scanned by CamScanner



$a = ?$

$\sum \vec{F}_{m_1 y} = m_1 \vec{a}_y$

$m_1 g - T = m_1 \vec{a}_y$ (1)

$\sum \vec{F}_{m_2 x} = m_2 \vec{a}_x = m_2 \left(\frac{\vec{a}_y}{2}\right)$

$2T = m_2 \left(\frac{\vec{a}_y}{2}\right)$ (2)

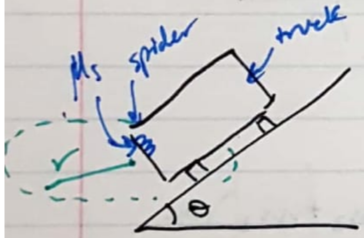
$$\frac{4m_1 g}{4m_1 + m_2} = a$$

$2(m_1 g - m_1 \vec{a}) = m_2 (\vec{a}/2)$

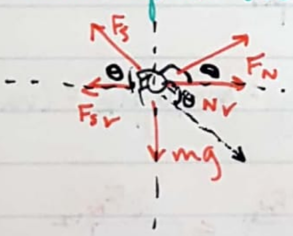
$4(m_1)(g - a) = m_2 a$

$4m_1 g - 4m_1 a = m_2 a$

$4m_1 g = m_2 a + 4m_1 a$

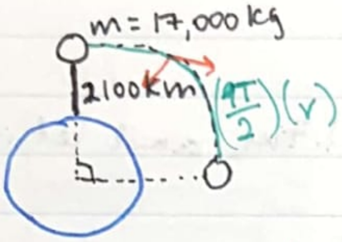


Vmax so spider doesn't slide



Faster = less N (more ← F_c)

Oct 2, 2017.



Find work done by gravity.

$W_T = \Delta K_e = 0$!

or... $W_T = \vec{F} \cdot \Delta\vec{d} = \underbrace{|\vec{F}||\vec{d}|}_{\text{These are } \perp} \cos\theta \leftarrow \cos 90° = 0.$

$$\boxed{\text{Total work on object} = \text{Change in object's kinetic energy}}$$

You hurl a cooper mini ($m = 690$ kg) at 6 m/s @ Mansour. He Stops over a distance of 3m then hurls it back @ same $\vec{v}$. W?

$W_T = \Delta K_e = 0$, again.

F, d stay the same: $\begin{cases} W_{F_1} = \vec{F} \cdot \vec{d} = |\vec{F}||\vec{d}| \cos 180° \leftarrow -1 & \text{when you stop} \\ W_{F_2} = \vec{F} \cdot \vec{d} = |\vec{F}||\vec{d}| \cos 0° \leftarrow +1 & \text{when you release} \end{cases}$

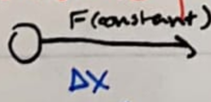
$\Delta W_T = W_{F_1} + W_{F_2}$ cancel out.

You deflect a hockey puck ($m = 42$g) moving at 32 m/s by 30 degrees. You hit it at 20° to its original direction so the final speed is same as initial. W?

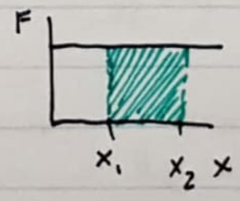
$\therefore$ No change in Kinetic energy

$W_T = \Delta E_k = 0$, again.

Variable Forces in 1D:

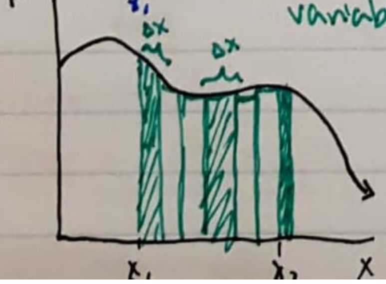


$W = |\vec{F}||\vec{d}| \cos 0 = |\vec{F}||\vec{d}|$

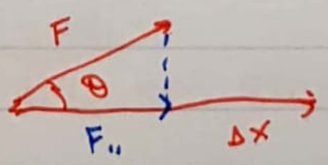


W = area under curve.

$\int_{x_1}^{x_2} \vec{F} \cdot d\vec{x}$



variable F



$W = |\vec{F}||\Delta\vec{x}| \cos\theta$

$= \vec{F}_{\parallel} \Delta x$

Example:

1) You lift a heavy ball from ground ↑ 1.7m and let it go at 7 m/s. ← 12kg

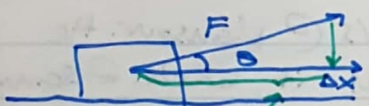
$W_T = \Delta K$

cosθ changes sign

$W_{you} + W_g = \Delta K$ ← actually, final − initial

$W_{you} = \frac{1}{2}mv^2 + m\vec{g}\cdot\vec{h}$

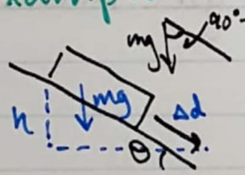
Work in 2D:



$F_{\parallel}$, or $F\cos\theta$.

Example:

1)



$W_g = ?$

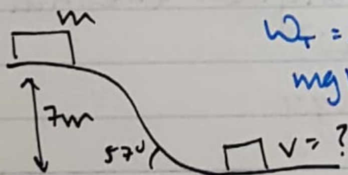
$W_g = m\vec{g}\cdot\Delta\vec{s}$

$= mg\Delta s(\sin\theta)$

$= mgh$

moral of the story: work done by gravity? all that matters is vertical displacement!

2)

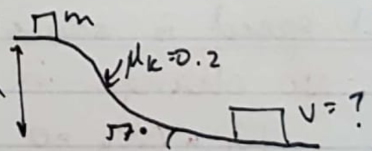


$W_T = \Delta K_e$

$mgh = \frac{1}{2}mv^2$

$v = \sqrt{2gh}$

3)



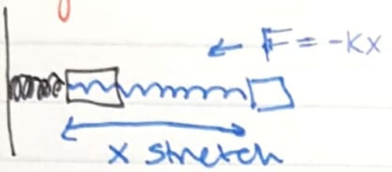
$W_T = \Delta K_e$

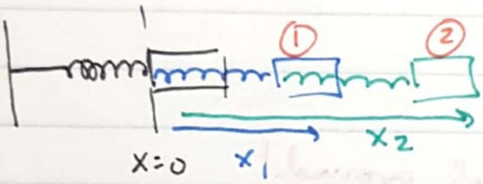
$W_g + W_f = \Delta K_e$

$mgh + (-mg\cos\theta\,\mu_k)\left(\frac{h}{\sin 57°}\right) = \frac{1}{2}mv^2$

Springs

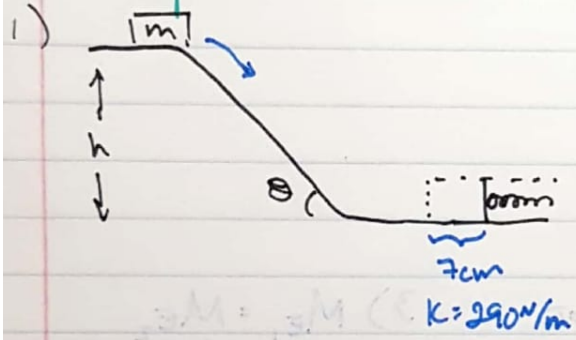
Oct 4, 2017





$$W_s = \int_{x_1}^{x_2} -kx\,dx \; \boxed{= \tfrac{1}{2}kx_1^2 - \tfrac{1}{2}kx_2^2}$$

Example:

1) 

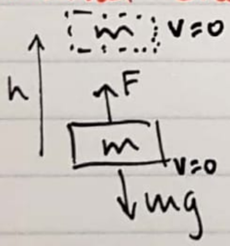
Block slides and hits already compressed spring. Max comp. of string?

$W_T = \cancel{\Delta K_e}^{\,0}$ $\quad W_T = W_g + W_s = 0$

$mgh + \frac{1}{2}kx_1^2 - \frac{1}{2}kx_2^2 = 0$

$(12)(9.8)(0.9) = \frac{1}{2}(290)(0.07)^2 = \frac{1}{2}(290)x_2^2$

Potential Energy:

A) 

$W_F = \vec{F}\cdot\vec{h} = mgh$

$W_g = m\vec{g}\cdot\vec{h} = -mgh.$

$\Delta P_E = -W_g$. ← this applies for any cons. force.

↳ $= \Delta U_g$.

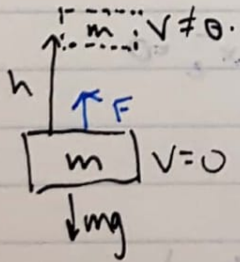
→ Conservative Forces:

↳ Can get ΔE back.

① ↳ $\boxed{F_f}$ is not conservative (can't get heat back).

② ↳ $\boxed{F_{app}}$ by humans

☆

B) 

$W_T = \Delta K_e$

$W_F + W_g = \Delta K_e \rightarrow W_{noncons.} + W_{cons.} = \Delta K_e$

$W_F - \Delta U_g = \Delta K_e \qquad W_{nc} - U_c = \Delta K_e$

$W_F = \underbrace{\Delta K_e + \Delta U_g}_{= \Delta M_E \text{ mech. energy}}$.

$$\boxed{W_{non.c} = \Delta M_E}$$

$W_T = \Delta K$

$W_c = -\Delta U_c$

$W_{nc} = \Delta M_E$

$W_{nc} = \Delta M_E$ VERY IMPORTANT

If $W_{nc} = 0$

$\hookrightarrow \Delta M_E = 0$, so

1) $\Delta K + \Delta U = 0$

2) $M_{E_1} = M_{E_2} = M_{E_3} \ldots$

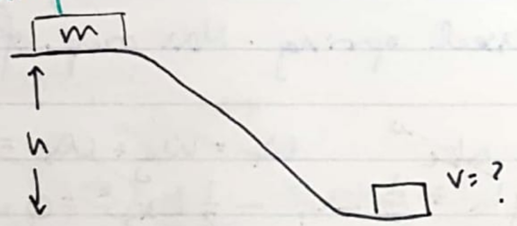
So...

$$\boxed{\begin{aligned}\Delta U_s &= -W_s \\ &= \tfrac{1}{2}kx_2^2 - \tfrac{1}{2}kx_1^2\end{aligned}}$$

switched around!

Example:

1)



1) $W_T = \Delta K$

$W_g = \Delta K$

$mgh = \frac{1}{2}mv^2$

2) $W_{nc} = \Delta M_e = 0$

$\Delta M_E = 0$

$\Delta K + \Delta U = 0$

$\Delta K = -\Delta U$

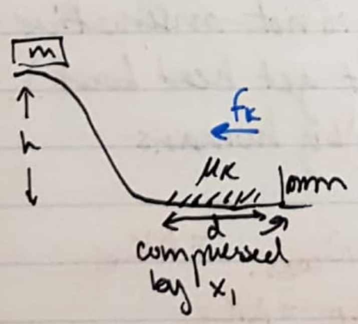
$\Delta K = -(-mgh)$

$\frac{1}{2}mv^2 = mgh$

3) $M_{E_1} = M_{E_2}$

$mgh = \frac{1}{2}mv^2$

2)



1) $W_T = \Delta K_e$

$W_g + W_F + W_s = \Delta K_e$

$mgh - mg\mu_K d + \frac{1}{2}kx_1^2 - \frac{1}{2}kx_2^2 = 0$

2) $W_{nc} = \Delta M_e$

$-mg\mu_K d = \Delta K_e + \Delta U$

$-mg\mu_K d = -mgh + \frac{1}{2}kx_2^2 - \frac{1}{2}kx_1^2$