How fo' solve one Atwood System in Pidgin

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Physics is a difficult subject that I struggled to understand. But I was able to succeed with the help and encouragement of Dr. Hervé Collin who allowed me to write this physics research paper in Hawaiʻi Creole English (HCE), also known as Pidgin in Hawaiʻi. I consider Pidgin as my first language because I grew up in the moku (district) of Waiʻanae on the mokupuni (island) of Oʻahu where Pidgin is commonly spoken. Writing in Pidgin helped to bridge the language gap between Pidgin and English, thus making it easier for me to clarify and comprehend physics concepts and problem solving methods. Not only has writing in Pidgin increased my physics comprehension, but it also made physics and writing more enjoyable for me. I hope that this research paper will help my fellow kānakas and Pidgin-speaking students succeed in physics and inspire other kānakas to purse a career in STEM.

Wats da magnitude of da velocity fo one atwood system, da one with two blocks and one pulley. Try picha block A stay on one incline plane connected to one string dat no can stretch and da odda block B is at da end of da string hangin' look laddat below. Wit dis info: da mass fo block A is 2 kg, da mass fo block B is 7kg, da angle fo da incline place is 30 degrees, da static friction is 0.5, da kinetic friction is 0.2, da mass fo da pulley is 5 kg, and da distance dat each block wen travel from rest is 0.5 meters, try figa out da final velocity.

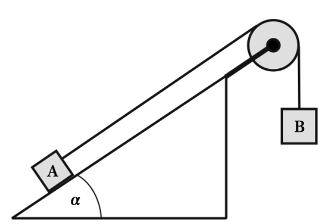

Figure 1: Atwood System Type tree (inclined plane).

Da first ting we go do is write all da known and given variables and dea values. We only get one known variable, da acceleration due to gravity (g) and all da rest stay given values. Now da given values is da mass of block A (m_A), mass of block B (m_B), mass of da pulley (m_p), distance travel (d), given angle (α), kinetic friction (μ_k), and static friction (μ_s). Jus' write em all down so goin be easy layta on.

$$g = 9.81m/s^2 \qquad m_A = 2kg \qquad \mu_s = 0.5$$
$$\alpha = 30^\circ \qquad m_B = 7kg \qquad \mu_k = 0.2$$
$$s = 0.5m \qquad m_P = 5kg \qquad d = 0.5m$$

Fo' dis problem, we gon' use da method fo' Energy Conservation Law so dat we can find out da velocity of da atwood system starting from rest after it wen move by da distance d.

$$\sum E_{inital} = \sum E_{final}$$

Firs' gotta identify all da systems in da whole atwood system. So, we get tree' massive systems: block A, block B and da pulley. Da next ting fo' do is pick da 2 points, da initial and final point wea' you gon' use da energy method and we gon' call it 1 and 2 in figa (2) on da diagram. Da ting gon look laddat below.

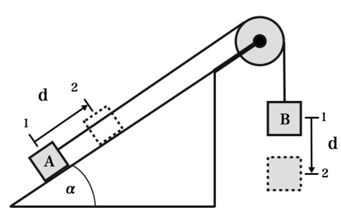

Figure 2: Diagram wit chosen points

Next ting' go pick youa coordinate system fo' each system. Rememba dat fo' energy oua coordinate system gotta be wit da positive y axis in da up direction so dat we can use da PE_g term in oua energy equation. We go start with da blocks firs'. Fo' each block you get da choice fo' put da coordinate system at point 1 or at point 2. We go pick point 2 fo da origin of dea coordinate system fo' both block A and B. Now fo' da pulley, cuz we dealin' wit someting dat rotates da first question we gotta ask oua self is da axis of rotation fixed or no? In oua question da pulley got one fixed axis of rotation. But in oua case cuz its one pulley, da axis of rotation stay at da center of mass and dat gon' be da origin of da coordinate system. All da origins gon' be used fo' get da PE_g terms in equation (11). Da overall diagram gotta look someting laddis below.

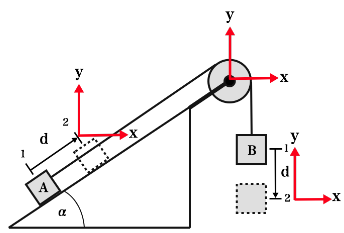

Figure 3: Da whole Atwood System Diagram wit da points and coordinate systems

Next we go write down oua generic energy equation fo oua systems.

$$\sum W + \sum PE_{g_1} + \sum PE_{s_1} + \sum KE_1 = \sum PE_{g_2} + \sum PE_{s_2} + \sum KE_2 \quad (1)$$

wea da terms stay laddis:

- W is da Work done by all da external forces
- PE_g is da Potential Energy due to da gravity
- PE_s is da Potential Energy due to one spring
- KE is da Kinetic Energy fo both rotational and translational

Cuz oua problem no mo' one spring in da atwood system we can tro' away da $\sum PE_s$ terms on both sides of da equation (1). So da equation gon' look laddis:

$$\sum W + \sum PE_{g_1} + \sum KE_1 = \sum PE_{g_2} + \sum KE_2 \quad (2)$$

Now we gotta figa out haw many work terms get. We expect da work terms to be one long list. Fo da pulley, cuz we dealin wit one massive pulley we expect da work done by da weight of da pulley (W_{W_P}), da work done by da tension on da pulley from block A ($W_{T_{Ap}}$), da work done by da tension on da pulley from block B ($W_{T_{Bp}}$) and da work done by da normal force from da table acting on da pulley (W_{N_T}). Fo' block B we expect da work done by its weight (W_{W_B}) and da work done by da tension acting on block B (W_{T_B}). Fo' block A we expect work done by its weight (W_{W_A}) and da work done by da tension acting on block A (W_{T_A}), work due to kinetic friction ($W_{f_{k_A}}$), work due to da normal force acting on A (W_{N_A}).

$$\sum W = W_{W_P} + W_{T_{Ap}} + W_{T_{Bp}} + W_{N_T} + W_{W_B} + W_{T_B} + W_{W_A} + W_{T_A} + W_{f_{k_A}} + W_{N_A} \quad (3)$$

We go tro away some terms. Da first ting we go tro away is da work due to da weight fo' each system A and B cuz we gon put da PE_g in oua equation (10). We can tro away da work due to da normal force acting on block A and da work due to da pulley cuz dey stay equal to zero. We can also ignore da work due to da tension on block A, block B, and da pulley cuz da ting gon cancel each oda. Now only get one term left das work due to friction acting on block A. We got talk about da details why dey get trown away.

So fo da Work done by da weight fo block A dat is goin' UP and using da figa (4) to express W_A along da displacement d:

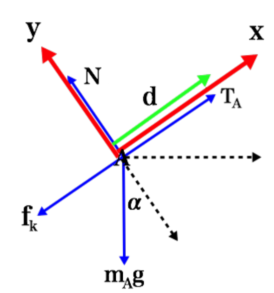

Figure 4: Free Body Diagram: Block A

Da work done by da weight of A is:

$$
\begin{aligned}
W_{W_A} &= \int_0^d \vec{W_A} \cdot d\vec{s'} \\
W_{W_A} &= \int_0^d -W_A sin\alpha ds' \\
W_{W_A} &= \int_0^d -m_A g sin\alpha ds' \\
W_{W_A} &= -m_A g sin\alpha \int_0^d ds' \\
W_{W_A} &= -m_A g sin\alpha d
\end{aligned} \tag{4}
$$

but no need dis cuz get PE_g already in da equation (2) and da ting goin look da same like da functional form fo' $PE_{g_{A1}}$ as da equations (10) and (11) way down below.
Da work done by da weight of B stay goin DOWN, try look at figa (5) below to express W_B along da displacement:

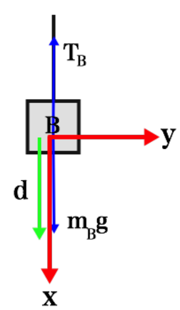

Figure 5: Free Body Diagram fo Block B

Da work done by da weight of B is:

$$W_{W_B} = \int_0^d \vec{W_B} \cdot d\vec{s'}$$
$$W_{W_B} = \int_0^d m_B g ds'$$
$$W_{W_B} = m_B g \int_0^d ds'$$
$$W_{W_B} = m_B g d \tag{5}$$

No need dis cuz we get PE_g in da equation (2) and same ting fo da Work done by the weight of block A. da ting gon' get da same functional form fo' $PE_{g_{B1}}$ as da equations (10) and (11) way down below.

Now get da work done by da normal force on da pulley (N_P). Da pulley no move so da displacement (ds') stay zero.

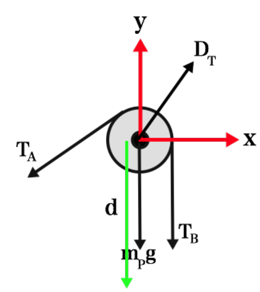

Figure 6: Free Body Diagram Pulley

Da work done by da normal force is:

$$W_{N_p} = \int_0^d \vec{N_p} \cdot d\vec{s'}$$
$$W_{N_p} = \int_0^d \vec{N_p} \cdot d\vec{0}$$
$$W_{N_p} = 0$$

Da pulley not goin' go anywea so da displacement (ds') stay zero and da work done by da weight (W_P) of da pulley gon be da same.

$$W_{W_p} = \int_0^d \vec{W_p} \cdot d\vec{s'}$$
$$W_{W_p} = \int_0^d \vec{W_p} \cdot d\vec{0}$$
$$W_{W_p} = 0$$

dis gon' be $PE_{g_{P_1}}$ and $PE_{g_{P_2}}$ in equation (9). Get foa moa work terms: one from T_A acting on A, den T_B acting on B, and da odda two T_A and T_B stay acting on da pulley. We go do da linear ones firs'.

Da work done by T_A acting on object A das TRANSLATING: T_A stay in da same direction like da displacement ds':

$$W_{T_A} = \int_0^d \vec{T_A} \cdot d\vec{s'}$$
$$W_{T_A} = \int_0^d T_A ds'$$
$$W_{T_A} = T_A \int_0^d ds'$$
$$W_{T_A} = T_A d$$

Da work done by T_B acting on object B stay TRANSLATING: T_B stay in da opposite direction from da displacement (ds'):

$$W_{T_B} = \int_0^d \vec{T_B} \cdot d\vec{s'}$$
$$W_{T_B} = -\int_0^d T_B ds'$$
$$W_{T_B} = -T_B \int_0^d ds'$$
$$W_{T_B} = -T_B d$$

So we know dat $T_B > T_A$ cuz da pulley get one angular acceleration so da torque stay non-zero so dey not gon cancel.... yet! We gon look at da

Net (faster) work done by T_A and T_B on da pulley. Da angular displacement we gon use look laddis $\theta = \frac{S}{R}$. S mo betta fo use but we gon change em to $s = R\theta$. So we get: $d(R\theta = s) = \theta dR + Rd\theta = ds$ but R stay constant yeah so da firs term gon be gone: $Rd\theta = ds$ and now we get $d\theta$ jus laddat: $d\theta = \frac{ds}{R}$

Da pulley rotates (wit one angular acceleration) so we go use da sum of da torques not da sum of da forces (like wit object A and B dat translate). Cuz $T_B > T_A$, da torque fo' T_B stay mo big so gon be da positive one.

$$W_{\sum\tau} = \int_0^{\theta} \sum \vec{\tau} \cdot d\vec{\theta'}$$

$$W_{\sum\tau} = \int_0^{\theta} (RT_B - RT_A) d\theta'$$

$$W_{\sum\tau} = (RT_B - RT_A) \int_0^{\theta} d\theta'$$

$$W_{\sum\tau} = (RT_B - RT_A) \int_0^{d} \frac{ds'}{R}$$

$$W_{\sum\tau} = (T_B - T_A) \int_0^{d} ds'$$

$$W_{\sum\tau} = (T_B - T_A)d$$

$$W_{\sum\tau} = T_B d - T_A d$$

Add this to W_{T_B} and W_{T_A} and you now get ZERO. So only get da work due to da friction acting on block A:

$$\sum W = W_{f_{k_A}} \tag{6}$$

We gotta use Newton's Method to figure out da friction term. Rememba da figa (4), da free body diagram fo block A we go use dat.

Newton's second law is:

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

Write dea equations wit Newton's second law.

$$\begin{cases} T_A - m_A g sin\alpha - f_k = m_A a \\ N = m_A g cos\alpha \end{cases}$$

Cuz $f_k = \mu_k N$ and we kno' dat $N = m_A g cos\alpha$, so we get $f_k = \mu_k m_A g cos\alpha$. We go figa our da work due to friction

$$\begin{aligned} W_{f_{k_A}} &= \int \vec{f_k} \cdot \vec{dr} \\ &= \int_0^d -f_k ds' \\ &= \int_0^d -\mu_k N ds' \\ &= \int_0^d -\mu_k m_A g cos\alpha ds' \\ &= -\mu_k m_A g cos\alpha \int_0^d ds' \\ &= -\mu_k m_A g cos\alpha d \end{aligned}$$

Now we kno oua work terms we go write out da full equation from equation numba (2). In da equation we go put in all da kinetic terms: translational fo block A and B (KE_T) and rotational fo da pulley (KE_R)

$$W_{f_{k_A}} + PE_{g_{A_1}} + KE_{T_{A_1}} + PE_{g_{B_1}} + KE_{T_{B_1}} + PE_{g_{P_1}} + KE_{R_{P_1}} \tag{7}$$

$$= \tag{8}$$

$$PE_{g_{A_2}} + KE_{T_{A_2}} + PE_{g_{B_2}} + KE_{T_{B_2}} + PE_{g_{P_2}} + KE_{R_{P_2}} \tag{9}$$

Now we go make small dis equation cuz of oua chosen coordinate system. Dea is tree' questions dat we go ask oua self. Da first question, fo' da PE_g, is da block on da x axis? if yes, $PE_g = 0$. Da next question, fo' KE_T, is da block moving at dat point? if no, $KE_T = 0$. Is da pulley rotating at dat point? if no, $KE_R = 0$. Cuz we wen pick oua coordinate system at point 2 and cuz its on da x axis so da $PE_{g_{A_2}}$=0 and $PE_{g_{B_2}}$=0. Also, cuz oua system is not moving or rotating at point 1, we get $KE_{T_{A_1}}$=0 and $KE_{T_{B_1}}$=0, and $KE_{R_{P_1}}$=0. And da las' ting, cuz PE_R is at da origin and da ting no move so get $PE_{g_{P_1}}$ and $PE_{g_{P_2}}$ both equal zero.

Oua shorten equation gon be:

$$W_{f_{k_A}} + PE_{g_{A_1}} + PE_{g_{B_1}} = KE_{T_{A_2}} + KE_{T_{B_2}} + KE_{R_{P_2}} \tag{10}$$

Next ting, pani (replace) all da energy terms wit dea functional form in equation (10) laddis below.

$$-\mu_k m_A g d cos\alpha + m_A g h_1 + m_B g h_2 = \frac{1}{2} m_A v_A^2 + \frac{1}{2} m_B v_B^2 + \frac{1}{2} I\omega^2 \tag{11}$$

We go figa out wea da height fo each block stay at. Based on figa (3) we gon get $h_{A_1} = -dsin\alpha$ and $h_{B_1} = d$. Cuz dis problem get one non-slipping pulley we can use da formula fo' angular velocity ($\omega = \frac{v}{R}$) fo replace ω so we get all oua kinetic energy terms wit' velocity. We go drop all da subscripts for velocity cuz dey gon' all be da same magnitude. Da last ting, we gotta do is figa out da moment of inertia (I). Cuz one pulley is one solid disk about one central axis (das da center of mass) da moment of inertia stay $I = \frac{1}{2} m R^2$. So oua new equation gon' look ladis:

$$-\mu_k m_A g d cos\alpha - m_A g d sin\alpha + m_B g d = \frac{1}{2} m_A v^2 + \frac{1}{2} m_B v^2 + \frac{1}{2}(\frac{1}{2} m_P R^2)(\frac{v}{R})^2$$

Now try look da second and third terms! Dey stay equal to da work terms from equations (4) and (5) cuz $PE_{g_{A_2}}$ and $PE_{g_{B_2}}$ stay zero!

Solve fo da velocity (v):

$$-gd(\mu_k m_A cos\alpha + m_A sin\alpha - m_B) = \frac{1}{2} v^2 (m_B + m_A + \frac{1}{2} m_p)$$

$$v = \sqrt{\frac{-2gd(\mu_k m_A cos\alpha + m_A sin\alpha - m_B)}{(m_B + m_A v + \frac{1}{2} m_p)}}$$

$$v = \sqrt{\frac{-2(9.81)(0.5)(0.2 * 2 * cos(30) + 2 * sin30 - 7)}{2 + 7 + \frac{1}{2}(5)}}$$

$$v = 2.76 m/s$$

Pau (Done)!

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