Stuff that may help!

$$\Delta x = \left[\frac{v_{x_0} + v_x}{2}\right]\Delta t$$

$$\vec{v}_{ave} = \frac{\Delta \vec{r}}{\Delta t}$$

$$\sin\theta = \frac{A_y}{|\vec{A}|}$$

$$\Delta x = v_{x_0}\Delta t + \tfrac{1}{2}a_x \Delta t^2$$

$$\vec{a}_{ave} = \frac{\Delta \vec{v}}{\Delta t}$$

$$\cos\theta = \frac{A_x}{|\vec{A}|}$$

$$v_x = v_{x_0} + a_x \Delta t$$

$$\tan\theta = \frac{A_y}{A_x}$$

$$v_x^2 = v_{x_0}^2 + 2a_x \Delta x$$

$$|\vec{A}| = \sqrt{A_x^2 + A_y^2}$$

$$\Delta y = \left[\frac{v_{y_0} + v_y}{2}\right]\Delta t$$

$$g = 9.8 m/s^2$$

$$\Delta y = v_{y_0}\Delta t + \tfrac{1}{2}a_y \Delta t^2$$

$$ax^2 + bx + c = 0$$

$$v_y = v_{y_0} + a_y \Delta t$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$v_y^2 = v_{y_0}^2 + 2a_y \Delta y$$

$$m \rightarrow 10^{-3}$$

$$g = 9.8 m/s^2$$

$$k \rightarrow 10^3$$

$$1m = 3.28 ft$$

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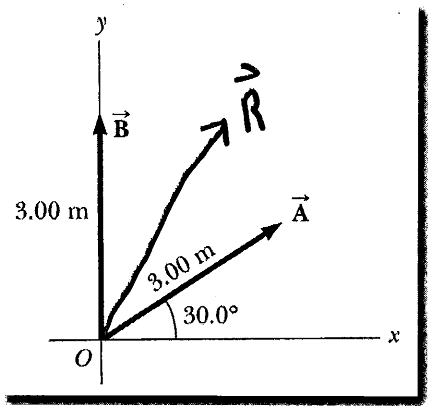
Test 1
PHYS 1111
Introductory Physics I
TEST 1

Name Charles Johnson

Show all work in the spaces provided. If the work is not shown you will not get credit. You will also need to have the correct units for all answers to get full credit. The total number of points is 55.



1) Using the vectors shown above find the following:

a) What are the x and y components of $\vec{A}$ and $\vec{B}$. (4 pts)

$A_x = |\vec{A}| \cos(30°)$ $\quad$ $A_y = |\vec{A}| \sin(30°)$

$A_x = (3m)\cos(30°)$ $\quad$ $A_y = (3m)\sin(30°)$

$\boxed{A_x = 2.598m}$ $\quad$ $\boxed{A_y = 1.5m}$

$\boxed{B_x = 0}$ $\quad$ $\boxed{B_y = 3M}$

b) Find $\vec{R} = \vec{A} + \vec{B}$ in terms of x and y components.(4 pts)

$R_x = A_x + B_x$ $\quad$ $R_y = A_y + B_y$

$R_x = 2.598M + 0$ $\quad$ $R_y = 1.5M + 3M$

$R_x = 2.598M$ $\quad$ $R_y = 4.5M$

c) Determine the magnitude and direction of $\vec{R}$. (4 pts)

$|\vec{R}| = \sqrt{R_x^2 + R_y^2}$

$|\vec{R}| = \sqrt{(2.598m)^2 + (4.5m)^2}$

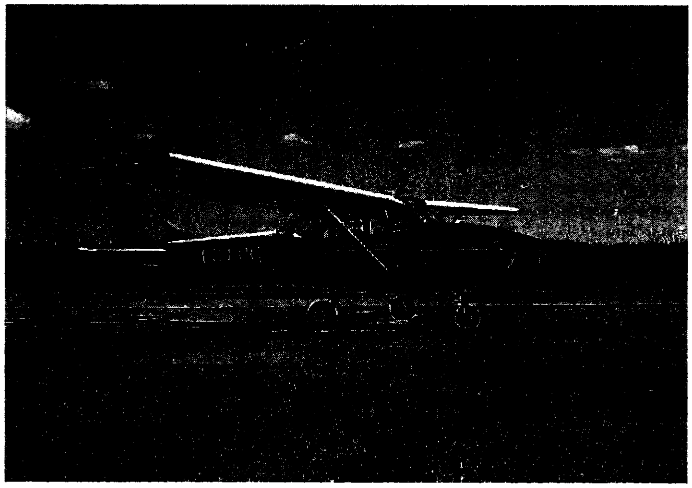
$\boxed{|\vec{R}| = 5.196m \approx 5.2M}$

$\theta = \tan^{-1}\left(\frac{R_y}{R_x}\right)$

$\theta = \tan^{-1}\left(\frac{4.5M}{2.598M}\right)$

$\boxed{\theta = 60°}$

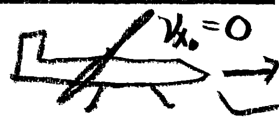
Test 1



$$120\frac{km}{hr}\left(\frac{1\,hr}{3600\,s}\right)\left(\frac{1000\,m}{1\,km}\right) = 33.33\,m/s$$

$v_x =$

2) A Cessna aircraft has a lift-off speed of $120\,km/hr$.



a) What minimum constant acceleration does the aircraft require if it is to be airborne after a takeoff run of $240\,m$? (5 pts)

$$v_x^2 = \cancel{v_{x_0}^2} + 2a_x\Delta x$$

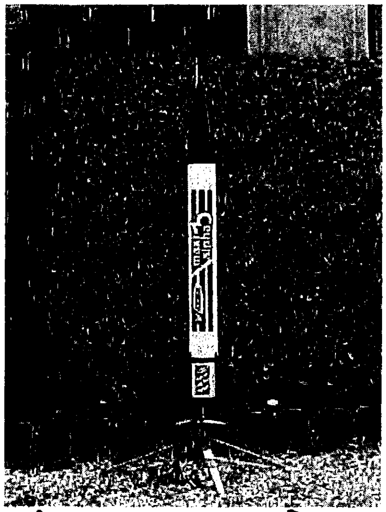
$$a_x = \frac{v_x^2}{2\Delta x} = \frac{(33.33\,m/s)^2}{2(240\,m)} = \boxed{2.31\,m/s^2}$$

b) How long does it take the aircraft to become airborne? (5 pts)

$$v_x = \cancel{v_{x_0}} + a_x t$$

$$t = \frac{v_x}{a_x} = \frac{33.33\,m/s}{2.31\,m/s^2} = \boxed{14.4\,s}$$

Test 1



3) A model rocket is launched straight upward with an initial speed of $50.0\,m/s$. It accelerates with a constant upward acceleration of $2.00\,m/s^2$ until its engines stop at an altitude of $150\,m$.

a) What is the maximum height reached by the rocket? Keeping in mind it is still moving upwards after the engine stops. (5 pts)

$$V_1^2 = V_{1o}^2 + 2a_1\Delta y_1$$

$$V_1 = \sqrt{(50\,m/s)^2 + 2(2\,m/s^2)(150\,m)}$$

$$V_1 = 55.6776\,m/s$$

$\Delta \downarrow a_2 = -9.8\,m/s^2$, $V_1 = ?$, $t_2 = ?$ $\Delta y_2 = ?$

$\Delta \uparrow a_1 = 2\,m/s^2$, $150\,m = \Delta y_1$, $t_1 = ?$

$50\,m/s$ V_{1o}

$$\cancel{V_2^2}^{\,=0} = V_{2o}^2 + 2a_2\Delta y_2$$

$$\Delta y_2 = \frac{-V_{2o}^2}{2a_2} = \frac{-(55.6776\,m/s)^2}{2(-9.8\,m/s^2)}$$

$$\Delta y_2 = 158.163\,m$$

$$\Delta y_{tot} = 150\,m + 158.163\,m = \boxed{308.16\,m}$$

b) How long does after lift-off does the rocket reach its maximum height? (5 pts)

t_1

$$V_1 = V_{1o} + a_1 t$$

$$t_1 = \frac{V_1 - V_{1o}}{a_1} = \frac{55.6776\,m/s - 50\,m/s}{2\,m/s^2} = 2.8388\,s$$

t_2

$$\cancel{V_2}^{\,=0} = V_{2o} + a_2 t$$

$$t = \frac{-V_{2o}}{a_2} = \frac{-55.6776\,m/s}{-9.8\,m/s^2} = 5.68\,s$$

$$t_{up} = 5.68\,s + 2.8388\,s$$

$$\boxed{t_{up} = 8.52\,s}$$

c) How long is the rocket in the air? (5 pts)

Δ $V_{yo} = 0$

$\Delta y = 308.16\,m$

$a_y = -9.8\,m/s^2$

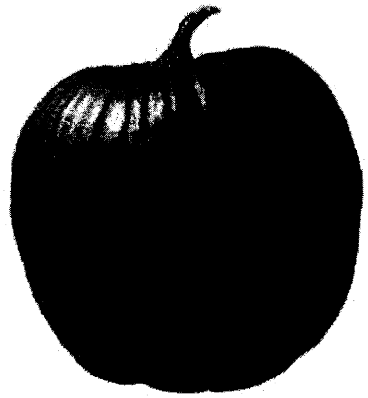
$t = ?$

$$\Delta y = \cancel{V_{yo}t}^{\,0} + \tfrac{1}{2}a_y t^2$$

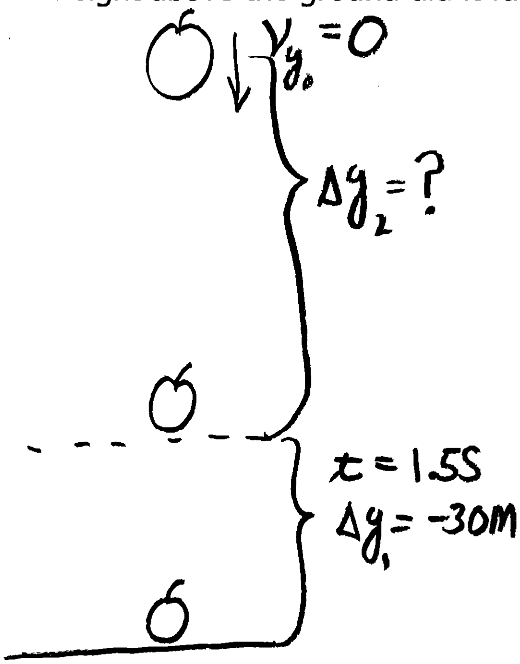
$$t = \sqrt{\frac{2\Delta y}{a_y}} = \sqrt{\frac{2(308.16\,m)}{-9.8\,m/s^2}}$$

$$t = 7.93\,s$$

$$\boxed{t_{tot} = 8.52\,s + 7.93\,s = 16.45\,s}$$



4) A pumpkin freely falling requires $1.5\,s$ to travel the last $30.0\,m$ before it hits the ground. From what height above the ground did it fall (10 points)



$a_y = -9.8\ m/s^2$

$v_y^2 = \cancel{v_{y_0}^2}^{\,0} + 2a_y \Delta y_2$

$\Delta y = \dfrac{v_y^2}{2a_y} = \dfrac{(-12.65 m/s)^2}{2(-9.8\ m/s^2)}$

$\Delta y = 8.16\ m$

$\Delta y_{tot} = 30m + 8.16m$

$\boxed{\Delta y_{tot} = 38.16m}$

$\Delta y = v_{y_0} t + \frac{1}{2} a_y t^2$

$v_{y_0} = \dfrac{\Delta y}{t} - \frac{1}{2} a_y t$

$v_{y_0} = \dfrac{-30m}{1.5S} - \frac{1}{2}(-9.8 m/s^2)(1.5S)$

$v_{y_0} = -12.65 m/s$

Stuff that may help!

Name Charles Jolson

$$\Delta x = \left[\frac{v_{x_0} + v_x}{2}\right] t$$

$$\Delta x = v_{x_0} \Delta t + \tfrac{1}{2} a_x t^2$$

$$v_x = v_{x_0} + a_x t$$

$$v_x^2 = v_{x_0}^2 + 2a_x \Delta x$$

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

$$\Delta y = \left[\frac{v_{y_0} + v_y}{2}\right] t$$

$$\Delta y = v_{y_0} t + \tfrac{1}{2} a_y t^2$$

$$v_y = v_{y_0} + a_y t$$

$$v_y^2 = v_{y_0}^2 + 2a_y \Delta y$$

$$g = 9.8 m/s^2$$

$$|\vec{A}| = \sqrt{A_x^2 + A_y^2}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\sin\theta = \frac{A_y}{|\vec{A}|}$$

$$\cos\theta = \frac{A_x}{|\vec{A}|}$$

$$\tan\theta = \frac{A_y}{A_x}$$

$$F_k = \mu_k N$$

$$F_s \le \mu_s N$$

PHYS 1111
Introductory Physics I
TEST 2

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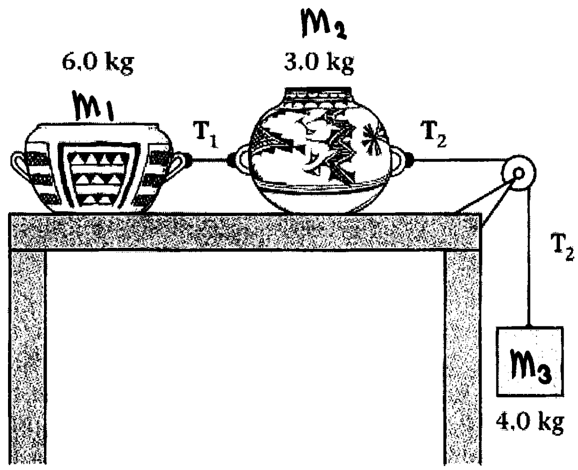
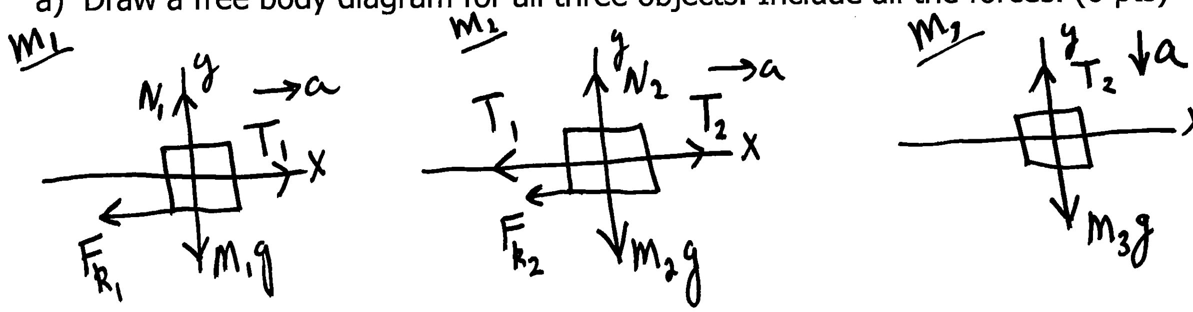
For full credit Show all your work and for each problem:

1) Draw and label a neat Free Body Diagram(s).
2) Include units for all quantities.



2) Two clay pots joined together by a light string rest on a table. The frictional coefficient between the pots and the table is 0.35. The pots are also joined to a 4.0 kg mass by a string of negligible mass passed over a frictionless pulley.

a) Draw a free body diagram for all three objects. Include all the forces. (6 pts)



b) Calculate the acceleration of the system when the 4.0 kg mass is released. (5 pts)

m_1

$\Sigma F_y = 0$

$N_1 - m_1 g = 0$

$N_1 = m_1 g$

$\Sigma F_x = m a_x$

$T_1 - F_{k_1} = m a$

$T_1 = F_{k_1} + m_1 a$

m_2

$\Sigma F_y = 0$

$N_2 - m_2 g = 0$

$N_2 = m_2 g$

$\Sigma F_x = m_2 a$

$T_2 - T_1 - F_{k_2} = m_2 a$

m_3

$\Sigma F_y = m a_y$

$T_2 - m_3 g = -m_3 a$

$T_2 = m_3 g - m_3 a$

$m_3 g - m_3 a - F_{k_1} - m_1 a - F_{k_2} = m_2 a$

$a(m_1 + m_2 + m_3) = m_3 g - F_{k_1} - F_{k_2}$

$a(m_1 + m_2 + m_3) = m_3 g - \mu_k m_1 g - \mu_k m_2 g$

$$a = \frac{g\,(m_3 - \mu_k m_1 - \mu_k m_2)}{(m_1 + m_2 + m_3)}$$

$$a = \frac{(9.8\,m/s^2)\,(4\,kg - (.35)(6\,kg) - (.35)(3\,kg))}{13\,kg}$$

$a = .64\,m/s^2$

c) Also find the tension T_1 and T_2 in the strings during acceleration. (5 pts)

$T_1 = F_{k_1} + m_1 a$

$T_1 = \mu_k m_1 g + m_1 a$

$\cancel{T_1 = (9.8\,m/s^2)}$

$T_1 = (6\,kg)\,[(.35)(9.8\,m/s^2) + .64\,m/s^2]$

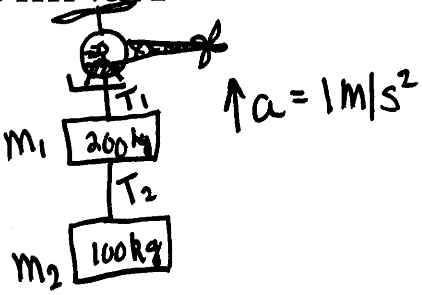
$T_1 = 24.42\,N$

$T_2 = m_3 g - m_3 a$

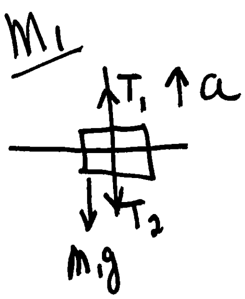
$T_2 = m_3 (g - a)$

$T_2 = (4\,kg)(9.8\,m/s^2 - .64\,m/s^2)$

$T_2 = 36.64\,N$



2) A helicopter is lifting two crates simultaneously. One crate with a mass of $200\ kg$ is attached to the helicopter by a cable. The second crate with a mass of $100\ kg$ is hanging below the first crate and attached to the first crate by a cable. As the helicopter accelerates upward at a rate of $1.0\ m/s^2$, what is the tension in each of the two cables? (10 pts)



$\sum F_y = ma_y$

$T_1 - T_2 - m_1 g = m_1 a$

$\cancel{T_2 = T_1 - m_1 g - m_1 a}$

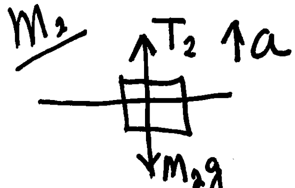
$\cancel{T_2 = (1080N) - (200kg)(9.8m/s^2 + 1m/s^2)}$

$\cancel{T_2 =}$

$T_1 = T_2 + m_1 g + m_1 a$

$T_1 = 1080N + (200kg)(9.8m/s^2 + 1m/s^2)$

$T_1 = 3240N$ //



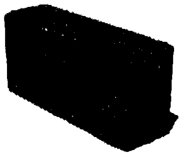
$\sum F_y = ma_y$

$T_2 - m_2 g = m_2 a$

$T_2 = m_2 g + m_2 a$

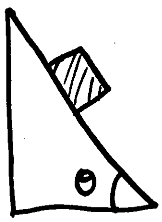
$T_2 = (100kg)(9.8m/s^2 + 1m/s^2)$

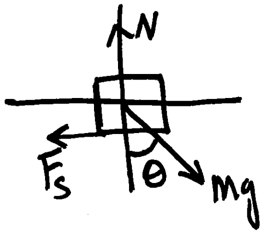
$T_2 = 1080N$



3) The coefficient of static friction between a brick and a wooden board is 0.40 and the coefficient of kinetic friction between the brick and board is 0.30. You place the brick on the board and slowly lift one end of the board off the ground until the brick starts to slide down the board.

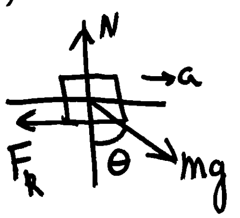
a) Using Newton's laws of motion what angle does the board make with the ground when the brick starts to slide? (6 pts)





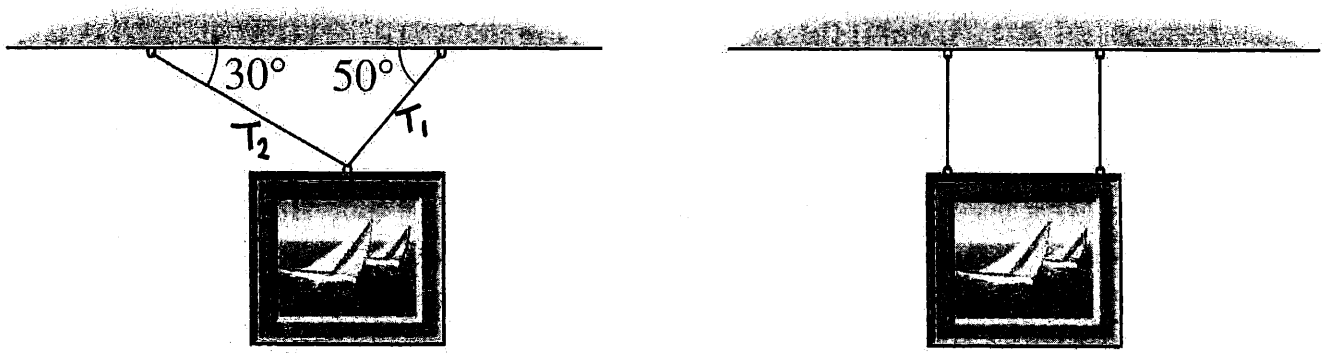
$$\Sigma F_y = 0$$
$$N - mg\cos(\theta) = 0$$
$$N = mg\cos(\theta)$$
$$\Sigma F_x = 0$$
$$mg\sin\theta - F_s = 0$$
$$mg\sin\theta = \mu_s N$$
$$\cancel{mg}\sin\theta = \mu_s \cancel{mg}\cos\theta$$
$$\mu_s = \frac{\sin\theta}{\cos\theta}$$
$$\mu_s = \tan\theta$$
$$\theta = \tan^{-1}(.4)$$
$$\theta = 21.8°$$

b) What is the acceleration of the brick as it slides down the board? (6 pts)



$$\Sigma F_y = 0$$
$$N - mg\cos\theta = 0$$
$$N = mg\cos\theta$$

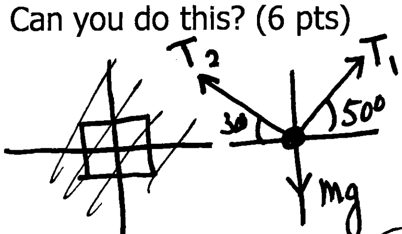
$$\Sigma F_x = ma_x$$
$$mg\sin\theta - F_k = ma$$
$$\cancel{m}g\sin\theta - \mu_k \cancel{m}g\cos\theta = \cancel{m}a$$
$$a = g(\sin\theta - \mu_k \cancel{g}\cos\theta)$$
$$a = (9.8\,m/s^2)[\sin\theta - \mu_k\cos\theta]$$
$$a = (9.8\,m/s^2)[\sin(21.8°) - (.3)\cos(21.8°)$$
$$a = .91\,m/s^2$$



(a) (b)

4) You want to hang a $15\ N$ picture as in image (a) using some very fine twine that will break with more than $12\ N$ of tension.

a) Can you do this? (6 pts)



$$\Sigma F_x = 0$$

$$-T_2 \cos(30°) + T_1 \cos(50°) = 0$$

$$T_2 = T_1 \frac{\cos(50°)}{\cos(30°)} = (13.19N)\frac{\cos(50°)}{\cos(30°)} = 9.79N$$

(will not break)

$$\Sigma F_y = 0$$

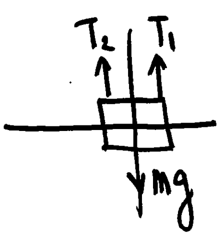
$$T_2 \sin(30°) + T_1 \sin(50°) - mg = 0$$

$$T_1 \frac{\cos(50°)}{\cos(30°)} \sin(30°) + T_1 \sin(50°) = mg$$

$$T_1 = \frac{mg}{\frac{\cos(50°)\sin(30°)}{\cos(30°)} + \sin(50°)} = \frac{15N}{\frac{\cos(50°)\sin(30°)}{\cos(30°)} + \sin(50°)}$$

$$T_1 = 13.19N \text{ (Will break)}$$

b) What if you have it as in image (b)? (6 pts)



$$\Sigma F_y = 0$$

($T_1 = T_2$ or it would rotate)

$$T_2 + T_1 = mg$$

$$2T = mg$$

$$T = \frac{15N}{2} = 7.5N \text{ (Will Not break)}$$

Stuff that may help!

Name Charles Johnson

$$\Delta x = \left[\frac{v_{x_0} + v_x}{2}\right] t$$

$$\Delta x = v_{x_0}\Delta t + \tfrac{1}{2} a_x t^2$$

$$v_x = v_{x_0} + a_x t$$

$$v_x^2 = v_{x_0}^2 + 2a_x \Delta x$$

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

$$\vec{v}_{ave} = \frac{\Delta \vec{r}}{\Delta t}$$

$$\vec{a}_{ave} = \frac{\Delta \vec{v}}{\Delta t}$$

$$W = Fd\cos\theta$$

$$W = \Delta KE$$

$$KE = \tfrac{1}{2} mv^2$$

$$PE_g = mgh$$

$$PE_s = \tfrac{1}{2} kx^2$$

$$\Delta KE + \Delta PE = W_f$$

$$\sin\theta = \frac{A_y}{|\vec{A}|}$$

$$\cos\theta = \frac{A_x}{|\vec{A}|}$$

$$\tan\theta = \frac{A_y}{A_x}$$

$$F_k = \mu_k N$$

$$F_s \le \mu_s N$$

$$\Delta y = \left[\frac{v_{y_0} + v_y}{2}\right] t$$

$$\Delta y = v_{y_0} t + \tfrac{1}{2} a_y t^2$$

$$v_y = v_{y_0} + a_y t$$

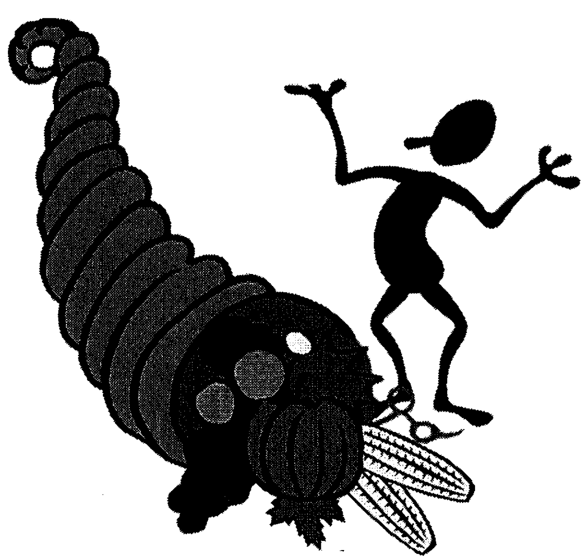
$$v_y^2 = v_{y_0}^2 + 2a_y \Delta y$$

$$g = 9.8 m/s^2$$

$$|\vec{A}| = \sqrt{A_x^2 + A_y^2}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

PHYS 1111



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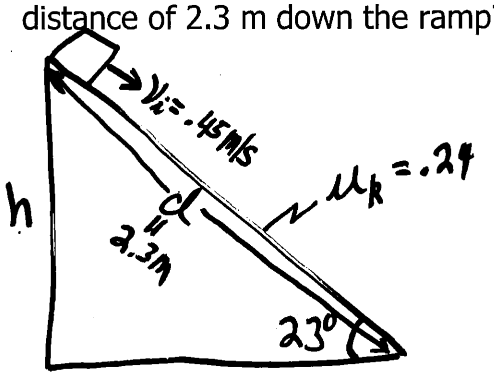
PHYS 1111
Introductory Physics I
TEST 3

Show <u>all work</u> in the spaces provided.
Unless otherwise directed you must use energy considerations.

1) A 55 kg carton of bananas with an initial speed of 0.45 m/s slides down a ramp inclined at an angle of 23° with the horizontal. The coefficient of friction between the carton and the ramp is 0.24. Using conservation of energy how fast, will the carton be moving after it has traveled a distance of 2.3 m down the ramp? (8 pts)



$h = d \sin(23°)$

$h = (2.3m)\sin(23°) = .898 m \approx .9m$

$\Delta KE + \Delta PE = W_f$

$KE_f - KE_i + \cancel{PE_f}^{0} - PE_i = F_f d \cos\theta^{-1}$

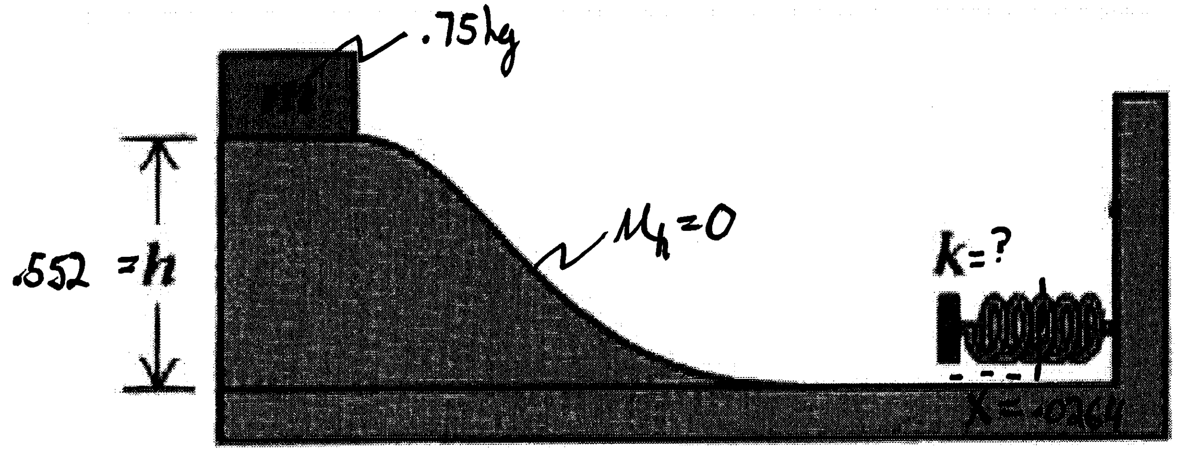
$\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 - mgh = -\mu_k mg \sin(67°) d$

$v_f^2 = v_i^2 + 2gh - 2\mu_k g \sin(67°) d$

$v_f^2 = (.45 m/s)^2 + 2(9.8 m/s^2)(.9m) - 2(.24)(9.8 m/s^2)\sin(67°) \cdot (2.3m)$

$v_f^2 = 7.88 m^2/s^2$

$v_f = 2.8 m/s$



2) A block of mass *m=750 g* is released from rest and slides down a frictionless track of height *h = 55.2 cm*. At the bottom of the track, the block slides freely along a horizontal table until it hits a spring attached to a heavy, immovable wall. The spring compressed *2.64 cm* at the maximum compression. What is the value of the spring constant *k*? (8 pts)

$$\cancel{\Delta KE}^{0} + \Delta PE = 0$$

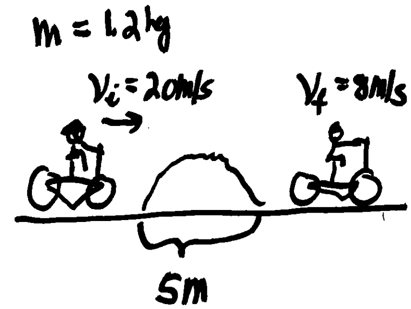
$$\Delta PE_s + \Delta PE_g = 0$$

$$PE_{s_f} - \cancel{PE_{s_i}}^{0} + \cancel{PE_{g_f}}^{0} - PE_{g_i} = 0$$

$$\frac{1}{2}kX^2 - mgh = 0$$

$$k = \frac{2mgh}{X^2} = \frac{2(.75kg)(9.8\,m/s^2)(.552m)}{(.0264)^2}$$

$$k = 11642.56\ N/m$$



3) A *1.20 kg* bike coasts through a *5.0 m* long snowdrift that has been blown onto the road. The bike has a speed of *20.0 m/s* as it approaches the drift and emerges with a speed of *8.00 m/s*.

a) Find the average net force acting on the bike in the drift? (10 pts)

$$W = \Delta KE$$

$$F \cdot d \cancel{\cos\theta}^{-1} = KE_f - KE_i$$

$$-Fd = \tfrac{1}{2} m V_f^2 - \tfrac{1}{2} m V_i^2$$

$$-Fd = \tfrac{1}{2} m \left[V_f^2 - V_i^2\right]$$

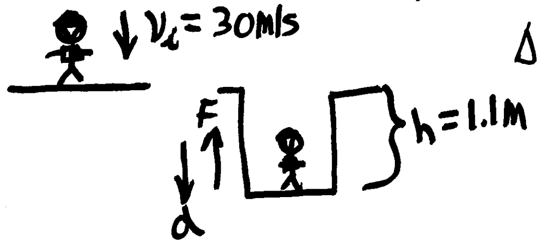
$$F = \frac{m\left[V_i^2 - V_f^2\right]}{2d} = \frac{(1.2kg)\left[(20m/s)^2 - (8m/s)^2\right]}{2(5m)} = 40.32N$$

b) Relative to the displacement of the bike, what is the direction of this net force? (3 pts)

180° //

4) A paratrooper fell 370 m after jumping from an aircraft without his parachute opening. He landed in a snow bank, creating a crater 1.1 m deep, but survived with only minor injuries. Assuming the paratrooper's mass was 80 kg and his terminal velocity was 30 m/s.

a) What was the work done by the snow in bringing him to rest? (5 pts)



$\Delta PE + \Delta KE = W$

$W = \cancel{KE_f}^{0} - KE_i + \cancel{PE_f}^{0} - PE_i$

$W = -\frac{1}{2} m v_i^2 - mgh$

$W = -\frac{1}{2}(80kg)(30m/s)^2 - mgh$

$W = \cancel{-36000J} = \cancel{-3.6 \times 10^4 J}$

$\cancel{35137.6J} \approx \cancel{3.5 \times 10^4 J}$

$3.7 \times 10^4 J$

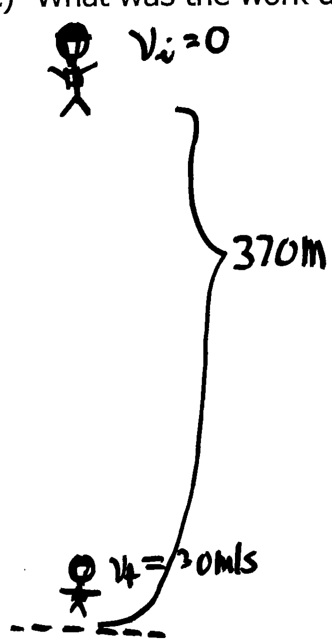
b) What is the average force exerted on him by the snow to stop him? (5 pts)

$W = F \cdot d \cos\theta$

$W = -F \cdot d$

$F = \frac{W}{-d} = \frac{\overset{3.7 \times 10^4}{\cancel{-3.6 \times 10^4 J}}}{-1.1m} = \overset{3.4 \times 10^4 N}{\cancel{3.27 \times 10^4 N}}$

c) What was the work done on him by air resistance as he fell? (5 pts)



$\Delta KE + \Delta PE = W_f$

$KE_f - \cancel{KE_i}^{0} + \cancel{PE_f}^{0} - PE_i = W_f$

$\frac{1}{2} m v_f^2 - PE_i = W_f$

$\frac{1}{2} m v_f^2 - mgh = W_f$

$m(\frac{1}{2} v_f^2 - gh) = W_f$

$(80kg)[(.5)(30m/s)^2 - (9.8m/s^2)(370m)] = W_f$

$-2.54 \times 10^5 J = W_f$