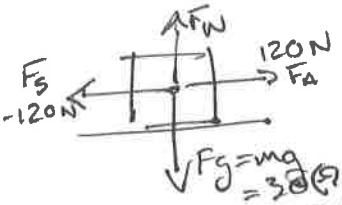
Newton's Second Law Problems with Coefficient of Friction

5) A postal worker loading boxes onto a truck finds that a 30kg box, at rest, needs a 120N horizontal force to set it in motion. After the box is in motion, however, a horizontal force of 60N is required to keep in ~~moving at~~ **constant** velocity. What are the coefficients of static and kinetic friction?

Static



$F_g = 294N$

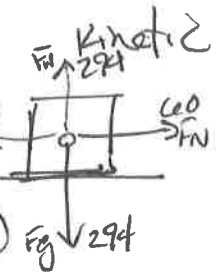
$\therefore F_N = 294$

$F_s = \mu_s F_N$

$\frac{120}{294} = \frac{\mu_s 294}{294}$

$\mu_s = 0.408$

Kinetic



$F_K = \mu_K F_N$

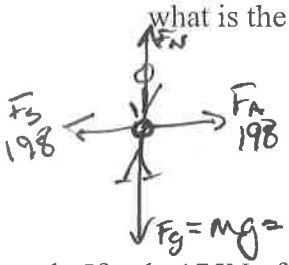
$60 = \mu_K 294$

$\mu_K = \frac{60}{294}$

$\mu_K = 0.204$

6) On one of Mr. Friel's cheap date tips of the month, he suggests that you go on National Skating Night to Blades R Us where you are allowed to skate for free. Unfortunately, while trying to impress your date you realize that you are horrible at skating and need her (or him) to push you the entire way around the track.

a. If your mass is 55kg and a 198N force is required to set you in motion, what is the coefficient of status friction of the ice?

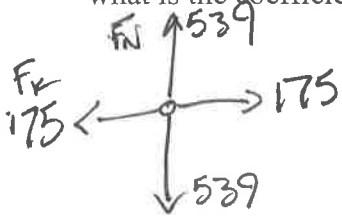


$F_s = \mu_s F_N$

$\frac{198}{539} = \frac{\mu_s 539}{539}$

$\mu_s = 0.367$

b. If only 175N of force are required to keep you in motion after you start moving, what is the coefficient of kinetic friction of the ice?



$F_K = \mu_K F_N$

$\frac{175}{539} = \frac{\mu_K 539}{539}$

$\mu_K = 0.325$

c. Do you think you will get another date?

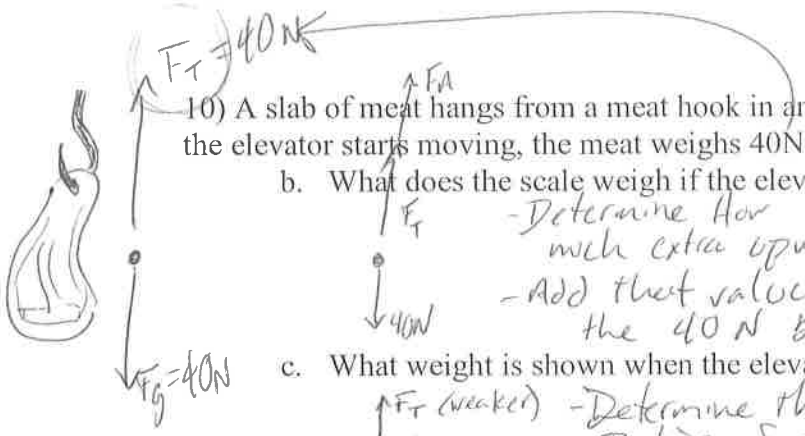
No.

Learn to skate beforehand.

Or make the struggle

fun / funny.

Try skating on epicycles.



10) A slab of meat hangs from a meat hook in an elevator in a butcher shop. Before the elevator starts moving, the meat weighs 40N.

b. What does the scale weigh if the elevator accelerates upward at 4 m/s^2?

- Determine How much extra upward Force
- Add that value to the 40 N baseline F_T

$\Sigma F = ma$

$\Sigma F = 4.08(4)$

$= 16.32N$

$+40$

16.32

$56.32N$

c. What weight is shown when the elevator accelerates downward at 2 m/s^2?

- Determine the unbalanced Portion of gravity
- Subtract that value from 40 N baseline F_T

$\Sigma F = 4.08(2)$

$\Sigma F = 8.16$

$40 - 8.16$

$31.84N$

$F_g = mg$

$40 = m(9.8)$

$m = \frac{40}{9.8}$

$m = 4.08kg$

d. What weight will be shown if the elevator is in free fall?

IN Freefall none of the gravity is balanced by F_T so the scale Reads ZERO

$0N$

11) Assume that the three blocks below move on a frictionless surface and that a 63-N force acts on the 6-kg block. Determine: a) the acceleration of the system. b) the tension in the cord connecting the 6kg and the 2kg block, and c) the force exerted by the 2 kg block on the 1 kg block.

- Determine accel of the whole system (A)
- Apply accel to $m_3 + m_2$ to find F_{T2} for (B)
- Apply accel to m_3 to find F_{T3} for (C)

(A) $\Sigma F = ma$

$63 = (6+2+1)a$

$a = \frac{63}{9}$

$a = 7 m/s^2$

(B) $\Sigma F = F_{T2} = ma$

$F_{T2} = (2+1)(7)$

$F_{T2} = 21N$

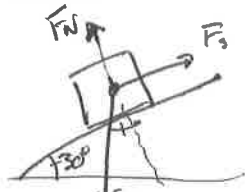
(C) $\Sigma F = F_{T3} = ma$

$F_{T3} = 1(7)$

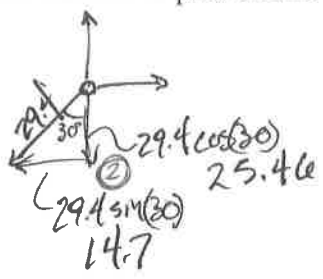
$F_{T3} = 7N$

7) The coefficient of static friction between a 3kg crate and the ramp at a 30° incline is 0.58.

a) What minimum force must be exerted to prevent the crate from sliding down the incline?



① $F_g = 29.4$



	x'	y'
F_g	-14.7	-25.46
F_N	0	+25.46 ③
F_s	+14.7	0
F_A		0
ΣF	0	0

④ $F_s = \mu_s F_N$

$F_s = 0.58(25.46)$

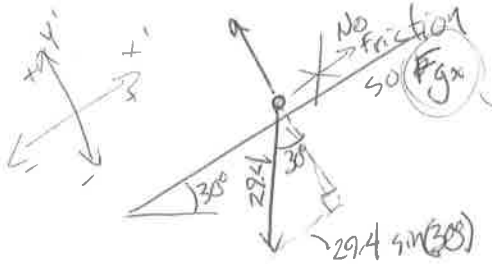
$F_s = 14.7\,N$

⑤ $-14.7 + 0 + 14.7 + x = 0$

$x = 0$

No Applied force Beyond the 14.7 N of friction

b) If the incline is 3 m long and the box starts from rest, how fast will the crate be moving at the bottom of the incline in the absence of friction?



$\Sigma F = ma$

$\frac{-14.7}{3} = \frac{3a}{3}$

$a = -4.9\,m/s^2$

X	-3
V_i	0
V_F	?
a	-4.9
t	

$V_F^2 = V_i^2 + 2ax$

$V_F^2 = 0^2 + 2(-4.9)(-3)$

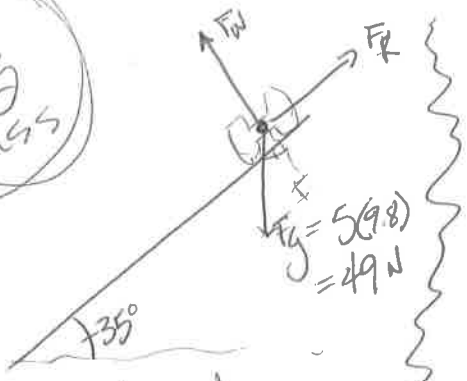
$\sqrt{V_F^2} = \sqrt{29.4}$

$V_F = \pm 5.42\,m/s$

$-5.42\,m/s$ Down the Ramp

8) A 5 kg barbell slides down a 2m workout bench inclined at a 35° angle with an acceleration of 2.5m/s^2 when starting from rest. If a second barbell with a mass of 10kg were placed at the top of the same workout bench, how long would it take the barbell to reach the end of the bench?

5kg mass



	x'	y'
	49sin35	49cos35
F_G	-28.1	-40.1
F_N	0	+40.1
F_K		0
ΣF	-12.5	0

$\Sigma F = ma$

$\Sigma F = 5(2.5)$

$\Sigma F = 12.5$

Find F_K

$-28.1 + 0 + x = -12.5$

$x = 15.6\,N$

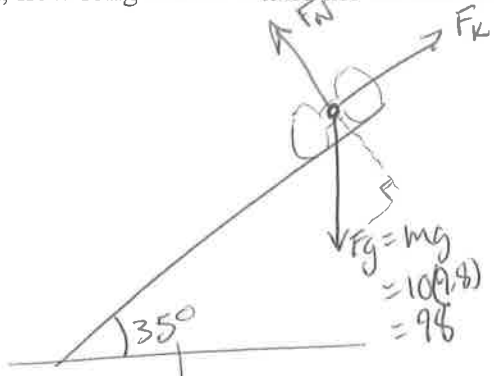
Determine μ_K

$F_K = \mu_K F_N$

$15.6 = \mu_K 40.1$

$\mu_K = \frac{15.6}{40.1}$

$\mu_K = 0.389$



	x'	y'
	98sin35	98cos35
F_G	-56.2	-80.3
F_N	0	+80.3
F_K	31.2	0
ΣF	25	0

$F_K = 0.389(80.3)$

$F_K = 31.2$

$\Sigma F = ma$

$\frac{25}{10} = \frac{10a}{10}$

$a = 2.5\,m/s^2$

All preceeding work was not needed. Acceleration of both should be identical.

x	2
V_i	0
V_F	
a	2.5
t	?

$\Delta x = v_i t + \frac{1}{2} a t^2$

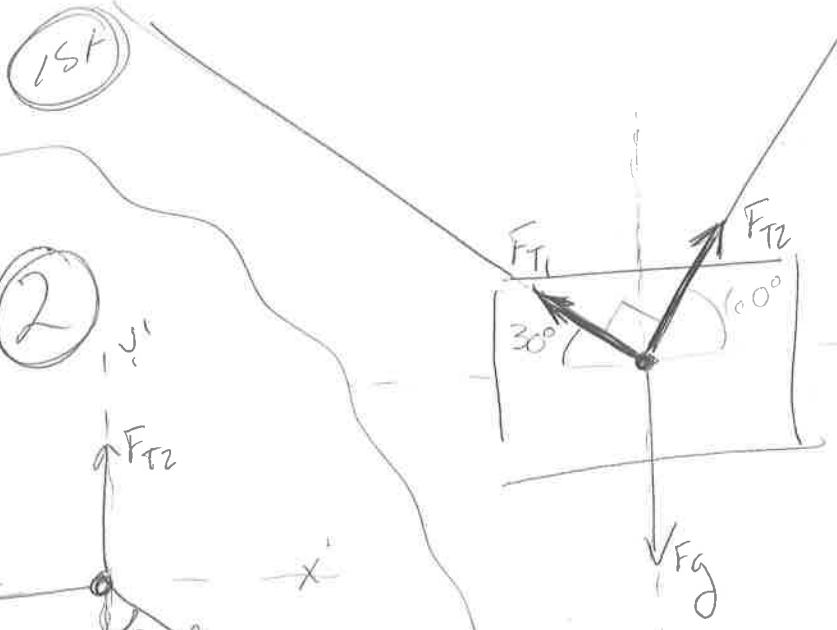
$2 = 0t + \frac{1}{2}(2.5)t^2$

$\frac{2}{1.25} = \frac{1.25 t^2}{1.25}$

$\sqrt{t^2} = \sqrt{1.6}$

$t = 1.265\,s$

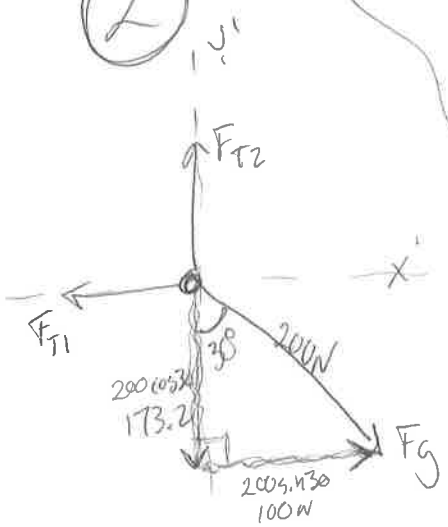
3) A tavern sign weighing 200N hangs from a vertical cable tied to two other cables. One of the upper cables is fastened to the ceiling at a 60°angle to the right while the other is fastened at a 30° angle to the left. What is the force on each cable?



	X	Y
F_g	0	-200N
F_{T1}		
F_{T2}		
ΣF	0	0

Not enough INFO

must Rotate Reference Frame



	X'	Y'
F_g	100	-173.2
F_{T1}	-100	0
F_{T2}	0	+173.2
ΣF	0	0

$F_{T1} = 100N$

$F_{T2} = 173.2N$