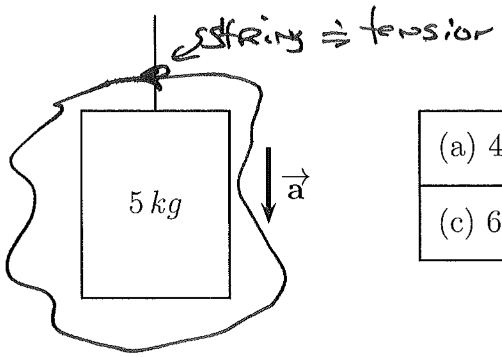
(1.) A 5.0-kg mass is attached to a massless string which is accelerated downwards at $2.5\,m/s^2$. What is the tension in the string?



(a) 49 N	(b) 12.5 N
(c) 61.5 N	$\boxed{\text{(d) } 36.5\,N}$

Long-Range ⇒ gravity, $w = (5kg)(9.8 m/s^2) = 49N$

$\uparrow \vec{T}$

$\downarrow \vec{w}$

$$\sum F_y = ma_y \Rightarrow T_y + w_y = ma_y$$

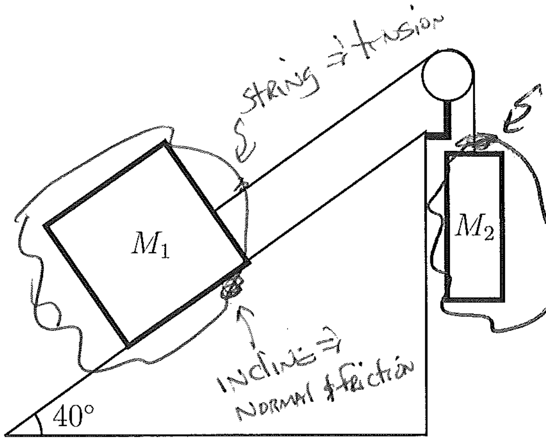
$$T_y = +T, \quad w_y = -49N, \quad a_y = -2.5 m/s^2$$

$$\Rightarrow T - 49N = (5kg)(-2.5 m/s^2)$$

$$T - 49N = -12.5N$$

$$\Rightarrow T = 49N - 12.5N = 36.5N$$

(2.) A $M_1 = 6.5\,kg$ mass is placed on a 40° incline and then connected by a massless string and over a perfect pulley to another mass, $M_2 = 5.0\,kg$, that is hanging vertically. The coefficient of static friction between M_1 and the incline is $\mu_s = 0.76$. If when released the two masses remain at rest, how much static friction is acting on M_1?



(a) $37.1\,N$	(b) $8.1\,N$
(c) $49\,N$	(d) $40.9\,N$

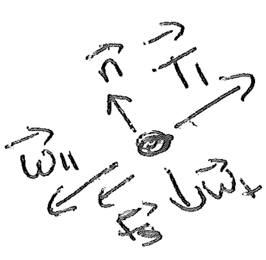
M_1 ON INCLINE ⇒ $W_{\parallel} = M_1 g \sin\alpha = (6.5\,kg)(9.8\,m/s^2)\sin 40° = 40.9\,N$

$W_{\perp} = M_2 g \cos\alpha = (6.5\,kg)(9.8\,m/s^2)\cos 40° = 48.8\,N$

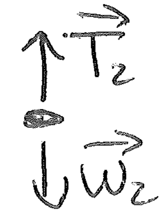
M_2 HAS FULL weight Acting ON IT ⇒ $W_2 = (5\,kg)(9.8\,m/s^2) = 49\,N$

Since $W_2 > W_{\parallel}$ without friction M_2 would fall AND M_1 go up INCLINE ⇒ Static friction ON M_1 IS DOWN INCLINE

Fbd for M_1:



Fbd for M_2:



(cont.)

M_1 AND M_2 BOTH at Rest $\Rightarrow \sum_i \vec{F} = 0$ for both.

For #2: $\sum_i F_y = 0 \Rightarrow T_{2y} + W_{2y} = 0$

$T_{2y} = +T_2$, $W_{2y} = -49N \Rightarrow T_2 - 49N = 0 \Rightarrow T_2 = 49N$

MASSless STRING, PERFECT Pulley $\Rightarrow T_1 = T_2$ SO $T_1 = 49N$

For #1: $\sum_i F_{\parallel} = 0 \Rightarrow T_1 - W_{\parallel} - f_s = 0$ SINCE $\vec{n}$ HAS NO Parallel ~~PERPENDICULAR~~ Component and $\vec{f_s}$ has NO PERP. Component.

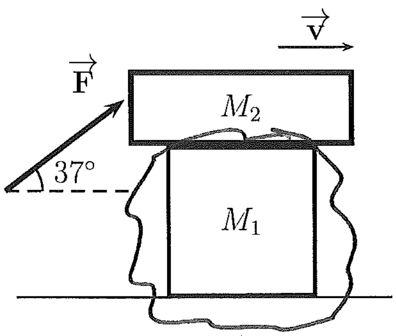
$\therefore$ $49N - 40.9N - f_s = 0 \Rightarrow 8.1N - f_s = 0$

$\Rightarrow f_s = 8.1N$

Notice: PROBLEM NEVER ~~..~~ IMPLIED that f_s at MAX VALUE, so we don't USE $\mu_s n = .76(48.8N)$

$= 37.1N$

(3.) One day finds your physics instructor moving a box, M_1, of old books.

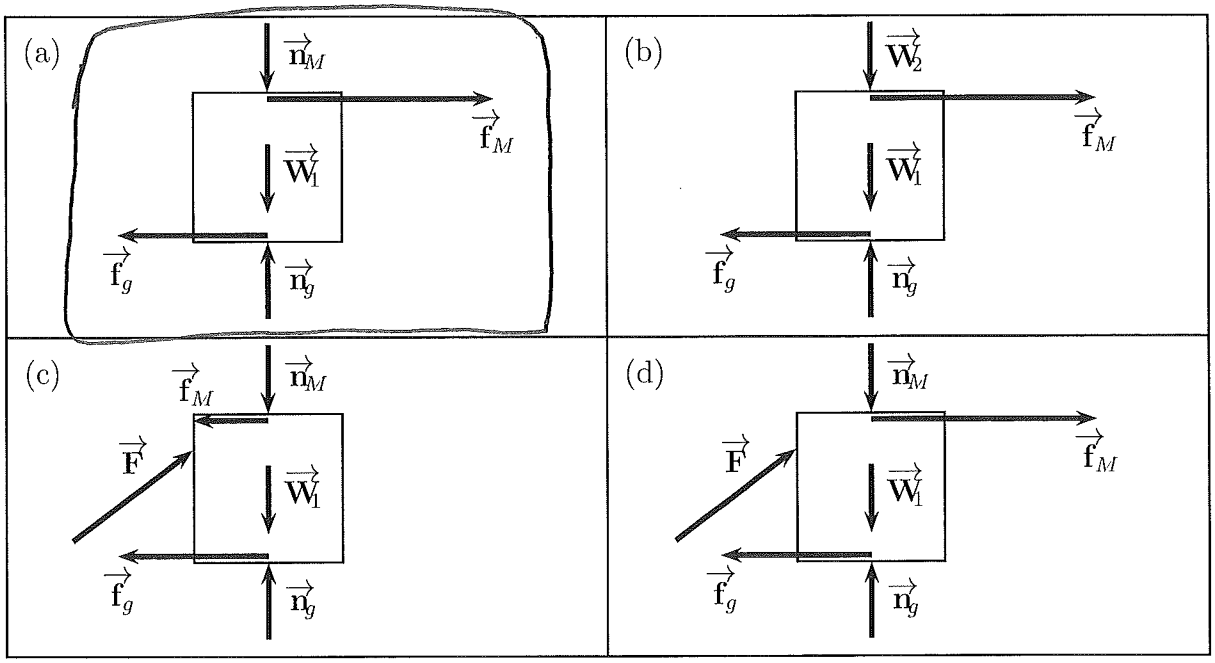


On the way to the recycling bin, he finds a box, M_2, of old physics demos, so he places it on top of the first. By exerting a force, $\vec{F}$ at 37° above the horizontal, to the upper box, he gets the combination to slide to the right.

only M_2 AND GROUND touch M_1 $\Rightarrow$ No $\vec{F}$ on #1's Fbd. ~~Also~~ $\vec{F}_{2 on 1}$ IS A NORMAL FORCE $\Rightarrow \vec{n}_M$ ON #1's Fbd

Which of the following is the correct free-body diagram for M_1? Assume the following definitions.

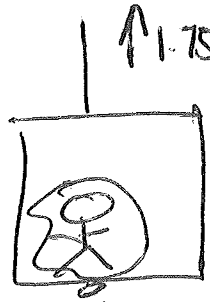
$\vec{W}_1$ = Weight of M_1	$\vec{W}_2$ = Weight of M_2
$\vec{n}_g$ = normal force due to ground	$\vec{n}_M$ = normal force between M_1 & M_2
$\vec{f}_g$ = frictional force due to ground	$\vec{f}_M$ = frictional force between M_1 & M_2



(4.) An 80-kg man is riding in an elevator that is accelerating upwards at $1.75\,m/s^2$. What is the *reaction* to his apparent weight?

(a) The downward 784 N force on the man
(b) The upward 924 N force on the man
(c) The upward 784 N force on the earth
(d) The downward 924 N force on the elevator

$\uparrow 1.75\,m/s^2$ LONG-RANGE: $w = (80kg)(9.8m/s^2) = 784N$



↳ GROUND ⇒ NORMAL, n = APPARENT weight

$\uparrow \vec{n}$

$\downarrow \vec{w}$

$$\sum F_y = ma_y \Rightarrow n_y + w_y = ma_y$$

$$n_y = +n,\; w_y = -784N,\; a_y = +1.75\,m/s^2$$

$$\Rightarrow n - 784N = (80kg)(1.75\,m/s^2) \Rightarrow n - 784N = 140N$$

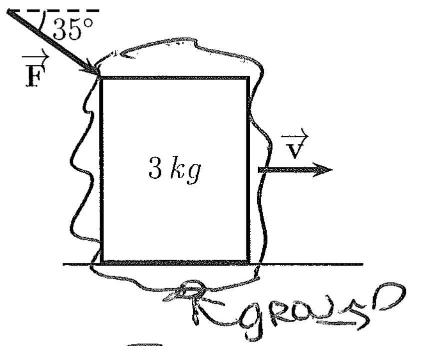
$$\Rightarrow n = 924N$$

IN 3RD LAW TERMS: $\vec{n} = \vec{F}_{EonM}$ = FORCE by elevator ON MAN

SO REACTION IS $\vec{F}_{MonEL}$ = FORCE by MAN ON ELEVATOR

$\vec{n} = 924N$ UP $\Rightarrow \vec{F}_{MonEL} = 924N$ DOWN

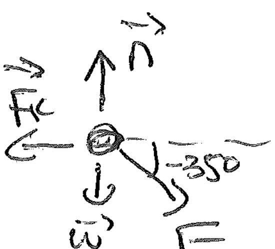
(5.) A 3.0 kg crate is being pushed across a horizontal floor by applying a force $\vec{\mathbf{F}}$, 35° below the horizontal. If the coefficient of kinetic friction is $\mu_k = 0.25$, what force F is needed to accelerate the crate at $2.0\, m/s^2$?



(a) 16.3 N	(b) 7.32 N
$\boxed{\text{(c) } 19.8\, N}$	(d) 13.35 N

Contact forces: F, $\vec{n}$ up (Horizontal Floor), $\vec{f_K}$ left (opposite to $\vec{v}$)

Long Range $\vec{w}$ DOWN, $w = (3kg)(9.8 m/s^2) = 29.4N$



$\Sigma F_x = ma_x, \quad \Sigma F_y = ma_y$

$\Rightarrow n_x + F_x + w_x + f_{Kx} = ma_x, \quad n_y + F_y + w_y + f_{Ky} = ma_y$

$n_x = 0, \; n_y = n$

$F_x = F\cos(-35°) = F(0.819) = 0.819F$

$F_y = F\sin(-35°) = F(-0.574) = -0.574F$

$w_x = 0, \; w_y = -29.4N$

$f_{Kx} = -f_K, \; f_{Ky} = 0, \; a_x = 2 m/s^2, \; a_y = 0$

$$\Rightarrow n_x + F_x + w_x + f_{kx} = ma_x \Rightarrow 0 + .819F + 0 - f_k = (3kg)(2m/s^2)$$

$$\Rightarrow 0.819F - f_k = 6N$$

$$n_y + F_y + w_y + f_{ky} = ma_y \Rightarrow n - 0.574F - 29.4N + 0 = 0$$

$$\Rightarrow n = 29.4N + 0.574F$$

Kinetic friction $\Rightarrow f_k = \mu_k n = 0.25[29.4N + 0.574F]$

$$\Rightarrow f_k = 7.35N + 0.1435F$$

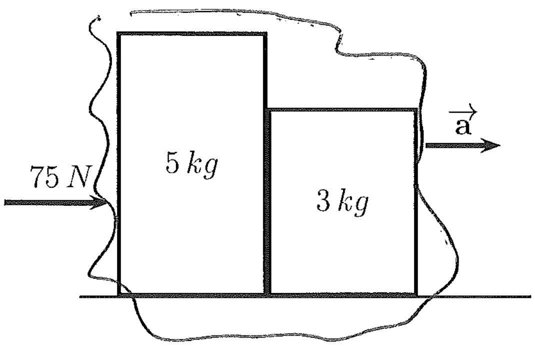
so $0.819F - f_k = 6N \Rightarrow 0.819F - [7.35N + 0.1435F] = 6N$

$$\Rightarrow 0.819F - 7.35N - 0.1435F = 6N$$

$$\Rightarrow 0.6755F = 6N + 7.35N = 13.35N$$

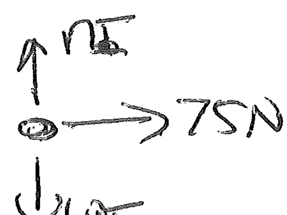
$$\Rightarrow F = \frac{13.35N}{0.6755} = 19.8N$$

(6.) Sitting on a horizontal surface sits two crates, one 5.0 kg, the other 3.0 kg. A 75 N, horizontal force is exerted on the crate to the left making the two masses accelerate. Ignoring friction, how large is the contact force that the one mass exerts on the other?



(a) 46.875 N	(b) 28.125 N
(c) 75 N	(d) 0 N

For Entire 8kg mass:

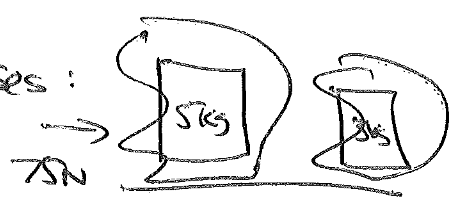


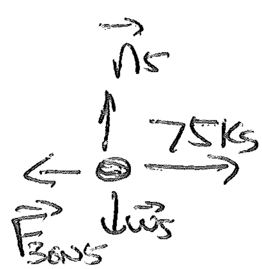
$\sum F_x = m a_x$

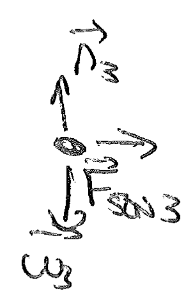
$\Rightarrow 75N = 8kg\, a_x$

$\Rightarrow a_x = \frac{75N}{8kg} = 9.375 m/s^2$

For Individual Masses:







On 3kg: $\sum F_x = m a_x \Rightarrow F_{5on3} = 3kg(9.375 m/s^2) = 28.125N$

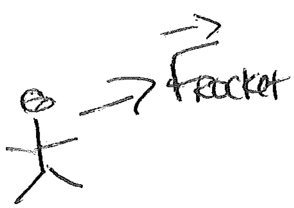
(7.) A man who weighs 720 N on earth, surprisingly finds himself in the middle of outer space. Luckily, he is in a spacesuit and, even better, there is a rocket next to him. What force must the rocket exert on the man in order to give him an acceleration of $9.8\,m/s^2$?

(a) 720 N	(b) 0 N	(c) 1440 N	(d) 360 N

earth's value

In outer space still has mass : $m = \frac{720N}{9.8\,m/s^2} = 73.5N$

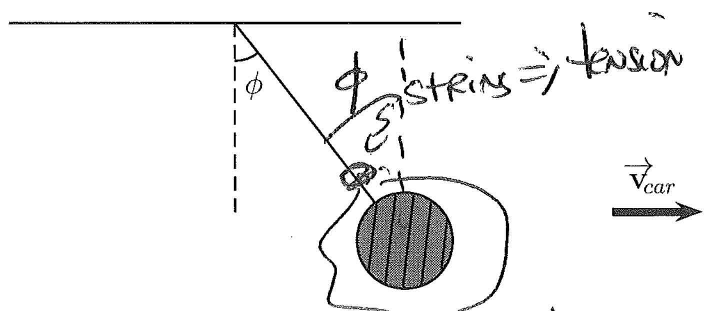
So earth's gravity



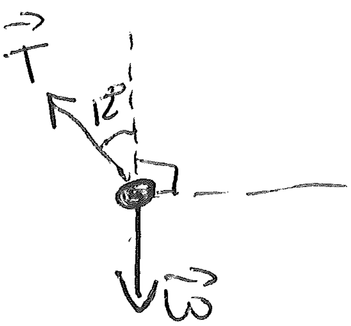
$$\sum F = ma$$

$$\Rightarrow F_{rocket} = ma = (73.5N)(9.8\,m/s^2) = 720N$$

(8.) One day finds you and your physics instructor going on a drive in his orange-colored, 1973 Gremlin. Hanging from the rear-view mirror, by a massless string, is a 0.65-kg mass pair of pink, fuzzy dice (schematically shown as a sphere in the picture below). At one point during your drive, the dice are hanging at a constant angle of $\phi = 12°$, what is the acceleration of the car at this instant? Also, given the direction of the car's velocity, is the car accelerating or decelerating?



Long Range: $w = (0.65kg)(9.8m/s^2)$
$= 6.37N$



So $\vec{T}$ at standard Angle of
$\theta = 90° + 12° = 102°$

$\sum_i F_x = ma_x, \quad \sum_i F_y = ma_y$

Car moving to Right AND either speeding up OR slowing Down
$\Rightarrow a_x = a = ?, \quad a_y = 0$

$\therefore \sum_i F_x = ma_x \Rightarrow T_x + w_x = ma$

$\sum_i F_y = ma_y \Rightarrow T_y + w_y = 0$

$T_x = T\cos 102° = T(-0.2079) = -0.2079T$

$T_y = T\sin 102° = T(0.978) = 0.978T$

$w_x = 0, \ w_y = -6.37N$

$T_y + w_y = 0 \Rightarrow 0.978T - 6.37N = 0 \Rightarrow T = \frac{6.37N}{0.978}$

$\Rightarrow T = 6.51N$

$T_x + w_x = ma \Rightarrow -0.2079T + 0 = (0.65kg)a$

$\Rightarrow -0.2079(6.51N) = (0.65kg)a$

$\Rightarrow -1.35N = (0.65kg)a$

$\Rightarrow a = \frac{-1.35N}{0.65kg} = -2.08 m/s^2$

$\vec{a}$ opposite to $\vec{v}$ so car is slowing DOWN.