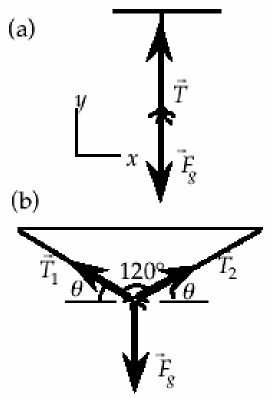
7. We choose a coordinate system as shown in the diagram.
In both parts, the spider is motionless and $\vec{a} = 0$, therefore $\sum \vec{F} = 0$.

(a) $\sum \vec{F} = T\hat{j} - F_g\hat{j} = 0$, which gives

$T = F_g = \boxed{3 \times 10^{-4}\ \text{N}}$.

(b) $\sum \vec{F} = -T_1 \cos\theta\,\hat{i} + T_1 \sin\theta\,\hat{j} + T_2 \cos\theta\,\hat{i} + T_2 \sin\theta\,\hat{j} - F_g\hat{j} = 0.$
Using the two component equations, we get
$T_1 \cos\theta = T_2 \cos\theta$, or $T_1 = T_2$; and
$T_1 \sin\theta + T_2 \sin\theta = 2T_1 \sin\theta = F_g$.
Thus $T_1 = (3 \times 10^{-4}\ \text{N})/(2 \sin 30°) = \boxed{3 \times 10^{-4}\ \text{N}}$



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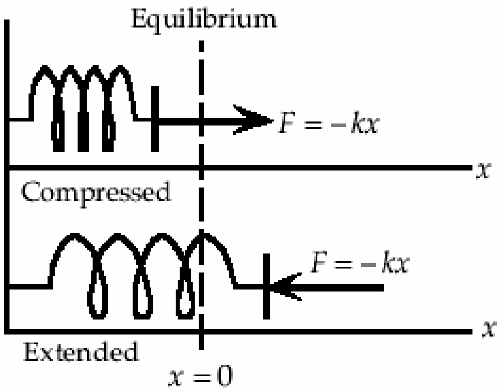

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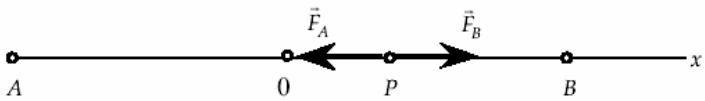


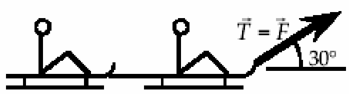
Set up a coordinate system with the origin at the midpoint of the line connecting points A and B. Consider the object (at point P), whose coordinate is x. It is a distance $L + x$ from point A and $L - x$ from point B. The forces exerted on it are $F_A = -c(L + x)$ and $F_B = c(L - x)$; so the net force is

$F = F_A + F_B = -c(L + x) + c(L - x) = \boxed{-2cx}$

When $x > 0$, $F < 0$ (to the right); and when $x < 0$, $F > 0$ (to the left). So F tends to pull the object back to $\boxed{\text{the origin (the midpoint between } A \text{ and } B)}$, where $F = 0$.

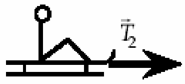
21. We need to look at horizontal forces only.
The tension in the pulled rope must be equal to the force the father exerts: $\boxed{T = F}$.
If we take both sleds as the object, we get the force diagram shown. Then for horizontal motion, we have

$\sum F = T \cos 30° = (m + m)a = 2ma$, so
$a = T(\cos 30°)/2m = 0.433T/m$.

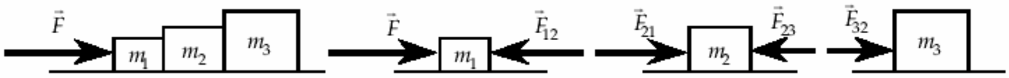


If we take the second sled as the object we get the force diagram shown. Then

$\sum F = T_2 = ma$, so $T_2 = m(0.433T/m) = \boxed{0.433F}$



28. In the diagrams for the set and each of the blocks below, only the horizontal forces are shown (as vertical normal forces balance the gravity forces).



(a) For the set we have $\sum F_x = ma_x$: $8.0\ \text{N} = (2.0\ \text{kg} + 3.0\ \text{kg} + 4.0\ \text{kg})\, a$, which gives $a = 0.89\ \text{m/s}^2$.

(b) For block 1 we have $\sum F_x = ma_x$: $F - F_{21} = m_1 a$;

$8.0\ \text{N} - F_{12} = (2.0\ \text{kg})(0.89\ \text{m/s}^2)$, which gives $F_{12} = 6.2$ N to the left.

The forces are $F = 8.0$ N to the right, $F_{12} = 6.2$ N to the left, and $F_{\text{net1}} = 1.8$ N to the right.

(c) For block 2 we have $\sum F_x = ma_x$: $F_{21} - F_{23} = m_2 a$ and $F_{21} = F_{12}$ (Newton's third law):

$6.2\ \text{N} - F_{23} = (3.0\ \text{kg})(0.89\ \text{m/s}^2)$, which gives $F_{23} = 3.5$ N to the left.

The forces are $F_{21} = 6.2$ N to the right, $F_{23} = 3.5$ N to the left, and $F_{\text{net2}} = 2.7$ N to the right.

(d) For block 3 we have $\sum F_x = ma_x$: $F_{32} = m_3 a$:

$F_{32} = (4.0\ \text{kg})(0.89\ \text{m/s}^2)$, which gives $F_{32} = 3.6$ N to the right (= F_{23}, Newton's third law).

The forces are $F_{32} = 3.6$ N to the right, and $F_{\text{net3}} = 3.6$ N to the right.

30. (a) The force acting on the table is the combined weight of the three identical blocks, so the weight of each block must be $\frac{1}{3}(3\ \text{N}) = 1$ N. The forces exerted on block 3 are: 3N of supporting force from the table, up; 1 N of its own weight, down; and 2 N of normal force from the other two blocks, down. The net force on block 3 is zero.

(b) The forces exerted on block 2 are: 2N of supporting force from block 3, up; 1 N of its own weight, down; and 1 N of normal force from the block 1, down. The net force on block 2 is zero.

(c) The forces exerted on block 1 are: 1N of supporting force from block 2, up; 1 N of its own weight, down. The net force on block 1 is zero.

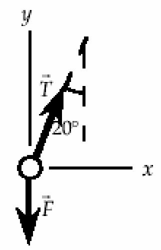
38. From the inertial frame of Earth, for the mass we can write

$\sum F_y = ma_y$: $T \cos 20° - F = 0$; $T \cos 20° = 6.0$ N, which gives

$T = 6.4$ N; and

$\sum F_x = ma_x$: $T \sin 20° = ma$; $(6.4\ \text{N}) \sin 20° = (2\ \text{kg})a$, which gives

$a = 1.1\ \text{m/s}^2$.



The observer in the noninertial frame of the truck will say that there are three forces:

$F = 6.0$ N in $-y$-direction,

T in the string $= 6.4$ N at 20° from $+y$, and

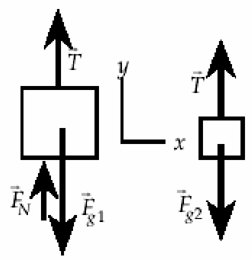
a fictitious force of $(2\ \text{kg})(1.1\ \text{m/s}^2) = 2.2$ N toward the back of the truck.

42. The coordinate system and the forces on each mass are shown. Since the system is at rest, $a = 0$ and we can write:

$\sum F_y = ma_y$;

$T + F_N - F_{g1} = 0$ for block M and

$T - F_{g2} = 0$ for block m.



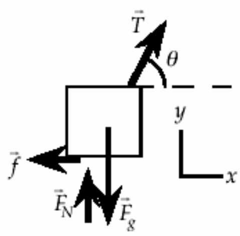
48. The coordinate system and the forces on the block are shown. Since the system is at rest, $a = 0$ and we can write:

$\sum F_x = ma_x$

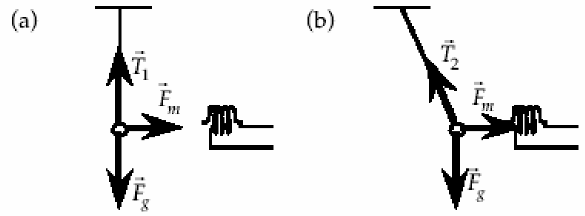
$T \cos \theta - f = 0$, which gives $f = T \cos \theta$.

$\sum F_y = ma_y$

$T \sin \theta + F_N - Mg = 0$, which gives $F_N = Mg - T \sin \theta$.



54.



58. We are given $\vec F_1 = (1.715, 0, 0)$ N, $\vec F_2 = (0, 1.128, 0)$ N, and $\vec F_3 = (F_{3x}, F_{3y}, 0)$.

(a) If the body does not accelerate, we can write $\sum \vec F = m\vec a = 0$:
For the components we get

x: $1.715\text{ N} + F_{3x} = 0$, which gives $F_{3x} = \boxed{-1.715\text{ N}}$;

y: $1.128\text{ N} + F_{3y} = 0$, which gives $F_{3y} = \boxed{-1.128\text{ N}}$;

z: $0 = 0$.

(b) Because the forces are constant, the acceleration will be constant and we can write

$\vec r = \vec r_0 + \vec v_0 t + \frac{1}{2}\vec a t^2$, or

$(1.000, 1.000, 0)\text{ m} = (0, 0, 0) + (0, 0, 0) + \frac{1}{2}\vec a\,(5.000\text{ s})^2$, which gives $\vec a = (0.08000, 0.08000, 0)\text{ m/s}^2$.

For $\sum F_x = ma_x$, we can write

$F_1 + F_{3x} = ma_x$, which gives $F_{3x} = (25.43\text{ kg})(0.08000\text{ m/s}^2) - 1.715\text{ N} = \boxed{0.3194\text{ N}}$.

For $\sum F_y = ma_y$, we can write

$F_2 + F_{3y} = ma_y$, which gives $F_{3y} = (25.43\text{ kg})(0.08000\text{ m/s}^2) - 1.128\text{ N} = \boxed{0.9064\text{ N}}$.

64. From the force diagram for the pulley and object we can write

$\sum F_x = T_2\cos 35° - T_1\cos 35° = 0$, which gives $T_1 = T_2$.

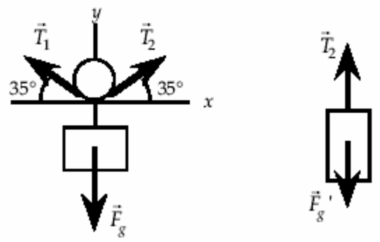
$\sum F_y = T_1\sin 35° + T_2\sin 35° - F_g$
$= 2T_2\sin 35° - (20\text{ N})$, which gives

$T_2 = 17.4$ N.

From the force diagram for the other object we can write

$\sum F_y = T_2 - F_g{'} = 0$, which gives

$F_g{'} = T_2 = \boxed{17.4\text{ N}}$.



66. During the drop, the only force is F_g (down); during the bounce, the forces are F_g (down) and F_N (up) from the slab; during the rise, the only force is F_g (down).

If we assume a mass of 20 g,

$F_g = (0.020\text{ kg})(10\text{ m/s}^2) = \boxed{0.20\text{ N down}}$.

If the ball falls $h = 1.0$ m, the speed just before it hits is

$v_1 = (2gh)^{1/2} = [2(10\text{ m/s}^2)(1.0\text{ m})]^{1/2} = 4.5\text{ m/s}$.

The speed just after it hits is

$v_2 = [2g(0.80)h]^{1/2} = (0.80)^{1/2}\,v_1 = 4.0\text{ m/s}$.

If we assume the bounce occurs in 0.10 s, we can write

$F_N - F_g = m\,\Delta v/\Delta t$, which gives

$F_N = (0.020\text{ kg})[4.0\text{ m/s} - (-4.5\text{ m/s})]/(0.10\text{ s}) + 0.20\text{ N}$
$= \boxed{1.9\text{ N up}}$.

71. We take up as positive, so $\vec F_g = -mg\hat j$, $\vec F_d = Av^2\hat j$, and $\vec v = -v\hat j$.

(a) We do a dimensional analysis of $F_d = Av^2$:

$[F_d] = [A][v^2]$, $[MLT^{-2}] = [A][LT^{-1}]^2$, which gives $[A] = \boxed{[ML^{-1}]\text{ with units of kg/m}}$.

(b) $dv/dt = \sum F/m = (Av^2 - mg)/m = \boxed{Av^2/m - g}$.

(c) At constant velocity: $dv/dt = 0$; $(A/m)v_t^2 - g = 0$, which gives $\boxed{v_t = \sqrt{mg/A}}$.

74. Since the initial speed is 2×10^6 m/s, the time the electron spends between the plates will be short and we will neglect the vertical acceleration $-g$ and assume that the vertical motion has constant velocity. From $\sum \vec{F} = m\vec{a}$, we get

$\sum F_y = ma_y$; $\sum F_x = ma_x$: $0 = a_y$; $F = ma_x$.

(a) For the vertical motion: $y = v_y t$; 1×10^{-2} m $= (2.0 \times 10^6$ m/s$)t$, which gives

$t = \boxed{5 \times 10^{-9}\text{ s}}$.

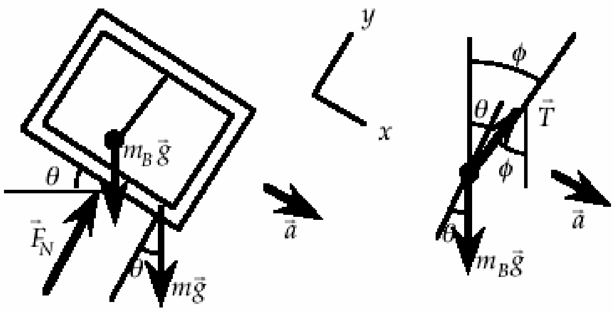
(b) We can find the horizontal acceleration from $\sum F_x = ma_x$:

$a_x = (3.0 \times 10^{-18}\text{ N})/(9.0 \times 10^{-31}\text{ kg}) = 3.3 \times 10^{12}\text{ m/s}^2$.

Since the acceleration is constant, the velocity is found from

$v_x = v_{0x} + a_x t = 0 + (3.3 \times 10^{12}\text{ m/s}^2)(5.0 \times 10^{-9}\text{ s}) = \boxed{1.7 \times 10^4\text{ m/s}}$.

77.



From the force diagram for the system of the frame and plumb bob, we can write

$\sum F_x = ma_x$:

$(m_B + m)g \sin\theta = (m_B + m)a$; and

$\sum F_y = ma_y$:

$F_N - (m_B + m)g \cos\theta = 0$.

From the x-equation we find

$a = g \sin\theta$.

From the force diagram for the system of the plumb bob, we can write

$\sum F_x = ma_x$:

$m_B g \sin\theta + T \sin(\phi - \theta) = m_B a$; and

$\sum F_y = ma_y$:

$T \cos(\phi - \theta) - m_B g = 0$.

Using $a = g \sin\theta$ in the x-equation, we find $\sin(\phi - \theta) = 0$, so $\boxed{\phi = \theta}$.