Basic Force Calculations
Show all your work and equations used on this page

1. A pumpkin has a mass of 3.5 kg. What is its weight in Newtons?

$F_g = m \cdot g$

$F_g = 3.5\,kg \times 9.8\,N/kg = 34.3\,N$

2. What is the mass of a saxophone if its weight is 21 N?

$F_g = mg$

$21\,N = m \cdot 9.8\,N/kg$

$m = 2.1\,kg$

3. What is the force of gravity acting on a 80 kg person?

$F_g = mg$

$F_g = 80 \times 9.8 = 784\,N$

4. With all of your textbooks in it, your bookbag weighs 160 N. Empty, your bookbag weighs 6 N. What is the mass of all of your textbooks?

$m = \frac{F_g}{g} = 160\,N / 10\,N/kg = 16\,kg$

$m = \frac{F_g}{g} = 6\,N / 10\,N/kg = 0.6\,kg$

$16 - 0.6 = 15.4\,kg$

Materials	μ_s	μ_k
Steel on Steel	0.74	0.57
Metal on Metal (lubricated)	0.15	0.06
Wood on Wood	0.35	0.2
Glass on Glass	0.94	0.4
Teflon on Teflon	0.04	0.04
Rubber on Dry Concrete	1.0	0.8
Rubber on Wet Concrete	0.3	0.25
Waxed Wood on Dry Snow	0.1	0.04
Ice on Ice	0.1	0.03
VERY Rough Surfaces		1.5

5. A spring with a spring constant k= 44 N/m is stretched by 0.29 m. How large is the force the spring is exerting when stretched?

Sign?

$F_s = -k \cdot \Delta x$

$F_s = -44\,N/m \cdot 0.29\,m = -12.76\,N$

6. When an 80 Newton weight is hung from a vertical spring, the spring stretches 23 cm. What is the spring constant of the spring?

$F_s = F_g = mg = 80\,N$

$F_s = -k \cdot \Delta x$

$80\,N = -k \cdot 0.23\,m$

$23\,cm = 0.23\,m$

$k = 347.8\,N/m$

7: A spring has a spring constant of 2.4 N/m. How far will it stretch if you hang a 75 **g mass** from it?

$75g = 0.075\,kg$

$F_g = mg = 0.075 \times 10 = 0.75N$

$F_s = -k \cdot \Delta x$

$0.75 = -2.4\,N/m\ \Delta x$

$\Delta x = -0.31\,m$

8. When a 120 N normal force is applied between two surfaces, the force of kinetic friction between them as they slide is 41 N. What is the coefficient of kinetic friction between the surfaces?

$F_f = \mu \cdot F_N$

$41N = \mu \cdot 120N$

$\mu = 0.34$

9. A wood block experiences a friction force of 23 N as it slides across a wood table. What is the normal force between the block and table?

$F_f = \mu \cdot F_N$

$23N = 0.2\,F_N$

$F_N = 115\,N$

10. A glass coffee pot is sitting on a glass table and the normal force between them is 15 N. You then start to push the coffee pot until it slides on the table. What is the force of friction a) just before the pot starts to slide, and b) as the pot is sliding?

a) $F_f = \mu \cdot F_N$

$F_f = 0.94 \cdot 15N$

$F_f = 14.1\,N$

b) $F_f = \mu \cdot F_N$

$F_f = 0.4 \cdot 15N$

$F_f = 6\,N$

More Advanced Problems

Surfaces	μ_s	μ_k
Cardboard on Wood	0.55	0.36
Rubber on Asphalt	1.00	0.80
Concrete on Wood	0.62	0.42
Steel on Grass	0.50	0.35
Alien Spacecraft on Sandstone	1.80	1.20
Wood on Brick	0.60	0.50
Polytetrafluoroethylene on Polytetrafluoroethylene	0.04	0.03

For all of the following practice problems, make sure you are drawing force diagrams and force tables.

1. A 2 kg cat hangs from a bungee cord at rest.
   a. What is the spring force pulling the cat up?

$F_s = F_g = m \cdot g = 2kg \times 10N/kg = 20N$

   b. If the bungee stretches 0.5 m, what is the bungee cord's spring constant?

$F_s = -k \cdot \Delta x$

$20N = -k \cdot (-0.5m)$

$k = 40 N/m$

2. A slinky, a slinky, everyone loves a slinky. A slinky has a spring constant of approximately 0.84 N/m. If a 0.113 kg G.I. Joe © jumps from the roof of a building with one end of the slinky in hand. How far will the slinky be stretched when Joe stops moving?

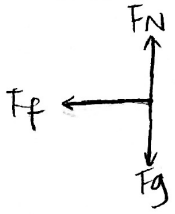
$F_s = F_g = m \cdot g = 0.113 \times 10 = 1.13N$

$F_s = -k \cdot \Delta x$

$1.13N = -0.84 N/m \cdot \Delta x$

$\Delta x = 1.35 m$

3. A 3500 kg alien spaceship crash lands on earth and slides to a stop somewhere in the Nevada desert. What is the normal force and the force of friction as it slides to a stop?

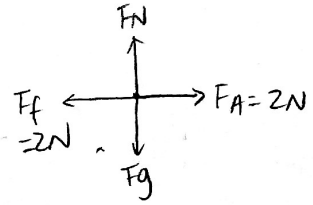


$F_N = F_g = m \cdot g = 3500\,kg \times 10\,N/kg = 35000\,N$

$F_f = \mu \cdot F_N$

$F_f = 1.20 \times 35000N = 42000\,N$

4. A 2 kg box is nudged with a 2 N applied force and slides with a constant velocity. What is the coefficient of friction between the box and table?



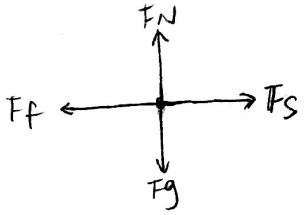
$F_N = F_g = m \cdot g = 2 \times 10 = 20N$

$F_f = \mu \cdot F_N$

$2N = \mu \cdot 20N$

$\mu = 0.1$

5. "The Boz" is training for the NFL combine. He pulls a 300 kg steel sled attached to a bungee cord on his harness. The coefficient of friction between the steel and grass is $\mu_k = 0.3$ and the spring constant for a bungee cord is 500 N/m. He pulls it at a constant velocity of 5 m/s for 10 seconds. How much does the bungee on his harness stretch during his pull?



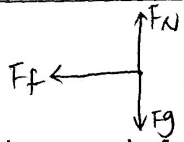
$F_N = F_g = m \cdot g = 300 \times 10 = 3000\,N$

$F_s = F_f = \mu \cdot F_N = 0.3 \times 3000N = 900\,N$

$F_s = -k \cdot \Delta x$

$900N = -500\,N/m \cdot \Delta x$

$\Delta x = 1.8\,m$



6. A 2014 Porsche 918 Spyder (1700 kg) can reach a speed of 1600 m/s in 2.2 seconds!!! Mr. Frost's 2018 Kia Niro (1800 kg) can reach 1600 m/s in about 10 seconds. Which car has a greater stopping force, and by how many Newtons?

Spyder:
$v_i = 0\ m/s$
$v_f = 1600\ m/s$
$\Delta t = 2.2\ s$
$V = v_0 + at$
$1600 = 0 + 2.2a$
$a = 727\ m/s^2$

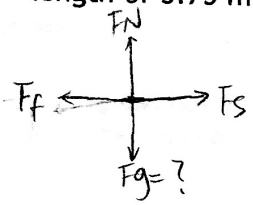
$\Sigma F = ma$
$\Sigma F = 1700 \times 727$
$= 1236363\ N$

Kia Niro:
$v_i = 0\ m/s$
$v_f = 1600\ m/s$
$\Delta t = 10\ sec$
$V = v_0 + at$
$1600 = 0 + 10a$
$a = 160\ m/s^2$

$\Sigma F = ma$
$\Sigma F = 1800 \times 160$
$= 288000\ N$

$288000N + 1236363N = 948363N$

7. A 3 m spring (spring constant of 400 N/m) pulls a wooden crate of stuffed parrots to the left with a constant velocity of 3 m/s across a concrete floor. While it slides, the spring has a length of 3.75 m. What is the mass of the of the crate of stuffed parrots?



$F_f = F_s = -k \cdot \Delta x = -400\ N/m \cdot (3.75 - 3\ m) = 400 \times 0.75 = 300N$

$F_f = \mu \cdot F_N$
$300N = 0.42 \cdot F_N$
$F_N = 714\ N$

$F_N = F_g = mg$
$714N = m \cdot 10\ N/kg$
$m = 71.4\ kg$

8. A mysterious cardboard package is delivered to a physicist's door. She has a meter stick, a spring, and a 1 kg mass. When the 1 kg mass is hung from the spring, it stretches 0.27 meters. The mystery package stretches the spring 0.45 meters. What is the most the spring could possibly stretch if it pulls the package horizontally on a wooden surface without it moving?

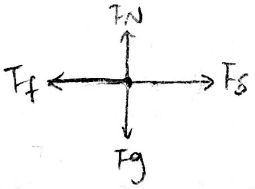
$F_s = -k \cdot \Delta x$
$k = \frac{F_s}{\Delta x}$

1 kg mass $F_s = F_g = 1kg \cdot 10 = 10N$

$k = \frac{10N}{0.27m} = 37\ N/m$

$F_{s\,package} = -k \cdot \Delta x$
$F_s = -37\ N/m \cdot (-0.45m)$
$F_s = 16.65\ N$

$F_s = F_g = m \cdot g$
$16.65N = m \cdot 10\ N/kg$
$m = 1.67\ kg$



$F_N = F_g = 1.67 \times 10 = 16.7N$
$F_f = \mu \cdot F_N = 0.55 \times 16.7N = 9.2N$
$F_f = F_s$
$F_s = -k \cdot \Delta x$
$9.2N = -37\ N/m \cdot \Delta x$
$\Delta x = 0.25\ m$