Common Forces

-gravitational forces (weight) UNIT=Newton (N)

WEIGHT

An object's weight, $\vec{F}_g$, is the product of its mass, m, and the acceleration due to gravity, g.

$$\vec{F}_g = m\vec{g}$$

Quantity	Symbol	SI unit
force of gravity (weight)	$\vec{F}_g$	N (newton)
mass	m	kg (kilogram)
acceleration due to gravity	$\vec{g}$	$\frac{m}{s^2}$ (metres per second squared)

Unit Analysis

(mass) (acceleration) = $kg\frac{m}{s^2}$ = N

Note: The symbol g is reserved for acceleration due to gravity on Earth. In this textbook, g with an appropriate subscript will denote acceleration due to gravity on a celestial object other than Earth, for example, g_{Moon}.

Nov 2 - 8:16 PM

Table 4.3 Free-Fall Accelerations Due to Gravity on Earth

Location	Acceleration due to gravity (m/s^2)	Altitude (m)	Distance from Earth's centre (km)
North Pole	9.8322	0 (sea level)	6357
equator	9.7805	0 (sea level)	6378
Mt. Everest (peak)	9.7647	8850	6387
Mariana Ocean Trench* (bottom)	9.8331	11 034 (below sea level)	6367
International Space Station*	9.0795	250 000	6628

*These values are calculated.

Table 4.4 Free-Fall Accelerations Due to Gravity in the Solar System

Location	Acceleration due to gravity (m/s^2)
Earth	9.81
Moon	1.64
Mars	3.72
Jupiter	25.9

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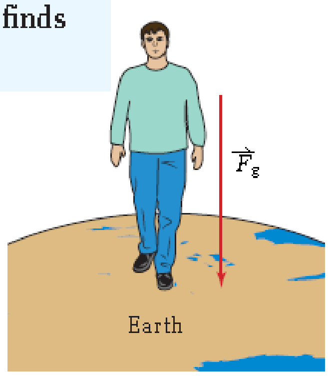
Weight and Mass Calculations

1. Calculate the weight of a 4.0 kg mass on the surface of the Moon.

Oct 25-8:03 PM

2. A student standing on a scientific spring scale on Earth finds that he weighs 825 N. Find his mass.



Oct 25-8:04 PM

Sticky Shoe Lab

Using your own shoe, measure and record the static frictional force and kinetic frictional force of at least 10 different surfaces in and around the school. Design a table to record your data. Remember to calculate the 'weight' of your shoe.

DO NOT disturb classes during this lab. Be mindful of the fact that 'some' teachers may not appreciate the science you are doing!

Nov 2 - 8:21 PM

Friction Forces

-kinetic frictional forces (when the object is moving)

-static frictional forces (when the object is not moving)

-strength of these forces depends on the nature of the two surfaces

-generally an electromagnetic force between the particles of the two surfaces

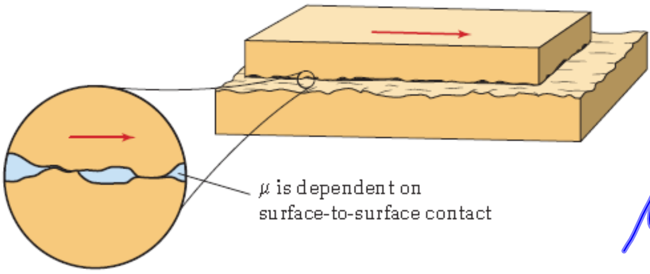
-"stick and slip"

-each material has a stickiness factor in relation to another material

-called the coefficient of friction and is unitless *(p. 140 of text)*

-whenever an object exerts a force on a surface, **the object exerts a force directly perpendicular to the surface and is called the *normal force***

Oct 18-8:18 PM



μ_s

μ_k

Surfaces	Coefficient of Static Friction μ_s	Coefficient of Kinetic Friction μ_k
rubber on dry solid surfaces	1 – 4	1
rubber on dry concrete	1.00	0.80
rubber on wet concrete	0.70	0.50
glass on glass	0.94	0.40
steel on steel (unlubricated)	0.74	0.57
steel on steel (lubricated)	0.15	0.06
wood on wood	0.40	0.20
ice on ice	0.10	0.03
Teflon™ on steel in air	0.04	0.04
lubricated ball bearings	< 0.01	< 0.01
synovial joint in humans	0.01	0.003

Nov 6-6:13 PM

SURFACE FRICTION

The magnitude of the force of surface friction is the product of the coefficient of friction and the magnitude of the normal force. The direction of the force of friction is always opposite to the direction of the motion.

$\propto$ θ

$$F_f = \mu F_N$$

$F_f = \mu F_N$

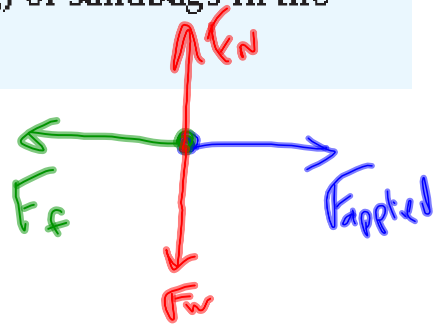
Quantity	Symbol	SI unit
force of friction	F_f	N (newton)
coefficient of friction	μ	none (coefficients of friction are unitless)
normal force	F_N	N (newton)

Note: Since the direction of the normal force is perpendicular to the direction of the force of friction, vector notations are omitted.

Oct 18-8:19 PM

Working with Friction

1. During the winter, owners of pickup trucks often place sandbags in the rear of their vehicles. Calculate the increased static force of friction between the rubber tires and wet concrete resulting from the addition of 200 kg (2.00×10^2 kg) of sandbags in the back of the truck.



$$F_f = \mu F_N$$

$$F_f = (0.7)(1960N) = \underline{1372N}$$

$$F_N = mg = (200)(9.8) = \underline{1960N}$$

2. A horizontal force of 85 N is required to pull a child in a sled at constant speed over dry snow to overcome the force of friction. The child and sled have a combined mass of 52 kg. Calculate the coefficient of kinetic friction between the sled and the snow.

$$F_f = \mu F_N$$

$$F_N = mg = (52)(9.8) = 509.6N$$

$$\mu = \frac{F_f}{F_N} = \frac{85N}{509.6N} = 0.17$$

Using your data, calculate the static and kinetic coefficient of friction for each surface you experimented with.

$F_f = \mu F_N$

$\mu_s = \frac{F_f}{F_N}$

μ_K

p 144
#5-8

Oct 19-11:29 AM