Name: _____

Period: _____

# Weight, Friction, and Equilibrium

## Weight

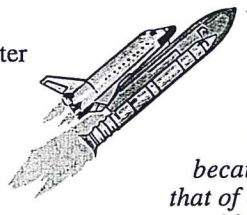
Force of Weight (in Newtons) → $F_w = mg$ ← Mass (in kg); ← Acceleration of gravity ($9.8\ m/sec^2$)

*Weight equals mass times the acceleration of gravity.*

**Weight** is the force of gravity on mass.

**Mass** is the amount matter (atoms and molecules) of an object.

Weight changes if gravity changes; mass does not change with gravity.



*On another planet your mass would be the same, but your weight would change depending on the amount of gravity.*

*On the moon you would weight 1/6th your weight on the earth, because the moon's gravity is 1/6th that of earth's. A large bag of dogfood could be carried easily with one arm.*

| *Ex. What is the weight of a 2 kg mass?* | |
|---|---|
| Variables:<br>2 kg = m<br>$g = 9.8\ m/s^2$<br>$F_w$ = ? | Equation:<br>$F_w = mg$<br>Solve:<br>$F = (2\ kg)(9.8\ m/s^2)$<br>$F = 19.6\ N$ |

| *Ex. What is the mass of a 39.2 N mass?* | |
|---|---|
| Variables:<br>$g = 9.8\ m/s^2$<br>39.2 N = $F_w$<br>m = ? | Equation: $F_w = mg$<br>$m = F_w/g$<br>Solve:<br>$m = (39.2\ N)/(9.8\ m/s^2)$<br>$m = 4\ kg$ |

If you know mass you can find weight; if you know weight you can find mass.

$F_w = mg$ allows you to convert between mass and weight easily.

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## The Feather or the Hammer?

Do heavy things fall faster?
NO! They fall at the same rate.

**Heavy and light object fall at the same rate.**

**g is a constant — $9.8\ m/s^2$**
**The acceleration of all falling objects is the same.**

Yet you know that a hammer will fall faster than a feather. Why?
Because the feather has more air friction.

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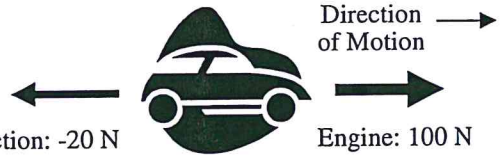
## Friction

Friction is caused by two things moving against each other.

**Friction always opposes motion.**

Friction causes things to wear out and causes **heat**, so we use **lubricants** to reduce friction.




**Net Force = 100N - 20N = 80N (right)**

**Kinds of Friction (from most to least friction):** sliding (rubbing) friction; rolling friction; viscous friction (in fluids); air friction.

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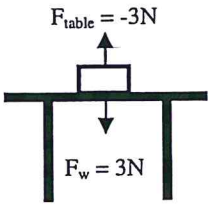
## Equilibrium (State of Equality)

At equilibrium the following are true:

**$F_{net} = 0$ N (no net force)**
**$a = 0\ m/s^2$ (no acceleration)**
**$\Delta v = 0$ m/s (constant speed)**

*An object at rest is also at equilibrium with a constant speed of 0 m/s.*

### Object on a Table




$F_{net} = 0$ N
$a = 0\ m/s^2$
At Equilibrium!

### Object at Constant Speed

$F_{net} = 0$ N
$a = 0\ m/s^2$
At Equilibrium!



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| | |
|---|---|
| 1. Weight | A. When all forces on an object are balanced. |
| 2. Equilibrium | B. The force of gravity on an object. |
| 3. Mass | C. The acceleration of gravity. |
| 4. Heat | D. The a product of friction. |
| 5. g | E. The measure of the matter in an object. |

| | |
|---|---|
| 1. Rolling friction | A. Resistance of a fluid on an object. |
| 2. Air friction | B. Resistance of air pushing against an object. |
| 3. Viscous friction | C. Resistance of two objects pushing against each other. |
| 4. Sliding friction | D. Any force that resists motion. |
| 5. Friction | E. Resistance of a wheel or ball. |

More, less, or the same as on the Earth

When an astronaut lands on the moon:

The astronaut's mass is: _____

The astronaut's weight is: _____

The astronaut's inertia is: _____

Which of Newton's Three Laws Applies? Law 1, 2, or 3?

___ Pushing a cart down the hall, when you try to turn it it tries to go straight.

___ More acceleration takes more force.

___ When you push your knuckles into a table, it hurts your knuckles.

___ A ball thrown into the ground bounces back up.

Using $g = 10\ m/s^2$, find the weight of a 4 kg object.

_____

An object weighs 350 N. Find its mass.
Use $g = 10\ m/s^2$.

_____

If 100 kg person weighed 400 N on the planet Zorg, what is the acceleration due to gravity on Zorg?

_____

A sled is pushed with 30 N and sliding friction is 10 N. Find the net force on the sled.

Two boys push on a box with 3 N and 6 N to the right. The net force is 7 N. Find the force of friction.

_____

A car's engine pushes with 45N to the right. If it is at equilibrium, how much air friction is there and what is the car's acceleration?

_____

A 25kg object accelerates at $5\ m/s^2$. Find the force.

_____

A boat's motor pushes with 25 N of force and viscous friction resists with 5 N. If the boat is 100 kg, find its acceleration.



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