Physics 11: Dynamics - Forces

Force: any push or pull

The units of force are:

Newton's (N)

There are four fundamental forces that make up all of the forces in the universe:

1) Gravitational
2) Electromagnetic
3) Strong Nuclear → keeps p^+ in the nucleus
4) Weak Nuclear → involved in radioactive decay

Force of Gravity

Force of Gravity: attracts all matter to other matter

Mass (kg): amount of matter that an object is made of

Weight (N): the force of gravitational attraction

Mass is constant throughout the universe but weight changes depending on where you are.

The formula for force of gravity is:

force of gravity → $F_g = mg$

Where:

m = mass

g = gravitational field strength (N/kg)
= acceleration due to gravity (m/s^2)

G-Forces

"G-forces" are actually a measurement of ***acceleration*** experienced by an object. It is related to the supporting reaction force that an object experiences due to acceleration. While at rest on Earth you are experiencing 1 *g*.

1 *g* = $9.80\ m/s^2$

For Example: A car accelerates at 4.9 m/s^2, how many g's is that? $4.9\ m/s^2 \times \frac{1g}{9.8\ m/s^2} = \boxed{0.50g}$

During lift-off a shuttle will accelerate at 28 m/s^2. How many g's are experienced by the astronaut? $28\ m/s^2 \times \frac{1g}{9.8\ m/s^2} = \boxed{2.9g}$

A normal human can withstand 4.0 g's, while a fighter pilot can withstand up to 9.0 g's. What acceleration would cause each to pass out?

$4.0g \times \frac{9.8\ m/s^2}{1g} = 39.2\ m/s^2 = \boxed{39\ m/s^2}$

$9.0g \times \frac{9.8\ m/s^2}{1g} = 88.2\ m/s^2 = \boxed{88\ m/s^2}$

g varies depending on...

- mass of the planet
- distance to planet

For Example: (not negative!)

- On Earth at sea level, g = $9.8\ m/s^2$
- On the moon, g = $1.6\ m/s^2$
- On Jupiter, g = $24.5\ m/s^2$
- On the Sun, g = $274\ m/s^2$

Determine your weight on Earth, the moon and Jupiter (in Newtons)

Your Mass: 100 kg (1 kg = 2.2 lbs)

Weight on Earth:

$F_g = mg$

$= (100kg)(9.8\ m/s^2) = \boxed{980\ N}$

Weight on the Moon:

$F_g = mg$

$= (100kg)(1.6\ m/s^2)$

$= \boxed{160\ N}$

Weight on Jupiter:

$F_g = mg$

$= (100kg)(24.5\ m/s^2)$

$= \boxed{2450\ N}$

Activity: **How high could you jump?**

Purpose: To determine how high you could jump on the surfaces of the Moon and the Sun.

Procedure:

1. Measure your best vertical on Earth, and determine the initial velocity of your jump
2. We will assume that your initial jump velocity will be the same on the Moon and the Sun.
3. Find your **vertical** and **hang time** on the moon using an acceleration = -1.60 m/s^2.
4. Find your **vertical** and **hang time** on the Sun using an acceleration = -274 m/s^2.

Earth

Vertical: _____

v_o = _____

Moon

d_{max}: _____

t = _____

Sun

d_{max}: _____

t = _____

Physics 11 – Dynamics - Newton's 1st Law

Newton's 1st Law:
An object in motion will... stay in motion
and an object at rest will... stay at rest
unless... acted upon by an external net force

This is also referred to as the **Law of Inertia**.

Inertia: how difficult it is to change an object's motion ≃ mass

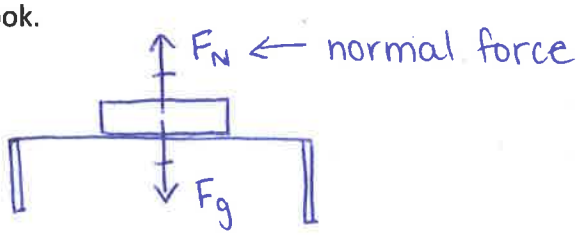
Imagine that you are racing around a track on a go-kart. List *three* times when you notice your *inertia*.

1) Stopping
2) Turning
3) Starting

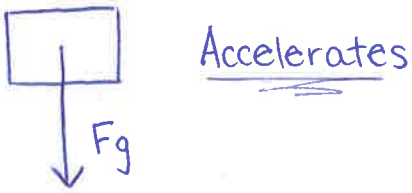
Another way of thinking of Newton's 1st Law is that if there is no net force on an object then it will stay at a constant velocity.

If it is not moving then it has a constant velocity of zero!!!

Ex. Imagine a book sitting on a table. There is a force of gravity pulling down on the book, but there is also a supporting (normal) force pushing up on the book.



Ex. If I drop the book from 2 m, there is only a downwards, gravitational force acting on it. Now that the forces on it are **unbalanced**, what does the book do?



Examples:

1) While riding a skateboard (or chuckwagon or unicycle, whatever), you fly forward off the board when hitting a curb or rock or other object which abruptly halts the motion of the skateboard.

2) The head of a hammer can be tightened onto the wooden handle by banging the **bottom** of the handle against a hard surface.

3) While you are sitting in the back seat of the car, it makes a hard right turn. You squish your sister against the side door (CORNERS!!!).

1) Headrests are placed in cars to prevent whiplash injuries during rear-end collisions.