Unit 4: Newton's Laws

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 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:

$F_g = mg$

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

Weight on the Moon:

$F_g = mg = (100\ kg)(1.6\ m/s^2) = 160\ N$

Weight on Jupiter:

$F_g = mg = (100\ kg)(24.5\ m/s^2) = 2450\ N$

Activity:
Jumping on the Moon

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

Procedure:

1. Have your lab partner measure your best vertical on Earth.
2. Determine the initial velocity of your jump. 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	**Moon**	**Sun**
Vertical: ____________		
	d_{max}: _______________	d_{max}: _______________
v_o = _____________	t = _________________	t = _________________

A Quick Aside on 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? $4.9\ m/s^2 \times \frac{1 g}{9.8\ m/s^2} = 0.5 g$

During lift-off a shuttle will accelerate at $28\ m/s^2$. How many g's are experienced by the astronaut?

$28\ m/s^2 \times \frac{1 g}{9.8\ m/s^2} = 2.9 g$

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?

$4.0 g \times \frac{9.8\ m/s^2}{1 g} = 39.2\ m/s^2$ $\quad$ $9.0 g \times \frac{9.8\ m/s^2}{1 g} = 88.2\ m/s^2$