Newton's Law of Universal Gravitation

- every object in the universe attracts every other object in the universe.
- the attraction between them is so small that though, that the attraction is not necessarily visible and the objects don't always come to each other.
- with a force directly proportional to the product of the masses and inversely proportional to the square distance between them.

$$Fg = force\ of\ gravity$$

$m = \ mass$

$$Fg \propto m1m2/d^2$$

$$d = distance$$

$$open\ infinity\ sign = directly\ proportional$$

the attraction between them is about a few hundred billionths of a newton.

$G = 6.67 \times 10^{-11}$

$$Fg \propto Gm1m2/d^2$$

- as the distance between two object decreases, the attraction between them increases.

$$Earth's\ Mass = 5.98 \times 10^{24} kg$$

- this can overcome the gravitational constant, so the earth is attracted to us and vice versa, and the attraction is so great that it's visible. This is gravity.
- all objects have the same mass, they have the same multiplier.

An 1000 kg rocket is fired into orbit of altitude (from the surface of the earth) to the Earth's' radii, up. In the process, it burns away half of its' mass. How much does it now weigh?

- we know that the mass in newtons is 9800 newtons
- pull of the earth = weight
    - if something is one radius away, you find the weight (which is 9.8 times of the mass). However, if it is more than one radius away, you need to use the formula above.
  - $no\ change = \times 1$
  - $doubling = \times 2$
  - $tripling = \times 3$

Solving;

(1)(½)(1) → (½) → 1 .

$(3)^2$ 9 18

- now plug the weight into the formula
- $9800/18 = 544.4\ Newtons$

What is the force of attraction between two 20 kilogram masses placed at a distance of 4 meters apart?

- use the formula
- plug everything in to solve for Fg

$$((20)(20)/4) \times 6.67 \times 10^{24} kg$$

- the answer is 1.67×10^{-9}

Momentum; the impact or damage on something. To solve for it, momentum is mass x velocity

p =momentum

$$p = mv$$

J =impulse

$$F = ma \Rightarrow F = m\,(\Delta V/t) \Rightarrow Ft = m\,(\Delta V) \Rightarrow Ft = \Delta\,(mv)$$

- now, plugging p and J into that final formula

$$J = \Delta P$$

An object has a momentum of 40 kilograms meters per second. It receives an impulse of 30 Newtons seconds. What is the new momentum?

$$J = \Delta P$$
$$30 = x - 70$$
$$x = 70$$

x=70

- you can change momentum by pushing an object

<u>The Law of Conservation of Momentum</u>

- Whatever amount of momentum you have initially, you must have finally.

$$\Sigma\,(mv)i = \Sigma(mv)f$$

A 3 kilogram rifle is firing a 50 gram bullet. The bullet goes off at a velocity of 100 meters per second. What is the recoil velocity of the rifle?

- the bullet has a lot of velocity and a little bit off mass, where we know that the rfife has much more mass than the bullet.
- knowing the law of conservation of momentum, we know that the initial needs to equal the final.

❑ initial momentum (before the bullet was fired) = 0
❑ this means that the final needs to equal 0 also

$$0 = (mv)bullet\ +\ (mv)rifle$$

❑ convert the mass of the bullet to kilograms by dividing it by 1000.

$$0 = (.05)(100)\ +\ (3)(x)$$
$$0 = 5 + 3x$$
$$-5 = 3x$$

x= -1.7 meters per second

There are two masses at a fixed distance. The force between them is 25 Newtons. Both masses are doubled as the distance is reduced to ⅓ of the previous distance. What is the force between them now?

$Fg = m1m2/d^2$ $Fg = (2)(2)/(1/3)^2$ $Fg = 4/(1/9)$

36 Newtons

- the number above is not the answer, but the change in the force. Now multiply the original force by 36

900 Newtons

A .05 kilogram bullet is fired from a 3 kilogram rifle at 50 meters per second. What is the new momentum of the bullet and the rifle after the bullet was fired?

- the answer is zero because according to The Law of Conservation of Momentum, the initial and final momentum are the same

- before the bullet was fired, the total momentum was zero, so the final answer must be zero.

A 5 kilogram mass is moving at 3 meters per second. It's given a push by a 4 Newton force for 2 seconds in the direction of motion. What is the object's new velocity?

$$J = Ft$$
$$J = (4)(2)$$
$$impulse\ =\ 8\, meters\ per\ second$$
$$J = \Delta P$$

- the change isn't the answer, you need to add the change

$$(5)(3) + 8$$

- the new momentum is 23
- you have the momentum and you have the mass so it's very simple to solve for velocity.

$$p = mv$$
$$23 = 5v$$

velocity = 4.6 meters per second

<u>The Three Scenarios</u>

#1; A 50 kilogram boy