Laws of Motion

1) Newton's 1st law of Motion – An object at rest or in motion will remain that way at the same speed and a straight line unless acted on by an outside force.

2) Inertia – tendency of an object to resist a change in motion. (Obeys Newton's 1st law of Motion)

3) Newton's 2nd law of Motion – An object's acceleration is dependent on the object's mass and the net force exerted on the object.

(Note: $F = m\,a$ F = Force, m = mass, a = acceleration)

4) Calculations

Example #1

$F =$ _____ $m = 10.0\ KG$ $a = 5.00\ m/s^2$

$$F = (m)(a) = (10.0\ KG)(5.00\ m/s^2) = 50.0\ \frac{KG\,m}{s^2} = \boxed{50.0\ N}$$

Example #2

$F = 60.0\ N$ $\quad 60.0\ \frac{KG\,m}{s^2}$ $\quad m =$ _____ $\quad a = 3.00\ m/s^2$

$$\frac{F}{a} = \frac{m\,a}{a}$$

$$m = \frac{F}{a} = \frac{60.0\ \frac{KG\,m}{s^2}}{3.00\ \frac{m}{s^2}} = \left(60.0\ \frac{KG\,m}{s^2}\right)\left(\frac{s^2}{3.00\ m}\right) = \boxed{20.0\ KG}$$

Exampl. #3

$F = 50.0\ N$ $\quad m = 10.0\ kg$ $\quad a = \_\_\_\_$

$50.0\ \frac{kgm}{s^2}$

$\frac{F}{m} = \frac{m\,a}{m}$

$$a = \frac{F}{m} = \frac{50.0\ \frac{kgm}{s^2}}{10.0\ kg} = \left(50.0\ \frac{kgm}{s^2}\right)\left(\frac{1}{10.0\ kg}\right) = \boxed{5.00\ \frac{m}{s^2}}$$

5) Gravity - attraction force between any two objects that depends on the masses of the objects and the distance between them.

Note: $F = \frac{(G)(m_1)(m_2)}{d^2}$

F = Force of Gravity
G = Gravitational Constant
m_1 = Object 1 Mass
m_2 = Object 2 Mass
d = distance apart

6) Calculation (Gravitational Force)

$F = \_\_\_\_$ $\quad m_1 = 1.00 \times 10^{25}\ kg$ $\quad m_2 = 1.00 \times 10^{75}\ kg$ $\quad d = 1.00 \times 10^{100}\ m$

$G = 6.674 \times 10^{-11}\ \frac{N m^2}{kg^2}$

$$F = G\frac{(m_1)(m_2)}{d^2} = \left(6.674 \times 10^{-11}\ \frac{N m^2}{kg^2}\right)\frac{\left(1.00 \times 10^{25}\ kg\right)\left(1.00 \times 10^{75}\ kg\right)}{\left(1.00 \times 10^{100}\ m\right)^2} =$$

$$= \frac{6.674 \times 10^{89}\ N m^2}{1.00 \times 10^{200}\ m^2} = \boxed{6.674 \times 10^{-111}\ N}$$

7) Acceleration of Gravity - $(9.8\ m/s^2)$ acceleration of an object in earth's gravitational field.

8) Weight - Measure of Force as the acceleration of gravity acts on the mass of an object.

9) Calculation (Weight)

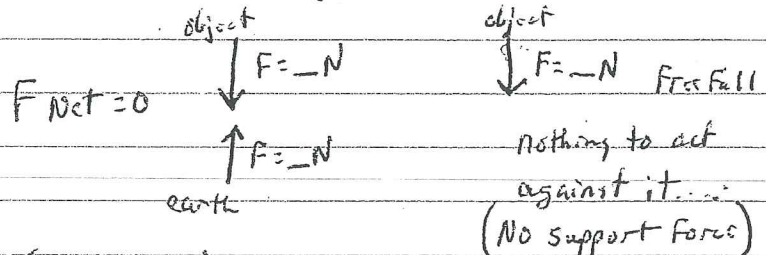
F= _____ $m = 25.0\ kg$ $g = 9.8\ m/s^2$

$F = mg = (25.0\ kg)\left(9.8\ \frac{m}{s^2}\right) = \frac{kg\ m}{s^2} = N$

10) Mass vs Weight
Mass - amount of matter
Weight - how the mass is effected by gravity.

11) Weightlessness - state of an object when the Force of the object can't be measured.
Note: Situation #1 No gravity $F = m(0)$

Situation #2 object in Free Fall which means the object has no force to act against it as it falls.



12) Free Fall (Calculations)

1 sec $V_1 = (g)(t_1) = (9.8\ m/s^2)(1\ s) = 9.8\ m/s$ $\bar{V} = \frac{V_F - V_I}{2} = \frac{9.8\ m/s - 0}{2} = 4.9\ m$

2 sec

5 sec $V_5 = (g)(t_5) = (9.8\ m/s^2)(5\ s) = 49.0\ m/s$ $\bar{V} = \frac{49.0\ m/s - 0}{2} = 24.5\ m/s$

10 sec $V_{10} = (g)(t_{10}) = (9.8\ m/s^2)(10\ s) = 98.0\ m/s$ $\bar{V} = \frac{98.0\ m/s - 0}{2} = 49.0\ m/s$

Distance travel

1 sec $d = \bar{v}\ \Delta t = (4.9\ m/s)(1\ s) = 4.9\ m$

5 sec $d = \bar{v}\ \Delta t = (24.5\ m/s)(5\ s) = 122.5\ m$

10 sec $d = \bar{v}\ \Delta t = (49.0\ m/s)(10\ s) = 490\ m$

Another Method using just time dropped $d = \frac{1}{2} g t^2$

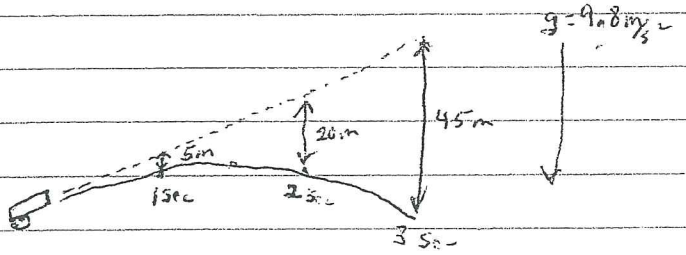
1 sec $d = \frac{1}{2} g t^2 = \frac{1}{2}(9.8\ m/s^2)(1\ s)^2 = (4.9\ m/s^2)(1\ s^2) = 4.9\ m$

5 sec $d = \frac{1}{2} g t^2 = \frac{1}{2}(9.8\ m/s^2)(5\ s)^2 = (4.9\ m/s^2)(25\ s^2) = 122.5\ m$

10 sec $d = \frac{1}{2} g t^2 = \frac{1}{2}(9.8\ m/s^2)(10\ s)^2 = (4.9\ m/s^2)(100\ s^2) = 490\ m$

13) Projectile Motion – curved path an object follows as it moves horizontally and is pulled down vertically by gravity.

14) Upwardly Launched Projection



15) Centripetal acceleration – acceleration toward the center of a curved or circular path.

16) Centripetal Force – net Force exerted toward the center of a curved path.

17) Satellite orbits – projectile travels fast enough to fall around the earth rather than into it. (8 Km/s)

18) Newton's 3rd Law of Motion – For every action there is an equal and opposite reaction.

19) Momentum – product of the mass and velocity of an object.

20) Law of Conservation of Momentum- Momentum can't be created or destroyed, when object gains it the other loses it.

21) Calculation (Momentum)

Example #1

$p = $ _____ $m = 2.0\ kg$ $V = 5.0\ m/s$

$p = m\,V = (2.0\ kg)(5.0\ m/s) = 10.\ \frac{kgm}{s}$

Example #2

Object A with a mass of 1 kg and velocity of 5 m/s hits object B with a mass of 2 kg, what will object B velocity be if object A stops after the collision?

$m_A = 1kg$ $V_A = 5m/s$ $m_B = 2kg$ $V_B = $ _____

$p_A = m_A V_A$ $p_B = m_B V_B$ $p_A = p_B$

$m_A V_A = m_B V_B$

$V_B = \frac{m_A V_A}{m_B} = \frac{(1kg)(5\ m/s)}{2kg} = \boxed{2.5\ m/s}$