Physical Science
Physics
Motion & Force

I. Need to Know Formulas for this unit:

- Speed = distance / time \[ S = \frac{D}{T} \]
- Distance = Speed x Time \[ D = ST \]
- Acceleration = Final Velocity – Initial Velocity \[ A = \frac{V_f - V_i}{T} \]
- Acceleration of gravity = \( g = 9.8 \text{ m/s}^2 \)
- Force = Mass x Acceleration \[ F = MA \]
- Weight = Mass \times \text{Acceleration of gravity}
- Momentum = Mass \times \text{Velocity}
- Pressure = Force / Area

II. Motion

A. Motion occurs when the distance between the object and a reference point is changing

B. Reference point - place or point used to determine if an object is in motion

C. SI

1. International System of Units: The metric system
2. Length – measured in meters
3. Mass – grams
4. Volume – liters
   a) \( 1 \text{ml} = 1 \text{cm}^3 \)
5. Weight – Newtons
6. Density – mass / volume

D. Speed – the distance an object travels in one unit of time

1. a magnitude only: it only tells us “how much”
2. 75 miles per hour, 18 meters per second

E. Velocity – when the speed and the direction is known then the velocity can be described

1. Specifies a magnitude AND a direction
2. 75 miles per hour in a northern direction, 18 meters per second east

F. Graphing motion

1. x axis – the horizontal units
2. y axis – the vertical axis
3. slope of the line = \( \frac{\text{rise}}{\text{run}} \) (the vertical change over the horizontal change)

G. Acceleration – the change in speed or the change in direction of an object

III. Forces

A. Force is measured in the units of Newtons (N): \( 1 \text{N} = 1\text{kg} \times 1 \text{m/s}^2 \)

B. Force - a force is simply a push or a pull on an object

1. Like velocity and acceleration Force shows a magnitude AND direction
2. Arrows called “Vectors”
3. Balanced force – opposite and equal forces acting on the same object result in NO motion of the object
4. Unbalanced forces – two or more forces of unequal strength acting upon on object results in the motion of the object.

5. Newton’s 1st Law of Motion: The Law of Inertia - an object at rest will remain at rest, and an object in motion will remain in motion and at a constant velocity until acted on by another force.

   a) The greater the mass of an object the greater the inertia
C. **Force = mass x acceleration**
1. **Newton’s Second Law of Motion** – The net force on an object is equal to the product of its acceleration and its mass:
   2. mass = Force / acceleration
   3. acceleration = force / mass

D. **Friction & Gravity**
1. **Friction**: the force of friction is the force that one surface exerts on another one when they are rubbed together.
   a) The strength of the force of friction depends on
      (1) The type of surfaces
      (2) How hard they push against each other
2. **Gravity**: the force that pulls objects towards each other
   a) **Earth’s Gravity pulls objects at 32 ft / s / s**
   b) Earth’s Gravity pulls objects down at \(9.8 \text{ m/s}^2\)
      (1) Velocity after one second: 9.8 m/s
      (2) Velocity after two seconds: 19.6 m/s
      (3) Velocity after three seconds: 29.4 m/s
      (4) Velocity after four seconds: 39.2 m/s
3. **Weight** – Force of gravity acting on an object
   a) **Weight = Mass x Acceleration of gravity**
4. **Newton’s Third Law of Motion**: For ever action there is an equal and opposite reaction.
   a) AKA: if one object exerts a force on another object, then the second object exerts a force of equal magnitude in the opposite direction of the first object.
5. **Momentum = Mass x Velocity**
   a) Conservation of Momentum: The total of any group of objects remains the same unless outside forces act on the objects

IV. **Forces in Fluids**

A. **Pressure: a force pushing on a surface**
1. Pressure = Force / Area
2. Unit of measure for Pressure is the Pascal
   a) 1 Pascal = 1 N / meter\(^2\)
   b) Remember that 1 N = 1 Newton = 1kg x 1 meter / 1 second\(^2\)
   c) When surface area is smaller than meter\(^2\) then the unit used is N/cm\(^2\)
3. **Fluid Pressure**
   a) Fluid is a substance that can flow easily. Therefore gas can be classified as a "fluid".
   b) In fluids, molecules are constantly moving in all directions.
   c) As a molecule moves and collides w/ a surface, it exerts a force on that surface.
   d) All of the forces exerted by the individual molecules are added together to make up the pressure exerted by the fluid.
   e) Fluid Pressure is the total force exerted by the fluid divided by the area over which the force is exerted: Pressure = Force / Area
4. **Air Pressure**
   a) At sea level air exerts a pressure of about 14 lbs / inch\(^2\) in the American system
   b) In the metric system, air pressure at sea level is about
10.13 N/cm²

c) 1 cubic meter of air at sea level weighs about 1 kilogram
d) Balanced force when fluid is **NOT** moving: the pressure pushing down on your hand is balanced by the pressure pushing up on your hand

5. **Variations in Fluid Pressure**
   
a) Air pressure decreases as elevation increases
b) Water pressure increases as depth increases

**B. Pascal’s Principle**
1. When force is applied to a **CONFINED FLUID**, an increase in pressure is transmitted equally to ALL parts of the fluid.
2. Hydraulic lift, hydraulic brakes and starfish tube feet

**C. Archimede’s Principle**
1. The buoyant force on an object is equal to the weight of the fluid displaced by the object.
2. The buoyant force is opposite (pushes up) to the force of gravity (pulls down)
3. Archimede’s Principle is why boats float
4. Density of water is 1 gm /ml
   a) If an object has a density greater than water: it sinks, less than water: it floats

**D. Bernoulli’s Principle**
1. The pressure exerted by a moving stream of a fluid is less than the pressure of the surrounding fluid.
2. The faster the fluid moves, the less pressure it exerts on the surface of the object
3. Bernoulli’s principle is why planes fly!