**St. CATHERINE HIGH**

**Department of Science**

**PHYSICS**

 Physics is the study of the principles of how Nature works. Over the years, collection of works by various contributors has led to the present conditions that exist today. For our study of the subject it is broken down in sections. Experiments are designed as validations to theory as proof with validity.

Structure of modules

**Module1. Mechanics** deal with the laws of motion and their dynamic principles which include measurements.

**Module2.Thermal Physics/Kinetic Theory** relates to the nature of heat and matter

**Module3. Waves and Optics** define the principle of the electromagnetic spectrum for which light is the main feature of the spectrum.

**Module4. Electricity and Magnetism** specifies the understanding through experimental evidences of the charges that balances our universe.

**Modules5. Physics of the Atom** the final development of the way we look at nature in its simples forms

With CSEC being designed for presentation of these topics to be completed in two years, the science department has structured teaching material as mechanics, thermal physics / Kinetic theory and parts of wave and optics as first year objectives with the rest completing the second year. Experiments are designed to facilitate the understanding of the theories for each topic as requirement for SBA.

***NB: Observe all definitions when viewing videos***

**MODULE1**

**MECHANICS**

*GENERAL OBJECTIVES*: On completion of this Section, students should:

1. Understand the importance of measurement and graphical representation of data

2. Appreciate the difference between scalar and vector quantities

3. Familiar with the various effects of forces

4. Appreciate the universal applicability of the laws of dynamics and the significance of conservation of energy which includes momentum, moments, energy and matter

 5. Aware of the application of hydrostatics in everyday life.

*SPECIFIC OBJECTIVES*: Students should be able to

1. Galileo’s methodology employed contributed to the development of Physics

<https://www.youtube.com/watch?v=OgaV5FLdP8c> **Suggested video research**

Simple Pendulum: investigate the factors which might affect the period of a simple pendulum and the value of gravity calculated. Conservation of Energy and various prosperities also defined

1. MEASUREMENTS includes appropriate number of significant figures, sources of error in any measurement, instruments to measure different quantities and apply the formula for density.
2. Forces, F which includes treating as a vector function thus having magnitude and direction, effects of forces, types of forces, weight of objects, force in a turning effect in terms of moment of a force, principle of moments, center of gravity, Hooke’s law and pressure
3. Forces as dynamic in a straight line at rest and in motion and how they are related to energy.
4. Forces as they relate to Newton’s three Laws of motion
5. ENERGY forms in relation to gravitational, elastic, chemical, electrical, magnetic, electromagnetic, thermal, nuclear, kinetic and sound with energy transformation(s). Work = force x displacement as a form of energy.
6. Use of energy from alternative sources, importance to the Caribbean.
7. Potential Energy, Ep and Kinetic Energy, Ek. Conservation of energy and power

**CONTENT MATERIAL**

1. **MEASUREMENTS** includes appropriate number of significant figures, sources of error in any measurement, instruments to measure different quantities and apply the formula for density.

Measurements are important as they become definitions of thing and usage for a universal purpose thus creating SI, International Standards which governs the on a worldwide scale. There is a collection of various forms of measurements and designs located in Paris, France.

<https://www.youtube.com/watch?v=zC2Wivnq344>

For ***CONVERSION***S from one in the same set of unit example gram to kilogram and centimeters to meters and others see video.

<https://www.youtube.com/watch?v=k_XXN2yQ-Y8&feature=youtu.be>

Calculation for density implies density is related to mass and volume being inversely proportional equation. $ density (ρ)=\frac{mass kg}{volume m^{3}} $. Conversion factor

Relative density, ρ, = density of substance ÷ density of water OR

 mass of certain volume of substance ÷ mass of equal volume of water

FUNDAMENTAL and DERIVED QUANTITIES

In order to be consistent around the world being the same information, fundamental and derived equations are developed leading to more formulation of other equations. Fundamental relates to units of measurements and symbols that are the base or common used in all areas. One can see the basis for this concept as we examine these measurements of time, length, mass, temperature and current.

<https://www.youtube.com/watch?v=dU5fZ4sZtTY>

**FORCES**

There are *two* **forms** of force which are motion and non-motion and *various* **types**.

**Types of Forces**

Force of ***weight***which is also related to ***non motion*** as it is the mass of the object multiplied by gravity $F=mg $

 (Up) Normal

 (Down) $mg$

The normal force can be described as reaction force due to the fact that the object is resting on something or being held in space. For nothing holding the object, like earth, a gravitational force field and rotation cause a balance to keep the object in that state.

When we step on a scale we measure the mass our body. Mass is different from weight by multiplying by gravity which give the term weight which in turn is a force that does not move.

When we stand on different locations in the universe, each location has a gravitational potential which has a value. As example, standing on earth as compared to standing on the moon, gravity varies but the mass remains the same. In deep space there is no gravity. Thus in calculations, mass *m* in unit of *kg* and *g* gravity’s unit $\frac{N}{kg} $gives the unit of force which then becomes $kg N/kg$ for which kilograms cancel leaving the unit as N, *Newton*.

Another form of Newton can be represented in the form of *motion*,$ F=ma$, where *a* is acceleration. The unit for acceleration, *a,* is$ \frac{m}{s^{2}} $. Thus in terms of motion force $N=kg m/s^{2}$. This implies that a Newton can be represented in two conditions of force with two different units based on the conditions of motion and non motion of the force.

Forces on an object in motion

 normal

 Applied force

 friction

 weight

The direction of the force move is the *net* force, which causes motion being greater than the sum of the other forces.

Force is a *vector* quantity implying both *magnitude* (size) and *direction* as compared to a *scalar* quantity which has only magnitude (size). <https://www.youtube.com/watch?v=Pj8Zh0A-uLU>

**T*urning effect*** Imagine pushing a door at its hinges as compared to pushing at the knob or close to it. Imagine pulling a tire for your car with a six inch spanner. You may notice when trucker’s change their tires, the mechanics uses an extra length of pipe in order to pull the nut from the bolt. When you pedal a bicycle, you are applying force to the pedal which in turn rotates the axle which rotates the wheel causing motion. This action is defined as *the moment of a force* defined as *the product of the magnitude of force F and the perpendicular distance d from the pivot to the line of action of the force*. $M=Fd (force x distance)$ <https://www.youtube.com/watch?v=EOz8iEPJrj8>

For a balanced object (equilibrium condition), the *principle of moments* states *When an object is in equilibrium, the sum of the clockwise moments about any given pivot equals the sum of the anticlockwise moment about the same point*.

Here the principle of moments implies clockwise $F1 x d1=F2 x d2$ anticlockwise.

Other cases can be examined in building a bridge, the weight of the columns holding the bridge must be equal or greater than the bridge and the maximum weight limit for that bridge. For this reason signs are posted for maximum weight.

<https://www.youtube.com/watch?v=R3cjFEtV5ug>

***Center of gravity***

For any condition to be in equilibrium it has to be balanced. This balanced can be related to the center of gravity of that object.

<https://www.youtube.com/watch?v=hqDhW8HkOQ8>

<https://www.youtube.com/watch?v=abUFbZfPzjY>

***Stretching force on material (spring)***

Forces can also be seen in materials which stretches in particular a spring. This notion was describes by Hooke’s law. *Provided stretching force does not extend a spring beyond its elastic limit, the extension of spring is directly proportional to the force.* $F=kx$, k is spring constant, x extension of the spring. In this case the force can be treated as non motion thus the force being the weight of the object that’s pulling the spring.

The elastic limit is the point at which further extension causes permanent damage which does not obey Hooke’s law.

<https://www.youtube.com/watch?v=FAHOI32oAns>

<https://www.youtube.com/watch?v=yAIb3T9DPyE>

<https://www.youtube.com/watch?v=3N3zB3OM1-4>

***Pressure and force***

Another important form of force can be seen in the form of pressure being measured in Pascal (Pa) derived from definition as $pressure=froce÷area \left(\frac{N}{m^{2 }}\right) or P=F/A$

<https://www.youtube.com/watch?v=pQ0xwoYeWoA>

<https://www.youtube.com/watch?v=so_TfwU9h2g>

<https://www.youtube.com/watch?v=tYd_CYpNpeY>

***Pressure and force in a liquid***

1. Pressure not affected by shape or cross-sectional area
2. All horizontal points when liquid at rest same pressure
3. Acts equally in all directions at same depth
4. Directly proportional to depth below surface or height of liquid above
5. Directly proportional to density

These factors indicate special features of pressure $P= ρhg$

This formulation also lends to atmospheric pressure in addition to regular pressure

For ***closed*** containers atmospheric pressure is zero thus pressure $P= ρhg$

For ***open*** containers at one end, $P= ρhg+atm pressure$

Atmospheric pressure also causes cyclones or depressions in weather conditions

Archimedes, along with all other Greek scientist calculated their information from the Egyptians, for which he developed the concept of why objects float and sink and other relevant information.

***Archimedes principle***

An object in liquid appears to lose weight. This determines whether the object sinks or floats in terms of up-thrust. Experimentally it can be shown that an object floats because the force of the liquid is greater than the object. When the object sinks, the force on the object is greater than that of the liquid. For an object to travel through a liquid, then the force is just a little greater than liquid.

<https://www.youtube.com/watch?v=05WkCPORlj4>

***Force in motion (Newton’s Second Law)***

Forces discussed before are based on the fact that they do not move. This non movement can be seen as weight for most cases, which were discussed above. Here we are dealing with motion for which the unit is meters per second squared. $F=ma$, where *a*, called acceleration of motion is a derived equation as velocity ÷ time $ \frac{v}{t}$

$$a=\frac{v}{t}$$

$$but v=\frac{x}{t} \left(\frac{m}{s}\right)$$

$$then a=\frac{\frac{x}{t}}{t} m/s^{2}$$

This is simplified through this video <https://www.youtube.com/watch?v=xzA6IBWUEDE>

Before an object moves it’s at rest where distance *x* is 0 and time is also 0 since it has not moved.

In motion, distance change as time change which is now some value in meters per second.

Then there is an initial and a final distance over an initial and final time. This implies the average velocity is the distance moved over the time taken. When this velocity changes over time it is described as acceleration. The total distance travelled can be derived from a plot of velocity versus time graph. <https://www.youtube.com/watch?v=V5E_LLUgbjI>

<https://www.youtube.com/watch?v=g550H4e5FCY>

From Newton’s second law,$ F=ma$**,**

$a=v/t$**,**

$$gives F=\frac{mv}{t}$$

Where, $Ft=mv.$

*F*t = impulse and *mv* = momentum

Having experience balance and equilibrium in the principle of *moments*, there is a general balance in the universe described as the ***conservation of energy and matter***, which states, *Energy/Matter is not created nor destroyed but changes form*

***Momentum*** as a product of mass and velocity implies motion and mass. This motion and mass can continue to move according to Newton’s first law. By the second law, impulse force gives motion with mass and by the third law the force is transfer the second object’s reaction force bringing it back to the first law, thus the cycle of conservation of force, matter and energy.

Newton’s laws of motion <https://www.youtube.com/watch?v=mn34mnnDnKU>

In a collision or motion of all object which includes /things, particles, people and energies, all three laws of motion come into play. If we look at a collision, the first object would be in motion while the second at rest. Both could be also moving, one faster than the other which satisfies the first law. In motion of either both or a single object in motion is satisfied by the second law. Upon contact of the first object that momentum is transferred to the second (in both cases) which in turn causes the second to have motion. This is a transfer of force and energy which is defined by the conservation of energy.

***Forces in motion and not in motion in terms of energy***

When force is applied to an object and it moves some distance, this is described as *work*,$ W=F x d$. When we do work, *energy* is generated. Biologically we eat to have energy in order to do work. This energy as it relates to force through work has two states. Since we have just seen that to move we must consider at rest before moving. This tells us that there is two forms of energy for which one is motion and the other non motion.

Just before we begin to walk or the object to begin motion, force is measured from that zero point which is simply weight. When we take that weight and refer it to a position of some distance this application is described as *potential energy*. This potential energy then force multiplied by distance work at rest in a stored *position*. Thus, $E\_{p }=mgh$ where h is height termed as gravitational potential energy.

Now the object has left its position and is now moving. This movement is related to some distance over some time which we call velocity, *v.* From calculations, that is a little heavy at the moment, the *kinetic energy* as the word indicate kinetic means motion, thus energy of *motion*. Where $E\_{k }= ^{1}/\_{2}mv^{2}$ as the velocity speed is squared and the mass of the object remains the same.

As discussed above all energies and principles have to obey the law of conservation as energies change form. This statement is qualified as

$E\_{p }$ = $E\_{k }$

$mgh= ^{1}/\_{2}mv^{2}$

There are two forms of energies potential and kinetic and various types of energies

<https://www.youtube.com/watch?v=k4b3oxO0WqE>

From our knowledge of energies, time becomes the next function. One of Newton’s notions of importance is that, things that are done over time. This implies a ***RATE*** of change, thus putting any function over time is classified as a rate of change of that function in general.

The various types of energies over a period of time give the ***power*** of that energy and to have energy, work has to be done to that type of energy.

$$P=\frac{W}{t}=\frac{Fxd}{t}=\frac{E}{t} (Watt)$$

**Students Note**

For the study of physics it is important for understanding of concepts before solving problems. All problems are solved mathematically through formulae which are derived in most case with names given to units of people responsible for creation of formula and or development of concept.

It is therefore my intention for the understanding of the concept over solutions to problem even with the later being important. For the first module the main concept deals with forces in motion and at rest.

Graphs are plotted as relationships between two functions that give the third function from the gradient, for any equation. Examples can expressed in a plot of velocity verses time where the gradient is acceleration and Hooke’s law where a plot of force verses extension give the spring constant.

What we have just covered can be described as classical physics which relates force of motion and non motion in terms of particles. The new physics of wave theory were developed with principle of classical physics as foundation to the new theory as we have discovered that energies can form from both particle and wave, the duality principle.

Now remember that the conservation principle hold for both energies and matter. This leads to the next module thermal physics and kinetic theory.

It is important to note that condition might be different but the formula remains the same, thus it is just which variable in the formula that you require and transpose to find solution. The rest is practice of various forms of sequence of event to fit formula to attain solution to any problem.

**Teacher contact:** **nattyphoto@gmail.com** **Mr. Reid**