Grade 10 Physics 1 Study Guide

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Chapter 1 Kinematics

Main Ideas:

1. Mechanical Motion and its description
   -A description of mechanical motion would usually contain the following:
      a. a frame of reference, b. a coordinate system.
   -Objects are usually simplified into a point of mass when being described.
   -In a coordinate system, the Greek letter Δ (delta) is usually used to describe the difference in coordinates, as in Δx and Δy.

2. Vector representation of Kinematics [1]
   -A vector quantity has moth magnitude and direction, whereas a scalar quantity only has a magnitude.
   -Displacement is defined as the change in position and is usually referred to as the letter x. The vector notation would be $\vec{x}$. Just like any vector, displacement can be decomposed into its x-component and y-component. Note that displacement does not have anything to with the shape or length of the path of motion.
   -Velocity is defined as the rate displacement changes with respect to time and is usually referred to as the letter v. A definition in a mathematical notation would be $\vec{v} = \frac{\overrightarrow{\Delta x}}{t}$ where t represents the time. The unit of velocity in SI is meters per second(m/s).
   -Acceleration is defines as the rate velocity changes with respect to time and is usually referred to as the letter a. A definition in a mathematical notation would be $\vec{a} = \frac{\overrightarrow{\Delta v}}{t}$. The unit of acceleration in SI is meters per second squared$(\frac{m}{s^2})$.
   -Speed, different to velocity, does care about the length of the path. In fact, Speed is defined the same as the "velocity" is defined in our middle school textbooks.
   -Instantaneous Velocity is defined as rate displacement changes with respect to time when the time becomes infinitely small. A definition in a mathematical notation would be $\lim_{t \to 0} \frac{\overrightarrow{\Delta x}}{t}$. Similarly, instantaneous acceleration can be represented as $\lim_{t \to 0} \frac{\overrightarrow{\Delta v}}{t}$ and instantaneous speed $\lim_{t \to 0} \frac{|\overrightarrow{\Delta x}|}{t}$.

3. Motion Graph
   -$x - t$ graphs, $v - t$ graphs are used to describe motion. The x or v in those graphs are the dependent variable graphed in cartesian coordinates.
   -The Slope and the Area under a $v - t$ graph are widely used to analyze problems in kinematics.
4. Uniform Linear Motion

- There is no acceleration and the velocity remains constant. $a = 0$ and $\vec{v} = \frac{\overrightarrow{\Delta x}}{t}$.

Because this type of motion is 1-dimensional, the vector notation is negligible.

5. Uniform accelerated Motion

   -An Object accelerates at a constant rate linearly.

   -These equations link the quantities in uniform accelerated motions and are referred to as the" Big Five".

$$v_t = v_i + at$$

$$x_t = x_i + v_i t + \frac{1}{2}at^2$$

$$x_t = x_i + v_t - \frac{1}{2}at^2$$

$$2a\Delta x = {v_t}^2 - {v_0}^2$$

The Proof is rather straightforward if we take the geometric meaning of all these quantities in a v-t graph into consideration. The proof is left for the reader as an exercise and the answer can be found on our textbook.

Chapter 2 Dynamics

Main Ideas:

1. From Aristotle's Physics to Newton's Physics.

   -As Heliocentrism takes over Geocentrism, a new standard of physics is needed urgently to match with astronomy, as Aristotle's Physics established on Geocentrism are no longer applicable.

2. Newton's 1st Law

   -Newton redefined the concept of force to be the reason of motion. Newton's 1st Law states that "An object moves with a velocity that is constant in magnitude and direction unless a non-zero net force acts on it".

   -The "Net Force" exerted on an object is the sum of all forces exerted on that object.

3. Newton's 2nd Law

   i. Inertia

   All objects have the tendency to remain in their current state of motion should there be no force. This quality is called inertia. Inertia is represented by the symbol m, which stands for mass, or inertial mass. The unit of inertial mass in SI is kilograms(kg).

   ii. Force

   A Force is represented by the symbol F.

   iii. Newton's 2nd Law

Newton's 2nd Law defined a unit of force as the amount of force needed to accelerate a unit of mass at a rate of $1(\frac{m}{s^2})$. i.e,

$$\vec{F}_{net} = m\vec{a}$$

Which means that the unit of force in SI is $(\frac{kg*m}{s^2})$, usually simplified to Newtons(N).

4. Newton's 3rd Law

-If object 1 and object 2 interact, the force $\overrightarrow{F_{12}}$ exerted by object 1 on object 2 is equal in magnitude but opposite in direction to the force $\overrightarrow{F_{21}}$ exerted by object 2 on object 1.

-This can be proven by taking a whole object and visually imagining it as two separate ones or taking two objects and analyzing their net force as if they were one single object.

5. Free Fall

-The acceleration exerted by earth is approx.. $9.8(\frac{m}{s^2})$. This special acceleration is referred to as g. Every Kinematics equation still apply and we simply have to substitute a with g.

6. Coordinate Decomposition

-Vectors can be decomposed into their x-components and y-components. This can be used to analyze forces in 2-D by finding the known and unknown quantities and putting them into the equation

$$\begin{cases} F_x = ma_x \\ F_y = ma_y \end{cases}$$

to solve for the unknown.

7. Projectile Motion

-Those problems can be solved by analogizing No5. By using the techniques mentioned in No6.

8. Simple Forces

i. Gravity (mg).

ii.Normal Force (N).

Normal Forces are always perpendicular to the surface of contact.

iii.Tension (T).

Tension Forces are the same within the same string.

$iiii$.. Friction (f)

a.Kinetic Friction

Kinetic Friction can be calculated by multiplying the normal force times the coefficient of friction.

In Mathematical Notation this can be represented as $f = \mu N$.

b. Static Friction

-Static Friction is smaller or equal to kinetic friction on the same surface, i.e.$f_s \leq \mu N$.

9. Toy Models

There are different models widely used in quizzes, such as the Atwood Machine. Because this guide is only targeted to summarize the basic knowledge, this part will not be discussed.

For any definitions that vary from that of the textbook, please refer to the textbook for a rigorous definition. For Math prerequisites, please refer to the *Grade 10 AP Calculus BC study guide.*