**IDX G9 PHY S STUDY GUIDE ISSUE 1**

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**2.1 Picturing Motion**

* **Motion:** An object is in motion if it changes position relative to another object.
* **Reference Point (Frame of Reference):**
  + A place or object used for comparison to determine if something is in motion.
* **Motion Diagrams:**
  + A series of images showing the positions at equal time intervals.
  + **Purpose:**
    - Helps visualize displacement and velocity.
* **Particle Model:**
  + Simplified motion diagram where the object is replaced by single points.
  + **Conditions:**
* The object’s size must be much less than the distance it moves.
* Internal motion is ignored (disregard the movement of arms and legs).
  + **Example:**
* Imagine the object as a very small point located at the center.

**2.2 When and Where**

* **Coordinate System:**
  + Zero point location and direction of increasing values.
  + **Origin:** Both variables = 0.
* **Scalars and Vectors:**
  + **Scalar:** Quantities with magnitude only (e.g., distance, time).
  + **Vector:** Quantities with magnitude and direction (e.g., position). Represented by arrows.
* **Vector Addition/Subtraction:**

1. Move the second vector’s tail to the first vector’s tip.
2. Connect vectors tail-to-tip.
3. Draw the resultant vector.

* **Position, Distance, Displacement:**
  + **Position:** Arrow from origin to object (vector).
  + **Distance:** How far apart objects are (scalar).
  + **Displacement:** Change in position (vector).
  + **Differences:**
    - Position and displacement have direction.
    - Distance and displacement show location change, position shows where an object is.
* **Time Interval:**
  + Difference between two times (SI unit: seconds).

**2.3 Position-Time Graphs**

* **Position-Time Graph:**
  + Time on the horizontal axis, position on the vertical axis.
  + **Y-axis:** Represents instantaneous position.
  + **Best-fit Line:** Shows likely positions between data points.
  + **Intersection:** Indicates two objects meet.

**2.4 How Fast**

* **Average Velocity:**
  + **Formula:**
  + Steeper slope = greater change in position.
  + **Unit of slope:** meters per second (m/s).
  + Slope indicates average velocity (magnitude and direction).
  + Average velocity ≠ speed.
* **Speed:**
  + Distance traveled per unit of time.
  + **Formula:**
  + **Average Speed:** Total distance ÷ total time.
  + **Key Point:** Objects with the same average speed can have different velocities.
* **Instantaneous Velocity:**
  + Velocity at a specific instant.
  + If velocity is constant, average velocity = instantaneous velocity.
* **Average Velocity on Motion Diagrams:**
  + Motion diagrams show direction and magnitude of average velocity.
  + Average velocity is proportional to displacement.

**3.1 Acceleration**

* **Different Kinds of Motion:**
  + **Uniform Motion:** Object moves in a straight line with constant velocity.
  + **Nonuniform Motion:**
    - Velocity changes along a straight line.
    - Motion is not confined to a straight line.
* **Calculating Acceleration:**
  + **Formula:**
  + **Unit of Acceleration:** m/s², m/s/hr, km/hr², etc.
  + Acceleration = 0 when velocity is constant.
  + If velocity changes at a constant rate, acceleration is constant.
  + **Instantaneous Acceleration:** Change in velocity at a specific moment.
* **Velocity-Time Graph:**
  + Slope of a position-time graph (d-t) represents average velocity.
  + **Uniformly Accelerated Motion:** Constant a.
  + **Graph Characteristics:**
    - Rising line:
    - Descending line:
    - Steeper slope = larger
* **Displaying Acceleration on Motion Diagrams:**
  + Average acceleration vectors show how velocity is changing.
  + Acceleration points in the direction of the velocity change.

**3.2 Motion with Constant Acceleration**

* **Position with Constant Acceleration:**
  + increases with equal time intervals.
  + **Area under the v-t graph** = displacement.
  + **Slope of v-t graph** = acceleration.
  + **Positive/Negative Areas:**
    - Area below v=0v = 0v=0 line means negative displacement.
* **Important Formulas:**