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**IDX G9 PHYSICS S STUDY GUIDE ISSUE 4**

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### ****1.3 Graphing Data****

#### ****1. Identifying Variables****

* **Independent Variable:** The factor that is changed or manipulated during an experiment.
* **Dependent Variable:** The factor that depends on the independent variable.
* **Line Graph:** Shows how the dependent variable changes with the independent variable.

#### ****Graphing****

* **Steps to Draw a Graph:**

1. **Choose a Simple Scale:**
   * + Use a scale that avoids awkward numbers (e.g., 1 large square = 1 N or 2 N).
     + Ensure the graph uses most of the paper.
2. **Label Axes:**
   * + Put the **independent variable** on the **x-axis** (horizontal).
     + Put the **dependent variable** on the **y-axis** (vertical).
3. **Plot the Data:**
   * + Mark at least 5 data points. Use an "X" to mark points.
4. **Draw the Line or Curve:**
   * + **Straight Line:** If the points form a straight line, draw the best-fit line.
     + **Curve:** If the points form a curve, draw a smooth curve through them.
5. **Anomalous Point**
   * + If a point is far from the line, check the measurement again. This is an **anomalous point**, and you may choose to ignore it.

#### ****Types of Graphs****

* **Linear Relationship:**
  + Represented by , where is the slope, and is the y-intercept.
  + **Slope Calculation:**
  + The slope can be positive, negative, or zero, depending on the relationship.
  + If the graph goes through the origin, the variables are directly proportional (if one doubles, so does the other).
* **Nonlinear Relationship:**
  + **Quadratic Relationship:**
  + A hyperbola. Rises more quickly as increases.
  + **Inverse Relationship:**
  + A hyperbola. decreases as increases.

#### ****Predicting Values****

#### ****Using the Graph:****

* + **Example:**  
    For a spring with different weights:  
     (x = weight in g, y = length in cm)
    - Find the length when the weight is 20g:  
      Use the graph or formula to estimate

### ****Check Your Understanding****

### What is the independent variable in an experiment where you measure the effect of temperature on the volume of gas?

### If the graph of a relationship between two variables shows a straight line that passes through the origin, what type of relationship does this suggest?

### ****5.1 Vectors****

#### ****Vectors Revisited****

* **Scalars vs. Vectors:**
  + **Scalar:** A quantity with only magnitude (e.g., mass, speed, time).
  + **Vector:** A quantity with both magnitude and direction (e.g., velocity, force, displacement).
  + **Graphical Representation:** A vector is represented by an arrow, where the length represents magnitude, and the direction shows the direction of the vector.
* **Tail-to-Tip Method for Vector Addition:**
  + Connect the tail of one vector to the tip of the previous one.
  + The **resultant vector** (net vector) points from the tail of the first vector to the tip of the last vector.

#### ****Representing Vectors to Scale****

* **Scale Representation:**
  + To represent vectors precisely, choose a scale (e.g., *1 cm = 10 m/s*).
  + Draw the vector with a length proportional to the scale.
  + Label the vector with its magnitude, unit, and direction.
* **Example:**  
  For *40 m/s East* using a scale of *1 cm=10 m*, the vector would be *4 cm* long, pointing East.

#### ****Vectors in Multiple Dimensions****

* **Graphical Solutions (Tail-to-Tip and Parallelogram Method):**
  + **Tail-to-Tip:** Use this method when vectors are not along the same line.
  + **Parallelogram Method:**
    - Place the vectors tail-to-tail.
    - Construct a parallelogram using the vectors as adjacent sides. The diagonal from the origin is the resultant vector.
* **Mathematical Solution:**
  + For vectors at right angles (e.g., North and East), use the **Pythagorean Theorem** to find the resultant:
  + The angle of the resultant is found using trigonometry:

#### ****Algebraic Addition of Vectors****

* **Vector Resolution:**
  + Vectors can be broken into **x** and **y** components.
  + **Components:**
  + The resultant vector is found by adding the x and y components:
    - The magnitude of the resultant vector:
    - The direction of the resultant vector:

### ****Check Your Understanding****

### If *A=30m North* and *B=40m South*, what is the resultant vector *A+B*?

### Two forces at 60° and at 120° act on an object. What is the magnitude and direction of the resultant force?

### ****5.2 Friction****

#### ****What is Friction?****

* **Friction Force:** A force that opposes the motion or the tendency of motion between two surfaces.
* **Caused by:** Irregularities in the surfaces in contact.
* **Direction:** Always parallel to the surface and opposite to the direction of motion or the tendency of motion.

#### ****Factors Affecting Friction****

* **Nature of Surfaces:**
  + **Smooth vs. Rough Surfaces:**
    - **Rough surfaces** create more friction because they interlock more.
    - **Smooth surfaces** create less friction.
* **Normal Force:**
  + The greater the normal force (the force pushing the surfaces together), the greater the friction.
* **Key Points:**
  + Friction increases when surfaces are rougher and when more force is applied to press the surfaces together.

#### ****Static vs. Kinetic Friction****

* **Static Friction ():**
  + Acts when two surfaces are not moving relative to each other, but there is a tendency for motion.
  + **Maximum static friction ():** The maximum force before an object begins to move.
  + **Equation:**
    - is the coefficient of static friction, and is the normal force.
* **Kinetic Friction ():**
  + Acts when two surfaces are sliding past each other.
  + The friction is generally lower than static friction for the same surfaces.
  + **Equation:**
    - is the coefficient of kinetic friction.

#### ****Measuring Friction****

* **When pushing an object:**
  + If the object is **at rest** but force is applied, static friction will match the applied force up to a maximum value.
  + Once the applied force exceeds the maximum static friction, the object will start moving, and kinetic friction will take over.
* **Example:**  
  For a 10 kg box with a coefficient of static friction and kinetic friction , we can calculate friction under different applied forces:
  + **No force applied (0 N):** No friction (object stays at rest).
  + **Applied force of 20 N:** Static friction equals *20 N* (object at rest).
  + **Applied force of 39.2 N:** Static friction equals *39 .2N*, which is the max static friction (object at rest ).
  + **Applied force of 40 N:** Object starts moving (kinetic friction ).

#### ****Important Relationships****

* **Static Friction vs. Kinetic Friction:**
  + **Static friction** is generally higher than **kinetic friction** for the same surfaces.
  + **Equation for static friction at maximum:**
  + **Equation for kinetic friction:**

**Check Your Understanding**

1. If you were to increase the normal force acting on an object (for example, by pressing down on it), explain how this would affect both static and kinetic friction.
2. A 25 kg box is pushed across a floor with a 49 N force at constant speed. What is the coefficient of friction?

### ****5.4 Force and Motion in Two Dimensions****

#### ****1. Equilibrium Revisited****

* **Equilibrium:** An object is in equilibrium when the net force acting on it is zero. This can happen when the object is at rest or moving with constant velocity.
* **Example:**  
  If three vectors form a closed triangle, the net force is zero, and the object is in equilibrium. The **equilibrant** is a force that balances the other forces. It has the same magnitude as the resultant but acts in the opposite direction.

#### ****2. Equilibrant Force****

* **For Two Forces:**  
  The equilibrant is equal in magnitude but opposite in direction to one of the forces.
* **For Three or More Forces:**  
  Find the resultant of the first two forces. The equilibrant is equal in magnitude to the resultant but in the opposite direction.
* **Example:**  
  A force of 1000 N at 15° North of East requires an equilibrant force of 1000 N at 15° South of West to maintain equilibrium.

#### ****3. Motion Along a Level Surface****

* **Constant Speed Motion:**  
  The applied force equals the friction force. If the force doubles, the object accelerates, with friction remaining constant.

#### ****4. Motion Along an Inclined Plane****

* **Forces on an Incline:**
  + The gravitational force splits into two components:
    - **Parallel to the slope** (causing motion),
    - **Perpendicular to the slope** (affecting the normal force).

**Check Your Understanding**

1. If three forces of 10 N, 15 N, and 20 N form a closed triangle, is the object in equilibrium?
2. Can 100N, 150N, and 300N form a equilibrium? Why?