**NOTE: This is an official document by Indexademics. Unless otherwise stated, this document may not be accredited to individuals or groups other than the club IDX, nor should this document be distributed, sold, or modified for personal use in any way.**

**IDX G9 PHYSICS S STUDY GUIDE ISSUE 3**

**By Ziyu Pan**

### **Contents:**

1. [4.2 Newton’s Laws](#_4.2 Using Newton’s Laws)
2. [1.1 Mathematics and Physics](#_1.1 Mathematics and Physics)
3. [1.2 Measurement](#_1.2 Measurement)

### **4.2 Using Newton’s Laws**

#### **Scales**

#### **Key Concepts:**

#### Scales measure ****weight (mg)****, not ****mass (m)****.

#### On Earth: ​

#### On other planets, scales give different readings due to differing gravitational acceleration.

#### **2. Apparent Weight**

* **Key Concepts:**
  + Apparent weight = Force exerted by the scale,
  + In equilibrium (no acceleration):
  + When accelerating:
    - (overweight)
    - (underweight)
    - (weightlessness)

#### **3. Drag Force**

1. **Key Concepts:**

* Drag force resists motion of an object through a fluid (air, water).
* Depends on:
  + 1. Motion of the object ()
    2. Properties of the object (size, shape)
    3. Properties of the fluid (viscosity, temperature)
* Drag force increases as velocity increases.

#### **Terminal Velocity**

#### **Key Concepts:**

#### Initial motion: → Downward acceleration.

#### Increasing velocity → Increasing drag force ().

#### When , net force = 0, and acceleration stops.

#### The object moves at a constant velocity called ****terminal velocity****.

### **Check Your Understanding**

1. If a bathroom scale reads 50 kg on Earth, what will it read on a planet where the gravitational acceleration is ?
2. When does the apparent weight equal zero?
3. How does the drag force on a falling object change as its velocity increases?
4. Why does a table-tennis ball reach terminal velocity more quickly than a bowling ball?

### **1.1 Mathematics and Physics**

#### ****SI Units****

#### ****Key Concepts:****

#### Measurements use units for standardization.

#### SI Units are a **base 10 system**, used universally in science.

#### **7 Base SI Units:** Meter (length), Kilogram (mass), Second (time), Kelvin (temperature), Mole (amount of substance), Ampere (electric current), Candela (luminous intensity).

#### Derived units are combinations of base units (e.g., velocity in m/s).

#### SI prefixes change unit scales by powers of 10.

| **Prefix** | **Symbol** | **Factor** |
| --- | --- | --- |
| Tera | T |  |
| Giga | G |  |
| Mega | M |  |
| kilo | k |  |
| deci | d |  |
| centi | c |  |
| milli | m |  |
| micro | μ |  |
| nano | n |  |
| pico | p |  |
| femto | f |  |

#### **Dimensional Analysis**

#### **Key Concepts:**

#### Treat units like algebraic quantities to cancel during conversions.

#### **Conversion factor:** Multiplier equal to 1 (e.g., 1 kg=1000 g1 \, \text{kg} = 1000 \, \text{g}1kg=1000g).

#### Example: Convert 1.34 kg to grams:

#### **Significant Digits**

* **Key Concepts:**
  + **Significant digits:** Valid digits in a measurement (measured + 1 estimated digit).
  + **Rules for significance:**

1. Nonzero digits are significant.
2. Zeros between nonzero digits are significant.
3. Leading zeros are not significant.
4. Trailing zeros with a decimal point are significant.
5. Trailing zeros without a decimal point are not significant.

* **Example:**
  + 3.58 cm: 3 significant digits.
  + 0.00340: 3 significant digits.
  + 32000g: 2 significant digits.

#### **Arithmetic with Significant Digits**

* **Key Concepts:**
  + **Addition/Subtraction:** Round to the least precise decimal place among measurements.
    - Example:
  + **Multiplication/Division:** Round to the smallest number of significant digits.
* **Scientific Notation:** Expresses very large or small numbers.
  + Form: , where
  + Example: (2 significant digits).

### **Check Your Understanding**

1. How many meters are in 2.3 km?
2. What is the derived SI unit for Force?
3. What is a conversion factor?
4. How many significant digits are in 0.0056070?
5. Add 1.45 m and 0.032m , rounding appropriately.
6. Multiply 3.4 kg by , rounding for significant digits.

### **1.2 Measurement**

#### **Comparing Results**

* **Measurement:** A comparison between an unknown quantity and a standard.
* **Representation:**
  + Absolute uncertainty: 1 significant figure.
  + Measured value's last significant figure aligns with the absolute uncertainty.
  + **Scientific Notation:** Match the power of 10 for both value and uncertainty.
    - **Example:**
  + **Reproducibility:** Measurements agree if their uncertainties overlap.

#### Propagation and Uncertainties

* **Addition/Subtraction:** Combine uncertainties directly:

#### **Precision vs. Accuracy**

#### **Precision:** Degree of exactness; depends on the instrument and reproducibility. (More significant digits = greater precision)

#### **Accuracy:** Agreement with the true or standard value.

#### Checked using ****two-point calibration.****

#### **Techniques for Accurate Measurement**

* **Parallax Error:** Avoid by positioning the eye directly above the scale for reading.

### **Check Your Understanding**

1. Compare and . Are they in agreement?
2. What is the difference between precision and accuracy?