

PHYSICS 1

Study Guide: Units, Physical Quantities, and Measurement

1. What is Physics?

Physics is the experimental science that serves as the foundation for all other sciences. It is the study of how the Universe works, relying on the science of measurement to describe natural phenomena through models, theories, laws, and equations.

2. Measurements and Physical Quantities

Measurement:* The process of determining the magnitude (size) of a physical quantity.

Physical Quantity:* Any property of a material or system that can be quantified (measured).

Fundamental Quantities:* These do not depend on other quantities.

Examples:* Mass, Length, Time, Temperature.

Derived Quantities:* These depend on one or more fundamental quantities.

Examples:* Area ($\text{Length} \times \text{Width}$), Speed ($\text{Distance} / \text{Time}$), Density ($\text{Mass} / \text{Volume}$).

3. Systems of Units

CGS:* Centimeter, Gram, Second (French origin).

MKS:* Meter, Kilogram, Second (French origin).

FPS:* Foot, Pound, Second (British origin).

SI (Système International):* The modern, global standard used by scientists. It is an extension of the MKS system.

Key SI Base Units

Base Quantity	Base Unit	Symbol
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Time	Second	s
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Length	Meter	m
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Mass	Kilogram	kg
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4. Scientific Notation

Scientific notation helps us write very large or very small numbers easily. It follows the format:

$M \times 10^n$

M :* The coefficient (must be $1 \leq M < 10$).

10 :* The base.

n :* The exponent (how many places the decimal moved).

5. Significant Figures (Rules)

Significant figures represent the "meaningful" digits in a measurement.

1. Non-zero digits: Always significant (e.g., $\backslash(35.6\backslash)$ has 3).
2. Zeros between non-zeros: Always significant (e.g., $\backslash(205\backslash)$ has 3).
3. Trailing zeros (with decimal): Significant (e.g., $\backslash(64.00\backslash)$ has 4).
4. Trailing zeros (no decimal): Not significant (e.g., $\backslash(400\backslash)$ has 1).

Calculations:

Addition/Subtraction: The result should have the same number of decimal places as the measurement with the fewest* decimal places.

Multiplication/Division: The result should have the same number of significant figures as the measurement with the fewest* significant figures.

6. Measurement Errors

Random Errors: Unpredictable fluctuations (like "noise"). They are caused by human error or environmental changes. Example: Reading a flask from a different angle each time.*

Systematic Errors: Consistent, repeatable errors usually caused by faulty equipment or poor calibration. Example: A scale that is not set to zero.*

7. Accuracy vs. Precision

Accuracy: How close a measurement is to the true/accepted value*. (Hitting the bullseye).

Precision: How close a group of measurements are to each other*. (Hitting the same spot repeatedly, even if it's not the bullseye).

> Pro-Tip for your test: If you are asked to identify which student is "precise and accurate," look for the set of numbers that are all very close to each other and very close to the target value!

I understand! Copying text that contains LaTeX math formatting can sometimes break the formulas.

Here is the entire study guide again in ***Plain Text*** format, replacing the symbols with easy-to-read text. You can copy this into any document and it will stay perfectly readable:

GENERAL PHYSICS 1: STUDY GUIDE

1. MEASUREMENT & MATH

- * FUNDAMENTAL VS. DERIVED: Fundamental units (Mass, Length, Time, Temp) stand alone. Derived units (Area, Speed, Density) depend on fundamental units.
- * SCIENTIFIC NOTATION: Format: $(M) \times 10^n$ where 1 is less than or equal to M and M is less than 10.
- * SIGNIFICANT FIGURES (SF):
 - * ADD/SUBTRACT: Keep the fewest decimal places.
 - * MULTIPLY/DIVIDE: Keep the fewest total SF.
- * ERROR TYPES:
 - * RANDOM: Unpredictable "noise" (human error, reaction time).
 - * SYSTEMATIC: Repeatable flaws (broken instruments, poor calibration).
- * ACCURACY VS. PRECISION:
 - * ACCURACY: How close to the true value.
 - * PRECISION: How close measurements are to each other.

2. KINEMATICS (MOTION)

- * FRAME OF REFERENCE: A stationary point used to observe motion.
- * DISTANCE (SCALAR): Total ground covered.
- * DISPLACEMENT (VECTOR): Straight-line change in position. (Change in $x = x_2 - x_1$).
- * SPEED (SCALAR): Speed = distance / time.
- * VELOCITY (VECTOR): Velocity = change in x / time.
- * ACCELERATION (VECTOR): Acceleration = change in v / change in t . (Slowing down = negative acceleration).

3. VECTORS & SCALARS

- * SCALAR: Magnitude only (Mass, Time, Temp, Distance).
- * VECTOR: Magnitude + Direction (Force, Velocity, Accel, Momentum).
 - * Arrow: Length = magnitude, Arrowhead = direction.

CALCULATING RESULTANTS

- * SAME DIRECTION: Add magnitudes.
- * OPPOSITE DIRECTION: Subtract magnitudes.
- * RIGHT ANGLES (90 deg): Resultant = Square root of $(a^2 + b^2)$.
- * COMPONENT METHOD (FOR COMPLEX ANGLES):
 1. PARTS: $F_x = F \cdot \cos(\theta)$, $F_y = F \cdot \sin(\theta)$.
 2. COMBINE: Sum all X parts (Sum F_x) and all Y parts (Sum F_y).
 3. MAGNITUDE: Resultant = Square root of $((\text{Sum } F_x)^2 + (\text{Sum } F_y)^2)$.
 4. DIRECTION: $\tan(\theta) = (\text{absolute value of Sum } F_y) / (\text{absolute value of Sum } F_x)$.

💡 Quick Tip for your test:

- * If a problem mentions North, South, East, West, or degrees, it is definitely a **Vector** problem.

- * Always check your units: Acceleration is m/s^2 , Velocity is m/s .
- * Drawing a quick triangle or arrow diagram will save you from making mistakes on the math!