PHYSICS

Concept Visual Notes

FULL COURSE | CORNELL-STYLE GUIDED NOTES

8 Units of Study | Kinematics through Magnetism

Visual Diagrams | Worked Examples | Practice Sets

Formula Reference Sheet | Lab Safety Poster

Answer Keys Included

UM Printables

Premium STEM Resources for Teachers

Table of Contents

LAB SAFETY RULES

Safety is ALWAYS the #1 priority in the physics lab!

1. Eye Protection: Wear safety goggles at all times when experiments are in progress.

2. Follow Instructions: Read all lab procedures carefully. Do not deviate without teacher approval.

3. No Horseplay: Running, pushing, or playing with equipment is strictly prohibited.

4. Electrical Safety: Keep water away from electrical outlets and equipment. Never touch exposed wires.

5. Report Accidents: Inform the teacher IMMEDIATELY of any spills, breaks, or injuries.

6. Handle Equipment Carefully: Physics apparatus (masses, carts, springs) can break or cause injury if misused.

7. Emergency Equipment: Know the location of the fire extinguisher, first aid kit, and eye wash station.

8. Clean Up: Return all equipment to its proper place and wipe down workstations at the end of lab.

THINK SAFE. ACT SAFE.

Physics Formula Quick Reference

Kinematics

$$d = v_i t + \tfrac{1}{2}at^2$$

$$v_f = v_i + at$$

$$v_f^2 = v_i^2 + 2ad$$

$$d = \tfrac{1}{2}(v_i + v_f)t$$

Forces

$$F_{net} = ma$$

$$w = mg$$

$$f_k = \mu_k N$$

$$f_s \leq \mu_s N$$

Momentum & Energy

$$p = mv$$

$$J = F_{avg}\Delta t = \Delta p$$

$$KE = \tfrac{1}{2}mv^2$$

$$PE_g = mgh$$

$$W = Fd\cos(\theta)$$

Electricity & Magnetism

$$F_e = kq_1q_2 / r^2$$

$$E = F_e / q$$

$$V = IR$$

$$P = IV = I^2R = V^2/R$$

$$R_s = R_1 + R_2$$

$$1/R_p = 1/R_1 + 1/R_2$$

$$F_m = qvB\sin(\theta)$$

Waves & Sound

$$v = f\lambda$$

$$T = 1 / f$$

$$v = 331 + 0.6T \text{ (m/s)}$$

$$f_{beat} = |f_1 - f_2|$$

Physics Definition
Branches of Physics
Scientific Method
Theory vs. Law

Physics is the branch of science that studies matter, energy, and the interactions between them. It seeks to understand the fundamental laws of the universe.

Mechanics: Motion and forces.
Thermodynamics: Heat and energy.
Optics: Light.
Electromagnetism: Electricity and magnetism.
Quantum: Subatomic particles.

1. **Observe** a phenomenon.
2. Ask a **question**.
3. Form a **hypothesis** (testable prediction).
4. Conduct an **experiment**.
5. **Analyze** data.
6. Draw a **conclusion**.

Scientific Theory: A well-substantiated explanation acquired through the scientific method and repeatedly tested and confirmed.

Scientific Law: A statement based on repeated experimental observations that describes some aspect of the world. (e.g., Law of Gravity)

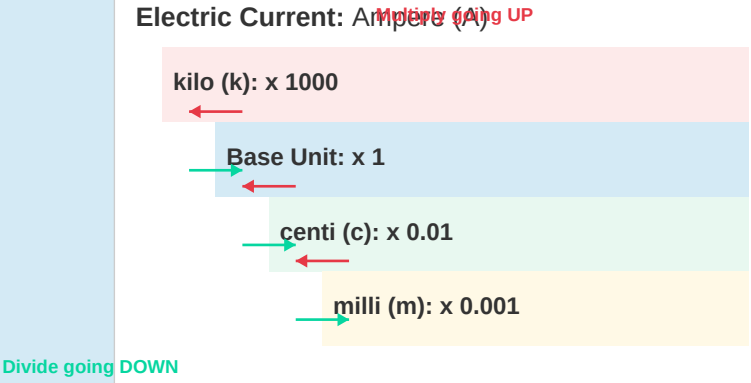
SUMMARY:

Physics is the study of energy and matter. The scientific method provides a structured way to explore questions, leading to theories (explanations) and laws (descriptions of behavior).

SI System
Base Units
Metric Prefixes
Conversion Method

The **International System of Units (SI)** is the standard metric system used in science.

Length: meter (m)
Mass: kilogram (kg)
Time: second (s)
Temperature: Kelvin (K)
Electric Current: Ampere (A)



Factor-Label Method: Multiply by conversion factor = 1

WORKED EXAMPLE

Example: Convert 5.4 kilometers to meters.

1. Start with the given: 5.4 km
2. Multiply by conversion factor (1000 m / 1 km):
3. 5.4 km x (1000 m / 1 km) = 5400 m
4. The "km" units cancel out, leaving "m".

SUMMARY:

Scientists use SI base units (m, kg, s). Metric conversions rely on prefixes that shift the decimal point. Always use the factor-label method to ensure units cancel properly.

Accuracy vs Precision
Sig Fig Rules
Math with Sig Figs

Accuracy: How close a measurement is to the true/accepted value.

Precision: How close multiple measurements are to each other; also refers to the fineness of a measuring tool.

Rule 1: Non-zero digits are ALWAYS significant. (452 has 3)
Rule 2: Leading zeros are NEVER significant. (0.004 has 1)
Rule 3: Captive zeros are ALWAYS significant. (405 has 3)
Rule 4: Trailing zeros are significant ONLY IF there is a decimal point. (40.0 has 3; 400 has 1)

Addition/Subtraction: Answer has same number of decimal places as the least precise measurement.
Multiplication/Division: Answer has same number of total sig figs as the measurement with the fewest sig figs.

WORKED EXAMPLE

Example: Calculate the area of a rectangle with sides 2.5 cm and 4.32 cm.

1. A = length x width = 2.5 cm x 4.32 cm
2. A = 10.8 cm^2
3. 2.5 has 2 sig figs; 4.32 has 3 sig figs.
4. Round answer to 2 sig figs: 11 cm^2

SUMMARY:

Accuracy is hitting the target; precision is grouping shots tightly. Sig figs communicate the precision of a tool. Calculation answers cannot be more precise than the least precise input.

PRACTICE SET

1. Identify the SI unit for Temperature.
2. Convert 4500 millimeters to meters.
3. Convert 0.08 kilometers to centimeters.
4. How many significant figures are in 0.00560?
5. How many significant figures are in 4200?
6. Calculate: 12.5 g + 3.42 g = ? (Apply sig fig rules)
7. Calculate: 4.2 cm x 2.11 cm = ? (Apply sig fig rules)

ANSWER KEY

1. Kelvin (K)
2. 4.5 m
3. 8000 cm
4. 3 sig figs (5,6,0)
5. 2 sig figs (4,2)
6. 15.9 g (1 decimal place)
7. 8.9 cm^2 (2 sig figs)

SUMMARY:

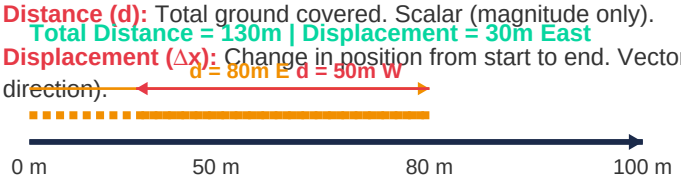
Review all SI prefixes and sig fig rules before moving to motion!

Distance vs Displacement

Speed vs Velocity

Distance (d): Total ground covered. Scalar (magnitude only).

Displacement (Δx): Change in position from start to end. Vector (magnitude + direction).



`Speed = Distance / Time | Velocity = Displacement / Time`

Speed is a scalar (e.g., 60 mph). **Velocity** is a vector (e.g., 60 mph *North*). If direction changes, velocity changes, even if speed is constant.

SUMMARY:

Distance is "how far" (scalar), displacement is "how far and which way" (vector). Speed is rate of distance; velocity is rate of displacement.

Acceleration

Motion Graphs

Acceleration (a): The rate at which velocity changes over time.

$$a = \Delta v / t = (v_f - v_i) / t$$

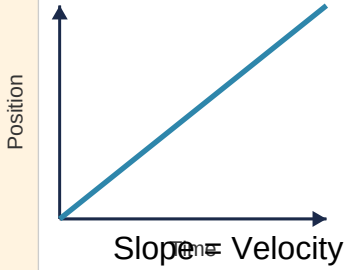
Units: m/s^2. Positive acceleration = speeding up OR moving more positive. Negative acceleration (deceleration) = slowing down OR moving more negative.

WORKED EXAMPLE

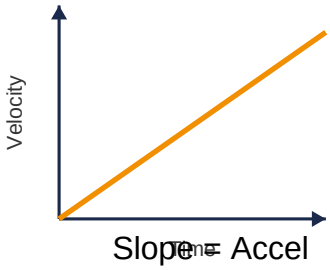
Example: A car accelerates from rest to 27 m/s in 9.0 seconds. What is its acceleration?

1. $v_i = 0$ m/s, $v_f = 27$ m/s, $t = 9.0$ s
2. $a = (27 - 0) / 9.0$
3. $a = 3.0$ m/s^2

Position vs Time (Constant v)



Velocity vs Time (Constant a)



SUMMARY:

Acceleration is the change in velocity. On a position-time graph, slope = velocity. On a velocity-time graph, slope = acceleration.

When to Use

These equations apply to motion with **constant acceleration**. Choose the equation based on which variable is missing (usually time or displacement).

1. $v_f = v_i + at$ (Missing d)

2. $d = v_i t + \frac{1}{2}at^2$ (Missing v_f)

3. $d = \frac{1}{2}(v_i + v_f)t$ (Missing a)

4. $v_f^2 = v_i^2 + 2ad$ (Missing t)

WORKED EXAMPLE

Example: A car starts at 10 m/s and accelerates at 2.0 m/s^2 for 4.0 s. How far does it travel?

1. $v_i = 10$, $a = 2.0$, $t = 4.0$. Missing v_f, so use Eq 2.
2. $d = v_i t + \frac{1}{2}at^2$
3. $d = (10)(4.0) + \frac{1}{2}(2.0)(4.0)^2$
4. $d = 40 + 0.5(2.0)(16) = 40 + 16$
5. $d = 56$ m

SUMMARY:

The 4 kinematic equations solve for unknowns in constant acceleration scenarios. Identify your knowns (v_i, v_f, a, t, d) to pick the right equation.