1-D Kinematics

Lesson 1 - Describing Motion with Words
b. Scalars and Vectors
c. Distance and Displacement
d. Speed and Velocity
e. Acceleration

Lesson 3 - Describing Motion with Position vs. Time Graphs
a. The Meaning of Shape for a p-t Graph
b. Meaning of Slope for a p-t Graph

Lesson 4 - Describing Motion with Velocity vs. Time Graphs
a. Meaning of Shape for a v-t Graph
b. Meaning of Slope for a v-t Graph
c. Relating the Shape to the Motion

Lesson 5 - Free Fall and the Acceleration of Gravity
b. Acceleration of Gravity
c. Representing Free Fall by Graphs
d. How Fast? and How Far?

Newton's Laws

Lesson 1 - Newton's First Law of Motion
a. Newton's First Law
c. State of Motion
d. Balanced and Unbalanced Forces

Lesson 2 - Force and Its Representation
b. Types of Forces
d. Determining the Net Force

Lesson 3 - Newton's Second Law of Motion
a. Newton's Second Law
b. The Big Misconception

Lesson 4 - Newton's Third Law of Motion
a. Newton's Third Law

Momentum and Its Conservation

Lesson 1 - The Impulse-Momentum Change Theorem
a. Momentum

Lesson 2 - The Law of Momentum Conservation
a. The Law of Action-Reaction (Revisited)

Work, Energy, and Power

Lesson 1 - Basic Terminology and Concepts
a. Definition and Mathematics of Work
f. Power
Circular Motion and Satellite Motion
Lesson 1 - Motion Characteristics for Circular Motion
c. The Centripetal Force Requirement
Lesson 3 - Universal Gravitation
b. The Apple, the Moon, and the Inverse Square Law
c. Newton's Law of Universal Gravitation

Waves
Lesson 1 - The Nature of a Wave
c. Categories of Waves
Lesson 2 - Properties of a Wave
a. The Anatomy of a Wave
b. Frequency and Period of a Wave
c. The Wave Equation
Lesson 3 - Behavior of Waves
b. Reflection, Refraction, and Diffraction
c. Interference of Waves
d. The Doppler Effect

Sound Waves and Music
Lesson 1 - The Nature of a Sound Wave
a. Sound is a Mechanical Wave
b. Sound as a Longitudinal Wave

Current Electricity
Lesson 2 - Electric Current
b. Requirements of a Circuit
Lesson 3 - Electrical Resistance
a. Journey of a Typical Electron
c. Ohm's Law
Lesson 4 - Circuit Connections
a. Circuit Symbols and Circuit Diagrams
b. Two Types of Connections
AP Physics 1 Summer Assignment

1. Scientific Notation:

The following are ordinary physics problems. Write the answer in scientific notation and simplify the units (π=3).

a. \( T_s = 2\pi \sqrt{\frac{4.5 \times 10^{-2} \text{ kg}}{2.0 \times 10^3 \text{ kg/s}^2}} = \)

b. \( F = \left( 9.0 \times 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2} \right) \frac{(3.2 \times 10^{-9} \text{ C})(9.6 \times 10^{-9} \text{ C})}{(0.32 \text{ m})^2} = \)

c. \( \frac{1}{R_p} = \frac{1}{4.5 \times 10^2 \Omega} + \frac{1}{9.4 \times 10^2 \Omega} = \)

d. \( K_{\text{max}} = \left( 6.63 \times 10^{-34} \text{ J} \cdot \text{s} \right) \left( 7.09 \times 10^{14} \text{ s} \right) - 2.17 \times 10^{-19} \text{ J} = \)

e. \( r = \sqrt{\frac{2.25 \times 10^8 \text{ m/s}}{3.00 \times 10^4 \text{ m/s}}} = \)

f. \( K = \frac{1}{2} \left( 6.6 \times 10^2 \text{ kg} \right) \left( 2.11 \times 10^4 \text{ m/s} \right)^2 = \)

g. \( (1.33) \sin 25.0^\circ = (1.50) \sin \theta \)

\( \theta = \)

AP Physics 1, Summer Assignment
2. Solving Equations:

Often problems on the AP exam are done with variables only. Solve for the variable indicated. Don’t let the different letters confuse you. Manipulate them algebraically as though they were numbers.

a. \[ K = \frac{1}{2} kx^2 \] , \( x = \) ____________

b. \[ T_p = 2\pi \sqrt{\frac{\ell}{g}} \] , \( g = \) ____________

c. \[ F_g = G \frac{m_1 m_2}{r^2} \] , \( r = \) ____________

d. \[ mgh = \frac{1}{2} mv^2 \] , \( v = \) ____________

e. \[ x = x_0 + vt + \frac{1}{2} at^2 \] , \( t = \) ____________

f. \[ B = \frac{\mu_0 I}{2\pi r} \] , \( r = \) ____________

g. \[ x_n = \frac{m \lambda L}{d} \] , \( d = \) ____________

h. \[ pV = nRT \] , \( T = \) ____________

i. \[ \sin \theta_c = \frac{n_1}{n_2} \] , \( \theta_c = \) ____________

j. \[ qV = \frac{1}{2} mv^2 \] , \( v = \) ____________
3. Conversion

Science uses the **KMS** system (SI: System Internationale). **KMS** stands for kilogram, meter, second. These are the units of choice of physics. The equations in physics depend on unit agreement. So you must convert to **KMS** in most problems to arrive at the correct answer.

- kilometers (km) to meters (m) and meters to kilometers
- centimeters (cm) to meters (m) and meters to centimeters
- millimeters (mm) to meters (m) and meters to millimeters
- nanometers (nm) to meters (m) and meters to nanometers
- micrometers (μm) to meters (m)

Other conversions will be taught as they become necessary.

What if you don’t know the conversion factors? Colleges want students who can find their own information (so do employers). Hint: Try a good dictionary and look under “measure” or “measurement”. Or the Internet? Enjoy.

a. \(4008 \text{ g} \quad = \quad \underline{\text{___________}} \text{ kg}\)

b. \(1.2 \text{ km} \quad = \quad \underline{\text{___________}} \text{ m}\)

c. \(823 \text{ nm} \quad = \quad \underline{\text{___________}} \text{ m}\)

d. \(298 \text{ K} \quad = \quad \underline{\text{___________}} \text{ °C}\)

e. \(0.77 \text{ m} \quad = \quad \underline{\text{___________}} \text{ cm}\)

f. \(8.8 \times 10^{-8} \text{ m} \quad = \quad \underline{\text{___________}} \text{ mm}\)

g. \(1.2 \text{ atm} \quad = \quad \underline{\text{___________}} \text{ Pa}\)

h. \(25.0 \mu \text{ m} \quad = \quad \underline{\text{___________}} \text{ m}\)

i. \(2.65 \text{ mm} \quad = \quad \underline{\text{___________}} \text{ m}\)

j. \(8.23 \text{ m} \quad = \quad \underline{\text{___________}} \text{ km}\)

k. \(40.0 \text{ cm} \quad = \quad \underline{\text{___________}} \text{ m}\)

l. \(6.23 \times 10^{-7} \text{ m} \quad = \quad \underline{\text{___________}} \text{ nm}\)

m. \(1.5 \times 10^{11} \text{ m} \quad = \quad \underline{\text{___________}} \text{ km}\)
4. Geometry

Solve the following geometric problems.

a. Line $B$ touches the circle at a single point. Line $A$ extends through the center of the circle.
   i. What is line $B$ in reference to the circle?
   ii. How large is the angle between lines $A$ and $B$?

b. What is angle $C$?

c. What is angle $\theta$?

d. How large is $\theta$?

e. The radius of a circle is 5.5 cm,
   i. What is the circumference in meters?
   ii. What is its area in square meters?

f. What is the area under the curve at the right?
5. Trigonometry

Using the generic triangle to the right, Right Triangle Trigonometry and
Pythagorean Theorem solve the following. Your calculator must be in degree
mode.

\[ \theta = 55^\circ \text{ and } c = 32 \text{ m}, \text{ solve for } a \text{ and } b. \]

\[ \theta = 45^\circ \text{ and } a = 15 \text{ m/s}, \text{ solve for } b \text{ and } c. \]

\[ b = 17.8 \text{ m and } \theta = 65^\circ, \text{ solve for } a \text{ and } c. \]

\[ a = 250 \text{ m and } b = 180 \text{ m}, \text{ solve for } \theta \text{ and } c. \]

\[ a = 25 \text{ cm and } c = 32 \text{ cm}, \text{ solve for } b \text{ and } \theta. \]

\[ b = 104 \text{ cm and } c = 65 \text{ cm}, \text{ solve for } a \text{ and } \theta. \]
Vectors

Most of the quantities in physics are vectors. **This makes proficiency in vectors extremely important.**

**Magnitude:** Size or extend. The numerical value.

**Direction:** Alignment or orientation of any position with respect to any other position.

**Scalars:** A physical quantity described by a single number and units. A quantity described by **magnitude only**.

Examples: time, mass, and temperature

**Vector:** A physical quantity with **both a magnitude and a direction.** A directional quantity.

Examples: velocity, acceleration, force

**Notation:** \( \vec{A} \) or \( \vec{A} \) →

Length of the arrow is proportional to the vectors magnitude.

Direction the arrow points is the direction of the vector.

**Negative Vectors**

Negative vectors have the same magnitude as their positive counterpart. They are just pointing in the opposite direction.

\[ \vec{A} \quad \text{or} \quad -\vec{A} \]

**Vector Addition and subtraction**

Think of it as vector addition only. The result of adding vectors is called the resultant. \( \vec{R} \)

\[ \vec{A} + \vec{B} = \vec{R} \]

So if \( A \) has a magnitude of 3 and \( B \) has a magnitude of 2, then \( R \) has a magnitude of 3+2=5.

When you need to subtract one vector from another think of the one being subtracted as being a negative vector. Then add them.

A negative vector has the same length as its positive counterpart, but its direction is reversed.

So if \( A \) has a magnitude of 3 and \( B \) has a magnitude of 2, then \( R \) has a magnitude of 3+(-2)=1.

**This is very important.** In physics a negative number does not always mean a smaller number.

Mathematically \(-2\) is smaller than \(+2\), but in physics these numbers have the same magnitude (size), they just point in different directions (180° apart).

There are two methods of adding vectors

**Parallelogram**

\[ A + B \]

\[ A - B \]

**Tip to Tail**

\[ A + B \]

\[ A - B \]
6. Drawing Resultant Vectors

Draw the resultant vector using the parallelogram method of vector addition.

Example

Draw the resultant vector using the tip to tail method of vector addition. Label the resultant as vector $R$

Example 1: $A + B$

Example 2: $A - B$

f. $X + Y$

g. $T - S$

h. $P + V$

i. $C - D$
**Component Vectors**

A resultant vector is a vector resulting from the sum of two or more other vectors. Mathematically the resultant has the same magnitude and direction as the total of the vectors that compose the resultant. Could a vector be described by two or more other vectors? Would they have the same total result?

This is the reverse of finding the resultant. You are given the resultant and must find the component vectors on the coordinate axis that describe the resultant.

Any vector can be described by an x axis vector and a y axis vector which summed together mean the exact same thing. The advantage is you can then use plus and minus signs for direction instead of the angle.

7. **Resolving a vector into its components**

For the following vectors draw the component vectors along the x and y axis.

a. ![Vector a](image)

b. ![Vector b](image)

c. ![Vector c](image)

d. ![Vector d](image)

Obviously the quadrant that a vector is in determines the sign of the x and y component vectors.
Rules for Significant Figures (sig figs, s.f.)

A. Read from the left and start counting sig figs when you encounter the first non-zero digit
1. All non zero numbers are significant (meaning they count as sig figs)
   613 has three sig figs
   123456 has six sig figs

2. Zeros located between non-zero digits are significant (they count)
   5004 has four sig figs
   602 has three sig figs
   600000000000002 has 16 sig figs!

3. Trailing zeros (those at the end) are significant only if the number contains a decimal point; otherwise they are insignificant (they don’t count)
   5.640 has four sig figs
   120000. has six sig figs
   120000 has two sig figs – unless you’re given additional information in the problem

4. Zeros to left of the first nonzero digit are insignificant (they don’t count); they are only placeholders!
   0.000456 has three sig figs
   0.052 has two sig figs
   0.00000000000000000000000000000052 also has two sig figs!

B. Rules for addition/subtraction problems
Your calculated value cannot be more precise than the least precise quantity used in the calculation. The least precise quantity has the fewest digits to the right of the decimal point. Your calculated value will have the same number of digits to the right of the decimal point as that of the least precise quantity.

In practice, find the quantity with the fewest digits to the right of the decimal point. In the example below, this would be 11.1 (this is the least precise quantity).

\[7.939 + 6.26 + 11.1 = 25.299\] (this is what your calculator spits out)

In this case, your final answer is limited to one sig fig to the right of the decimal or 25.3 (rounded up).

C. Rules for multiplication/division problems
The number of sig figs in the final calculated value will be the same as that of the quantity with the fewest number of sig figs used in the calculation.

In practice, find the quantity with the fewest number of sig figs. In the example below, the quantity with the fewest number of sig figs is 27.2 (three sig figs). Your final answer is therefore limited to three sig figs.

\[(27.2 \times 15.63) \div 1.846 = 230.3011918\] (this is what you calculator spits out)

In this case, since your final answer is limited to three sig figs, the answer is 230. (rounded down)

D. Rules for combined addition/subtraction and multiplication/division problems
First apply the rules for addition/subtraction (determine the number of sig figs for that step), then apply the rules for multiplication/division.

E. Practice Problems
1. Provide the number of sig figs in each of the following numbers:
   
   (a) \(0.000055\) g ______
   (b) \(3.40 \times 10^3\) mL ______
   (c) 1.6402 g ______
   (d) 1.020 L ______

2. Perform the operation and report the answer with the correct number of sig figs.
   
   (a) \((10.3) \times (0.01345)\) = ____________
   (b) \((10.3) + (0.01345)\) = ____________
   (c) \([10.3 + (0.01345)] \div [10.3 \times (0.01345)]\) = ____________
Massachusetts Comprehensive Assessment System
Introductory Physics Formula Sheet

Formulas

Average Speed = \( \frac{d}{\Delta t} \)

Average Acceleration = \( \frac{\Delta v}{\Delta t} \)

Average Velocity = \( \frac{\Delta x}{\Delta t} \)

\( v_f = v_i + a \Delta t \)

\( \Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2 \)

\( v_f^2 = v_i^2 + 2a\Delta x \)

Average Velocity = \( \frac{v_i + v_f}{2} \)

\( F = ma \)

\( p = mv \)

\( F = G \frac{m_1 m_2}{d^2} \)

\( V = IR \)

\( F = k \frac{q_1 q_2}{d^2} \)

\( P = IV \)

\( KE = \frac{1}{2} mv^2 \)

\( Q = mc\Delta T \)

\( PE = mg\Delta h \)

\( v = f\lambda \)

\( W = Fd \)

\( \lambda = \frac{c}{f} \)

\( P = \frac{W}{\Delta t} \)

\( T = \frac{1}{f} \)

Variables

- \( a \) = acceleration
- \( c \) = specific heat
- \( d \) = distance
- \( f \) = frequency
- \( F \) = force
- \( \Delta h \) = change in height
- \( I \) = current
- \( KE \) = kinetic energy
- \( \lambda \) = wavelength
- \( m \) = mass
- \( p \) = momentum
- \( P \) = power
- \( PE \) = gravitational potential energy
- \( q \) = charge of particle
- \( Q \) = heat
- \( R \) = resistance
- \( \Delta t \) = change in time
- \( \Delta T \) = change in temperature
- \( T \) = period
- \( v \) = velocity
- \( v_i \) = initial velocity
- \( v_f \) = final velocity
- \( \Delta v \) = change in velocity
- \( V \) = voltage
- \( W \) = work
- \( \Delta x \) = displacement

Definitions

- \( c \) = speed of electromagnetic waves = \( 3.00 \times 10^8 \) m/s

- \( G \) = Universal gravitational constant = \( 6.67 \times 10^{-11} \frac{N \cdot m^2}{kg^2} \)

- \( k \) = Coulomb constant = \( 8.99 \times 10^9 \frac{N \cdot m^2}{C^2} \)

- \( g \) = 10 m/s^2

- \( 1 \text{ N} = \frac{1 \text{ kg} \cdot m}{s^2} \)

- \( 1 \text{ J} = 1 \text{ N} \cdot m \)

- \( 1 \text{ W (watt)} = \frac{1}{s} \)