Honors Physics 1.1 & 1.2 - Introduction to Physics

I. What is Physics? (1.1)

- Physics is the study of ___________________, ___________________, and the interactions between them.
- Physicists observe the world and try to find ___________________ and principles that describe how it works.
- **Major Branches of Physics**
    - **Mechanics:** The study of ___________________ and its causes (forces).
    - **Thermodynamics:** The study of ___________________ and temperature.
    - **Electromagnetism:** The study of electricity, magnetism, and ___________________.
    - **Relativity:** The study of objects moving at very ___________________ speeds.
    - **Quantum Mechanics:** The study of ___________________ particles.

II. The Scientific Method (1.2)

- A logical, systematic process for learning about the ___________________ world.
- **Key Components**
    - **Observation:** The process of gathering information using our ___________________.
    - **Hypothesis:** A ___________________ statement that provides a possible explanation for an observation.
    - **Experiment:** A controlled procedure designed to test a ___________________.
    - **Theory:** A broad, in-depth ___________________ for a wide range of phenomena that has been repeatedly tested. Theories explain the "**why**."
    - **Scientific Law:** A concise statement that describes an observed ___________________ in nature. Laws describe the "**what**."

Worked Examples (Fill-in)

Ex 1 — Classify the statement: "Gravity causes the apple to fall."

1. **Analyze the statement:** Does it describe *what* happens or explain *why* it happens?
    - The statement proposes an underlying cause, which is "___________________."
2. **Identify the component:** An explanation for a broad set of observations is best described as a ___________________.
3. **Conclusion:**
    - This statement is part of a scientific ___________________.

Ex 2 — Is "The sun will rise tomorrow" a valid scientific hypothesis?

1. **Recall the definition of a hypothesis.**
   - A hypothesis must be a __________________ prediction.
2. **Can this statement be tested?**
   - Yes, by __________________ until tomorrow.
3. **Is it based on observation?**
   - Yes, it is based on all __________________ days.
4. **Conclusion:**
   - Yes, it is a __________________ scientific hypothesis.

Honors Physics 1.3 - Scientific Measurement

I. Systems of Measurement

- Measurements require both a ___________________ and a ___________________ to be meaningful.
- The International System of Units (SI) is the standard used in science worldwide.
- **The Seven Base SI Units**
  - Length: ___________________ (m)
  - Mass: ___________________ (kg)
  - Time: ___________________ (s)
  - Temperature: Kelvin (K)
  - Electric Current: ampere (A)
  - Amount of Substance: mole (mol)
  - Luminous Intensity: candela (cd)

II. Accuracy and Precision

- **Accuracy:** How close a measurement is to the ___________________ or accepted value.
- **Precision:** How close a series of measurements are to ___________________ ___________________. It reflects reproducibility.
- A measurement can be precise without being accurate if there is a ___________________ error.

III. Significant Figures

- A way of communicating the ___________________ of a measurement. It includes all digits that are known for certain, plus one final ___________________ digit.
- **Rules for Counting Significant Figures**
  - ___________________ digits are always significant.
  - Zeros ___________________ non-zero digits are significant (e.g., 101).
  - ___________________ zeros (before non-zero digits) are not significant (e.g., 0.05).
  - Trailing zeros are significant only if the number contains a ___________________ ___________________ (e.g., 100.0).
- **Rules for Calculations**
  - **Multiplication/Division:** The result has the same number of significant figures as the measurement with the ___________________ significant figures.
  - **Addition/Subtraction:** The result is rounded to the same number of ___________________ ___________________ as the measurement with the fewest.

Worked Examples (Fill-in)

Ex 1 — How many significant figures are in the measurement 0.00720 m?

1. **Non-zero digits:** The '7' and '2' are ___________________.
2. **Leading zeros:** The three zeros before the '7' are ___________________ significant.
3. **Trailing zeros:** The zero after the '2' is ___________________ because the number has a decimal point.
4. **Conclusion:** There are a total of ___________________ significant figures.

Ex 2 — Calculate the area of a rectangle with a length of 4.5 cm and a width of 2.33 cm.

1. **Formula:** Area = Length × Width
2. **Raw Calculation:** 4.5 cm × 2.33 cm = ___________________ cm^2
3. **Identify Significant Figures:**
   - 4.5 cm has ___________________ significant figures.
   - 2.33 cm has ___________________ significant figures.
4. **Apply Rule:** The answer must be rounded to ___________________ significant figures.
5. **Final Answer:** ___________________ cm^2

Honors Physics 1.4 - Math Tools for Physics

I. Measurement and Uncertainty

- **Scientific Notation**
  - A method for writing very large or very small numbers compactly.
  - Format: A coefficient (between 1 and 10) × 10 raised to a __________________.
  - Moving the decimal to the LEFT results in a __________________ exponent (e.g., 5,800 becomes 5.8×10^3).
  - Moving the decimal to the RIGHT results in a __________________ exponent (e.g., 0.045 becomes 4.5×10^{-2}).
- **Significant Figures**
  - Communicates the __________________ of a measurement.
  - Includes all certain digits plus one __________________ digit.

II. Physics Equations as Tools

- Equations are tools for __________________ and describing the natural world.
- They show the relationships between different physical __________________ (variables).
- Example: Speed = __________________ / __________________ ($v = d/t$).

III. Graphing Data

- Graphs visualize the relationship between two __________________.
- The **independent** variable (what you control) is plotted on the ________-axis.
- The **dependent** variable (what responds) is plotted on the ________-axis.
- **Interpreting Slope**
  - The slope of a line graph represents the __________________ between the variables.
  - Slope is calculated as "rise over run" (_________ / _________).
  - For a distance vs. time graph, the slope represents the __________________.

IV. Dimensional Analysis (Unit Conversion)

- A technique for converting a measurement from one __________________ to another.
- It involves multiplying by one or more __________________ __________________, which are fractions equal to 1.
- The key is to set up the factor so that the unwanted units __________________ out.

Worked Examples (Fill-in)

Ex 1 — Convert 365 days into seconds.

1. **Starting Value:** 365 days
2. **Conversion Factors:**
   - __________ hours / 1 day
   - __________ minutes / 1 hour
   - __________ seconds / 1 minute
3. **Dimensional Analysis Setup:**
   - (365 days) × (__________ / 1 day) × (__________ / 1 hr) × (__________ / 1 min)
4. **Final Answer:** ____________________ s

Ex 2 — A car travels 150 km in 2 hours. Find the slope of its distance-time graph.

1. **Identify Variables:**
   - Independent (x-axis): ____________________
   - Dependent (y-axis): ____________________
2. **Identify Points:**
   - Starting point: (0 hr, __________ km)
   - Ending point: (2 hr, __________ km)
3. **Calculate Slope:**
   - Slope = Rise / Run = (__________ km - __________ km) / (__________ hr - __________ hr)
4. **Final Answer & Meaning:**
   - Slope = ____________________ km/hr. This represents the car's average ____________________.

Honors Physics 1.5 - Resolving Vectors

I. Scalars vs. Vectors

- **Scalar:** A quantity that has only ____________________ (a numerical value).
  - Examples: speed, distance, ____________________, time.
- **Vector:** A quantity that has both magnitude and ____________________.
  - Examples: velocity, ____________________, force.
- Vectors are represented graphically by ____________________. The length represents magnitude, and the point indicates direction.

II. Essential Math: Right Triangle Trigonometry

- To work with vectors, we use the trigonometry of ____________________ triangles.
- **SOH CAH TOA**
  - SOH: Sin(θ) = ____________________ / ____________________
  - CAH: Cos(θ) = ____________________ / ____________________
  - TOA: Tan(θ) = ____________________ / ____________________
- **Using Your Calculator**
  - **IMPORTANT:** Make sure your calculator is in ____________________ mode.
  - To find a side length, use the `sin`, `cos`, or `tan` buttons.
  - To find an angle, use the ____________________ trig functions (e.g., `sin⁻¹`, `cos⁻¹`).

III. Resolving Vectors into Components

- Any vector can be "resolved" into two perpendicular ____________________, usually along the x and y axes.
- These components, when added together, are ____________________ to the original vector.
- We create a right triangle with the vector as the ____________________.
- **Calculating Components**
  - The **x-component** (adjacent side) is found using ____________________: $v_x = v * \cos(\theta)$
  - The **y-component** (opposite side) is found using ____________________: $v_y = v * \sin(\theta)$

Worked Examples (Fill-in)

Ex 1 — A car travels at 25 m/s at an angle of 60° north of east. Find the components.

1. **Identify Magnitude and Angle:**
   - Magnitude (v) = __________ m/s
   - Angle (θ) = __________ °
2. **Calculate x-component (East):**
   - v_x = v * cos(θ) = __________ m/s * cos(__________°)
   - v_x = ____________________ m/s
3. **Calculate y-component (North):**
   - v_y = v * sin(θ) = __________ m/s * sin(__________°)
   - v_y = ____________________ m/s

Ex 2 — A hiker walks 12.0 km on a path 20° south of west. Find the components.

1. **Determine the angle from the positive x-axis.**
   - West is 180°. 20° south of west is 180° + __________° = __________°.
2. **Calculate x-component (West):**
   - x = d * cos(θ) = 12.0 km * cos(__________°)
   - x = ____________________ km (The negative sign means West)
3. **Calculate y-component (South):**
   - y = d * sin(θ) = 12.0 km * sin(__________°)
   - y = ____________________ km (The negative sign means South)

Honors Physics 1.6 & 1.7 - Adding and Subtracting Vectors

I. Fundamentals of Vectors

- A **scalar** is a quantity with ____________________ (size) only. Examples: 10 m/s (speed), 5 kg (mass).
- A **vector** is a quantity with both magnitude and ____________________. Examples: 10 m/s North (velocity), 20 N Down (force).
- We represent vectors graphically with ____________________. The arrow's length corresponds to the magnitude, and its orientation shows the direction.
- One-dimensional vectors can be added or subtracted ____________________. A negative sign indicates the ____________________ direction.
- Example: A vector of +7 and a vector of -3 sum to ____________________.

II. Graphical Addition: Head-to-Tail Method

- This is the primary visual method for adding two-dimensional vectors.
- Step 1: Draw the first vector to __________________ and in the correct direction.
- Step 2: Draw the second vector, placing its __________________ at the __________________ (arrow tip) of the first vector.
- Step 3: The **resultant** (the sum) is the vector drawn from the __________________ of the first vector to the __________________ of the second vector.
- The order of addition __________________ (A + B = B + A). This is the **commutative property of vector addition**.
- If adding more than two vectors, continue placing each new vector __________________. The resultant always goes from the very start to the very end.

III. Mathematical Addition for Perpendicular Vectors

- When two vectors are perpendicular (at a __________________ angle), they form a right triangle with their resultant.

Finding the Magnitude (the Hypotenuse)

- Use the Pythagorean theorem: R^2 = __________________ + __________________.
- Example: A person walks 90m East (A) and then 50m North (B).
- R = √(² + ² ***) = √(__________________ + __________________) = √***____________ ≈ __________________ m.

Finding the Direction (the Angle)

- Use inverse trigonometry (SOH CAH TOA). Tangent is often easiest.
- = __________________(opposite/adjacent).
- For the example, θ = __________________(50m / 90m) ≈ __________________°.
- Direction must be stated fully: __________________ North of East.

IV. Component Method for Non-Perpendicular Vectors

- This is the most powerful and precise method for adding any vectors.
- The core idea is to resolve every vector into its perpendicular __________________ and __________________ components.

Step 1: Resolve Each Vector

- For each vector, create a right triangle with the vector as the __________________.
- Use trigonometry to find the length of the sides (the components).
- V_x = __________________
- V_y = __________________

- Pay close attention to ___________________ based on the quadrant (e.g., West is -x, South is -y).

Step 2: Sum the Components

- Add all the x-components together to get a single resultant x-component (R_x).
- Add all the y-components together to get a single resultant y-component (R_y).

Step 3: Combine the Resultant Components

- You now have two perpendicular vectors (R_x and R_y).
- Use the ___________________ theorem with R_x and R_y to find the final resultant's magnitude.

Ex 1 — A motorboat heads due east at 16 m/s across a river flowing due north at 9.0 m/s. Find the resultant velocity.

- **Magnitude:** R = √(__² + __²) ≈ ____ m/s.
- **Direction:** θ = $\tan^{-1}$(__ / __) ≈ ____ ° N of E.

Ex 2 — A hiker walks 11 km north, then 11 km east. Find their displacement.

- **Magnitude:** R = √(__² + __²) ≈ ____ km.
- **Direction:** θ = $\tan^{-1}$(__ / __) = ____ ° N of E.

Ex 3 — John pushes a crate 185 N East. Joan pushes 165 N at 30° N of E. Find the resultant force.

- **Sum components:**
  - R_x = ____ + **cos(**°) ≈ ____ N
  - R_y = **sin(**°) = ____ N
- **Resultant:**
  - R = √(____² + ____²) ≈ ____ N
  - θ = $\tan^{-1}$(____ / ____) ≈ ____ ° N of E.

Ex 4 — An airplane flies North at 90 km/h while being blown West at 50 km/h. Find its resultant velocity.

- **Magnitude:** R = √(__² + __²) ≈ ____ km/h.
- **Direction:** θ = $\tan^{-1}$(__ / __) ≈ ____ ° W of N.