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 = $\sqrt{(\ ^2 + ^2\ )}$ = $\sqrt{(}$ _____ + _____ $)$ = $\sqrt{}$_____ ≈ _____ 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.