AP Physics - Core Concept Cheat Sheet

04: Kinematics in One Dimension

Key Physics Terms

- **Vector:** A quantity that represents magnitude (size) and direction. It is usually represented with an arrow to indicate the appropriate direction. Vectors may or may not be drawn to scale.
- **Scalar:** A quantity that represents its magnitude, or size. It has no direction associated with its size.
- **Distance:** The quantity that describes the position of an object. **Distance is a scalar**.
- **Displacement:** The quantity that describes the change in location of an object and includes its direction of motion. **Displacement is a vector**.
- **Speed:** The distance an object travels per unit of time; the magnitude of velocity. **Speed is a scalar**.
- **Velocity**: Speed of an object including its direction of motion. **Velocity is a vector quantity**.
- **Instantaneous velocity**: The velocity of an object at any given instant in time.
- **Average velocity**: The total distance traveled divided by total time interval.
- **Constant velocity**: A velocity that does not change with time.
- **Acceleration:** The rate at which an object's velocity changes with time; this change may in speed, direction, or both. **Acceleration is a vector**.

Variables Used

- d = distance
- t = time
- v = velocity (usually average velocity or constant velocity)
- a = acceleration
- v_f = final velocity
- v_i = initial velocity
- Δ = change in

Key Formulas

- $v = d/t$
- $a = \Delta v/\Delta t = (v_f - v_i)/t$
- $d = v_i t + at^2/2$
- $v_f^2 = v_i^2 + 2ad$
- For the vertical sign convention of up is positive: Acceleration due to gravity, g, = -9.8 m/s^2

Key Metric Units

- Displacement and distance: meters, m
- Time: s
- Velocity and speed: m/s
- Acceleration: m/s^2, m/s/s

Key Conventions

- Assign a direction as positive.
- Keep this convention throughout the problem.
- Any quantities in the opposite direction must be negative.
- Often, up and right are positive, while down and left are negative.
- Even if someone else chooses the opposite direction as positive, for their sign convention they will arrive at the correct answer, assuming everything else is done correctly.

Constant Velocity vs. Constant Acceleration

- An object moving with a **constant velocity** would cover equal amounts of distance in equal time intervals.
- An object moving with a **constant acceleration** would cover varying amounts of distance in equal time intervals.

Constant Velocity Diagram

The motion of an object moving with a **constant velocity** is pictured below. The distance moved in each unit of time is constant since the velocity is constant too.

Constant Acceleration Diagram

The motion of an object moving with a **constant acceleration** is pictured below. The distance moved in each unit of time increases. In fact, it is proportional to the square of the time.

Kinematics Problem Solving Tips

These tips will make it easier to solve any kinematics physics problems.

- Thoroughly read the entire problem.
- Draw a diagram if needed.
- Identify all given information.
- Identify the quantity to be found.
- Select appropriate formula(s) that incorporate what you know and what you want to find.
- Convert units if needed. Use units throughout your calculations.
- Do any mathematical calculations carefully.

Typical Kinematics Problem

Example: A boy drops a book from a shelf that is 1.5m above the floor. How long will it take until the book hits the ground below?

Known: Displacement = -1.5 m
(Use convention, down is negative)
Initial velocity = 0 m/s
Acceleration due to gravity = -9.8 m/s^2

Unknowns:
Time: ?
Final velocity: ?

Define: $d = v_i t + at^2/2$
Since v_i = 0 m/s $d = at^2/2$
Rearranging for t: $t = \sqrt{(2d/a)}$

Output: $t = \sqrt{((2 \times -1.5\ m)/(-9.8\ m/s^2))}$
$t = .55$ s

Substantiate: Units are correct, sig fig are correct. Magnitude looks reasonable.

Since we kept downward negative, both the acceleration from gravity and the distance were negative, the two negatives canceled to give a positive value for time.

How to Use This Cheat Sheet: These are the keys related this topic. Try to read through it carefully twice then writeit out on a blank sheet of paper. Review it again before the exams.