Calculus Physics - Core Concept Cheat Sheet

03: Kinematics in One Dimension

Key Physics Terms

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

Key Formulas

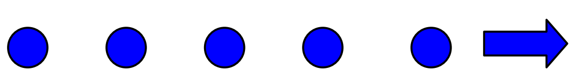
- $v=d/t$
- $a = \Delta v/\Delta t=(v_f-v_i)/t$
- $d=v_it+at^2/2$
- $v_f^2=v_i^2+2ad$
- acceleration due to gravity = -9.8 m/s^2
- $v=dx/dt$
- $a=dv/dt$

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

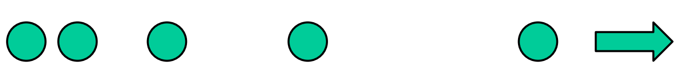
Constant Velocity Diagram

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.



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.

Typical Key Metric Units

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

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?

Given information:
distance = 1.5 m
initial velocity = 0 m/s
acceleration from gravity = -9.8 m/s^2

Unknowns:
Time: ?
Final velocity: ?

Probable formula to use: $d= v_it +at^2/2$

Since v_i = 0 m/s $d= at^2/2$

Rearranging for t: $t =\sqrt{(2d/a)}$

Substituting values: $t = \sqrt{(2(-1.5m))/(-9.8m/s^2)}$

t = .55 seconds

Since we kept downward negative, both the acceleration from gravity and the distance were negative since they each pointed down.

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

