Motion in 1 Dimension

Physics H

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Motion

- What is motion?
- How do we measure/know that something is moving?
- All motion must be measured relative to something else
  - We must choose a frame of reference
  - Sitting in the room, rotating about Earth's Axis, Revolving around the sun, traveling through space…
- Usually we'll use the ground.
  - THERE IS NO ABSOLUTE FRAME OF REFERENCE

Displacement

- Displacement is a change in position.
- We measure the displacement by comparing an objects starting location to its final location.
- Displacement = final position – initial position.
- $\Delta x = x_f - x_i$

- Ex: A frog hops away from the river. When he starts his journey he is 2m from the river. After 3min he is 5m from the river. What is his displacement?
  - $\Delta x = x_f – x_i$
  - $\Delta x = 5m – 2m = 3m$
- Displacement is NOT the same as distance
  - Ex: track

Displacement

- Ex2: An apple falls from a tree 4m off the ground. It hits a man on the head 1m before it hits the ground. What is it's displacement. (Assume up is positive and down is negative)
- $\Delta x = x_f - x_i$
  - $\Delta x = 1m - 4m = -3m$
  - Displacement can be positive or negative.

Velocity

- The average velocity is displacement divided by time.
  - $v_{avg} = \Delta x/\Delta t = (x_f - x_i)/(t_f - t_i)$
  - Units for v are m/s
  - Avg. v can be + or – depending on the displacement
- This is an average velocity. It does not mean the object traveled at this speed constantly, only that this was the average.

Velocity Examples

- Jessica runs from the start line to the finish of the 100m dash in 12.9s. What is her v_{avg}?
- You walk with an average v of 1.2m/s to the north for 9.5min. How far do you go?
- Simpson drives with a v_{avg} = 48 km/h. How long will it take him to go 144km?

- $v_{avg} = \Delta x/\Delta t$
  - V_{avg} = (100m-0m)/(12.9s-0s)
  - V_{avg} = 7.75 m/s

- $v_{avg} = \Delta x/\Delta t$
  - 1.2m/s = Δx/9.5min
  - 1.2m/s = Δx/570s
  - Δx = 684m
- $v_{avg} = \Delta x/\Delta t$
  - 48km/h =144km/ Δt
  - Δt = 3h

Velocity vs. Speed

- Speed is distance traveled/time
  - Since distance & displacement are not the same, speed and velocity are not the same.
- On a graph of dist v. time, the slope of the line is the same as the average v
- Instantaneous velocity is an object velocity at a single point in time.
  - The speedometer in your car show you instantaneous velocity.

Acceleration

- Acceleration is the rate at which velocity changes.
  - $a_{avg} = \Delta v/\Delta t$
  - Units = m/s/s or m/s^2
- Velocity and acceleration can both be positive or negative
  - pg 51 - chart

Constant Acceleration

- Means that the velocity is changing at the same rate in each time segment
- With a constant acceleration, we can get some equations for velocity and displacement.

- Diplacement
  - $\Delta x = \frac{1}{2}(v_i + v_f)\Delta t$
  - $\Delta x = \frac{1}{2}a(\Delta t)^2 + v_i\Delta t$
- Velocity
  - $v_f = a\Delta t + v_i$
- Final v after any displacement
  - $v_f^2 = v_i^2 + 2a\Delta x$

Ex:

- Jane pushes a stroller from rest with a constant accel. of .50 m/s^2. What its velocity after it has gone 4.75m?
- $v_f^2 = v_i^2 + 2a\Delta x$
  - $v_f^2 = (0m/s)^2 + 2(.50\ m/s^2)(4.75m)$
  - $v_f^2 = 4.75\ m^2/s^2$
  - $\sqrt{(v_f^2)} = \sqrt{(4.75\ m^2/s^2)}$
  - $v_f = 2.18\ m/s$

Ex

- An airplane starts from rest and undergoes a constant acceleration of 4.8 m/s^2 for 15s before takeoff. A) what is it's speed at take off? B) How long must the runway be?

- A) $v_f = a\Delta t + v_i$
  - $v_f = (4.8\ m/s^2)(15s) + 0m/s$
  - $v_f = 72\ m/s$
- B) $\Delta x = \frac{1}{2}a(\Delta t)^2 + v_i\Delta t$
  - $\Delta x = \frac{1}{2}(4.8m/s^2)(15s)^2 + (0m/s)(15s)$
  - $\Delta x = 540m$

Free fall

- If a feather and a rock are dropped at the same time which will hit the ground faster? Why?
- What if there was no air resistance?
- Gravity causes all objects to accelerate at a constant rate.
  - Acceleration due to gravity is 9.8 m/s^2 or 32 ft/s^2
  - Because gravity acts downward, we will make both of these values negative.

Thrown objects

- A ball thrown up into the air will slow down on its way up, at the same rate that it will speed up on its way down.
  - What is the velocity of a thrown ball at the top of its arc? What is its acceleration?

Reaction Time

- With a partner and a meter stick, determine your reaction time.
  - Have your partner drop a meter stick and catch it with you're your fingers.
  - Use the measurement and the displacement equation to determine your reaction time.
- Include the calculations with your homework.

Homework

- p 70:12,13,28,29,34, 35-49 odd