Motion in One Direction

MCHS Honors Physics 2014-15

Kinematics

- Kinematics is the study of classical mechanics which describes the motion of:
  - » Points
  - » Bodies (objects)
  - » Systems of bodies (groups of objects)
- Kinematics does not study or describe the causes of motion.

Motion

- In this unit, you will learn how to analyze motion in terms of displacement, time, speed, and velocity.
- We will compare and contrast motion which is accelerated and motion which is not accelerated.
- This is motion which represents much of our "everyday" experience.
  - » Walking, Riding a Bike, Driving a Cars
- We will study definitions and equations to make predictions about several aspects of motion, given certain initial conditions.

Motion in One Direction

- We will start our study motion by focusing on motion in one direction:
  - » Displacement and Velocity
    - – Motion, Displacement, Velocity
  - » Acceleration
    - – Changes in Velocity
    - – Motion with Constant Acceleration
  - » Falling Objects
    - – Free Fall

Displacement and Velocity

- Motion happens all around us. Every day, we see objects moving at different speed and in different directions.
- We are so familiar with motion, that it requires a special effort to analyze motion as a scientist does.
- One way to simplify the concept of motion is to consider only the kinds of motion that take place in one direction.

One Directional Motion

- One-dimensional motion means objects can move:
  - » Right or Left
  - » Up or Down
  - » Forward or Backward
- Motion takes place over time, and depends on a frame of reference
  - » Frame of reference: A system for specifying the precise location of objects in space and time
  - » A car travelling down a road

Frame of Reference

- Motion takes place over time, and depends on a frame of reference
  - » Frame of reference: A system for specifying the precise location of objects in space <u>and</u> time
  - » A car travelling down a road going forward is simple enough but…
    - – The earth is spinning on its axis
    - – The earth is orbiting the sun
    - – The solar system is orbiting the center of our galaxy.
    - – Our galaxy is hurtling though space!

Frame of Reference

- If an object is stationary, its position does not change with respect to a fixed frame of reference.
- In physics, any frame of reference can be chosen, as long as it is used consistently.

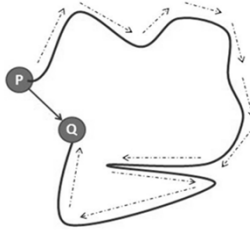- Some frames of reference make explaining (and predicting) motion easier.
- Discuss…

Frame of Reference

- If all this motion is happening, how does this effect time travelling Marty McFly?
- Discuss…

Displacement

- The distance - in a straight line - that an object moves from its initial position, is its displacement.

Path covered by the object (--->) = 20m

Shortest distance between initial point "P" and final point "Q" (→) = 2m

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Displacement

- Displacement is a change in position

$\Delta \vec{x}$ = Displacement
$\vec{x}$ = Final position
$\vec{x_0}$ = Initial position
$\Delta \vec{x} = \vec{x} - \vec{x_0}$ (units = meters)

- Displacement is not always equal to the distance travelled.
- Displacement can be positive or negative.
  - » Direction of motion can be indicated by displacement being positive or negative

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Velocity

- Average velocity is displacement divided by the time interval

Average speed = $\frac{distance}{time}$ (units = m/s) = How fast
Average velocity = $\frac{\vec{x} - \vec{x_0}}{t - t_0} = \frac{\Delta \vec{x}}{\Delta t}$ = Speed & Direction
Instantaneous velocity = At an instant in time

- Average Velocity can be positive or negative, depending on the sign of the displacement.
- Velocity is not the same as speed
- Velocity can be graphed