PHYSICS I

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MOTION IN ONE DIMENSION

Kinematics

Describes motion while ignoring the external agents that might have caused or modified the motion

For now, will consider motion in one dimension

- Along a straight line

Motion represents a continual change in an object's position.

Types of Motion

Translational

- An example is a car traveling on a highway.

Rotational

- An example is the Earth's spin on its axis.

Vibrational

- An example is the back-and-forth movement of a pendulum.

Particle Model

We will use the particle model.

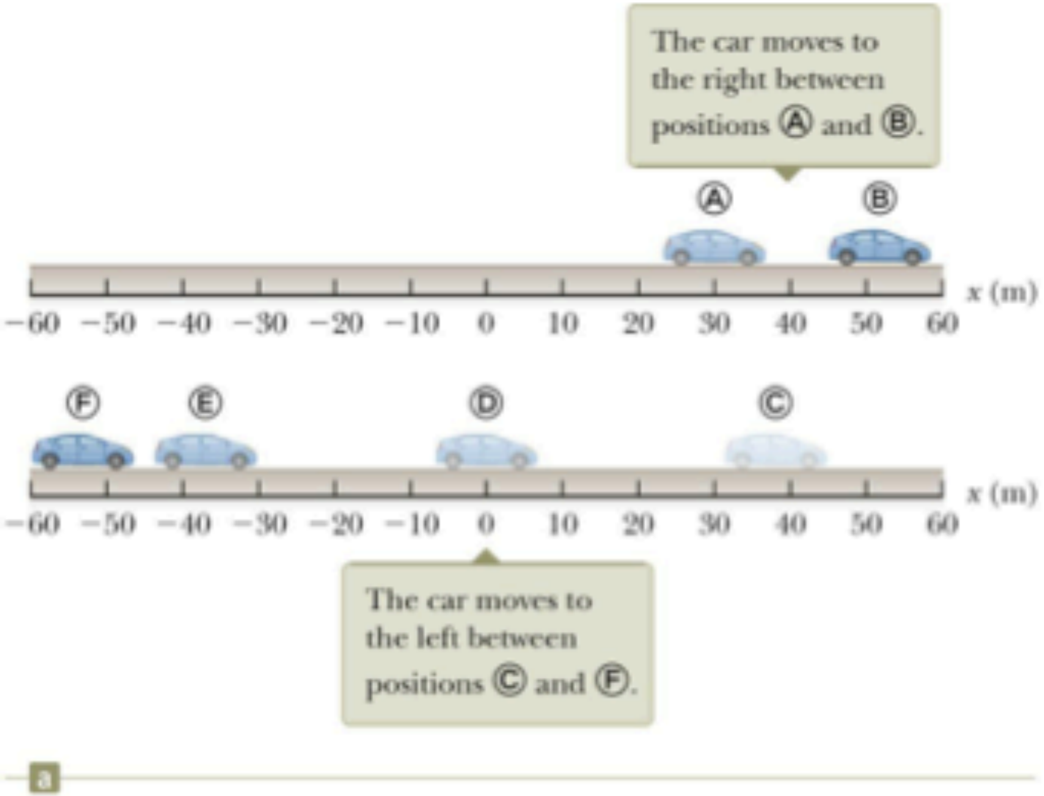
A particle is a point-like object; has mass but infinitesimal size

Position

The object's position is its location with respect to a chosen reference point.

- Consider the point to be the origin of a coordinate system.

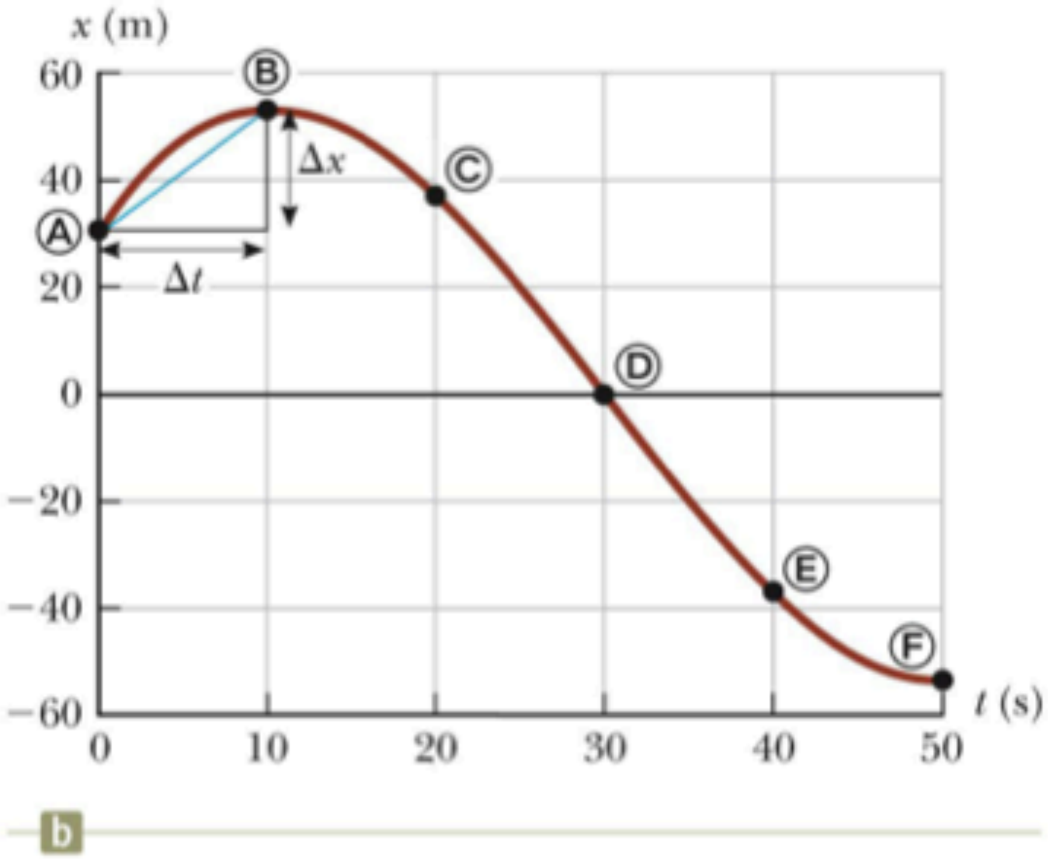
Only interested in the car's translational motion, so model as a particle



Position-Time Graph

The position-time graph shows the motion of the particle (car).

The smooth curve is a guess as to what happened between the data points.



Data Table

The table gives the actual data collected during the motion of the object (car).

Positive is defined as being to the right.

TABLE 2.1

Position of the Car at Various Times

Position	t (s)	x (m)
Ⓐ	0	30
Ⓑ	10	52
Ⓒ	20	38
Ⓓ	30	0
Ⓔ	40	−37
Ⓕ	50	−53

Representations of the Motion of Car

Various representations include:

- Pictorial
- Graphical
- Tablular
- Mathematical
  - The goal in many problems

Using alternative representations is often an excellent strategy for understanding the situation of a given problem.

- For example, compare the different representations of the motion.

Alternative Representations

Using alternative representations is often an excellent strategy for understanding a problem.

- For example, the car problem used multiple representations.
  - Pictorial representation
  - Graphical representation
  - Tabular representation

Goal is often a mathematical representation

Displacement

Displacement is defined as the change in position during some time interval.

- Represented as Δx

  $\Delta x \equiv x_f - x_i$

- SI units are meters (m)
- Δx can be positive or negative

Different than distance

- Distance is the length of a path followed by a particle.

Distance vs. Displacement – An Example

Assume a player moves from one end of the court to the other and back.

Distance is twice the length of the court

- Distance is always positive

Displacement is zero

- $\Delta x = x_f - x_i = 0$ since $x_f = x_i$

Vectors and Scalars

Vector quantities need both magnitude (size or numerical value) and direction to completely describe them.

- Will use + and – signs to indicate vector directions in this chapter

Scalar quantities are completely described by magnitude only.

Average Velocity

The **average velocity** is rate at which the displacement occurs.

$$v_{x,avg} \equiv \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{\Delta t}$$

- The x indicates motion along the x-axis.

The dimensions are length / time [L/T]

The SI units are m/s

Is also the slope of the line in the position – time graph

Average Speed

Speed is a scalar quantity.

- Has the same units as velocity
- Defined as total distance / total time: $v_{avg} \equiv \frac{d}{t}$

The speed has no direction and is always expressed as a positive number.

Neither average velocity nor average speed gives details about the trip described.

Average Speed and Average Velocity

The average speed is <u>not</u> the magnitude of the average velocity.

- For example, a runner ends at her starting point.
- Her displacement is zero.
- Therefore, her velocity is zero.
- However, the distance traveled is not zero, so the speed is not zero.

Instantaneous Velocity

The limit of the average velocity as the time interval becomes infinitesimally short, or as the time interval approaches zero.

The instantaneous velocity indicates what is happening at every point of time.

Instantaneous Velocity, graph

The instantaneous velocity is the slope of the line tangent to the *x* vs. *t* curve.

- This would be the green line.

The light blue lines show that as Δt gets smaller, they approach the green line.