Chapter 2

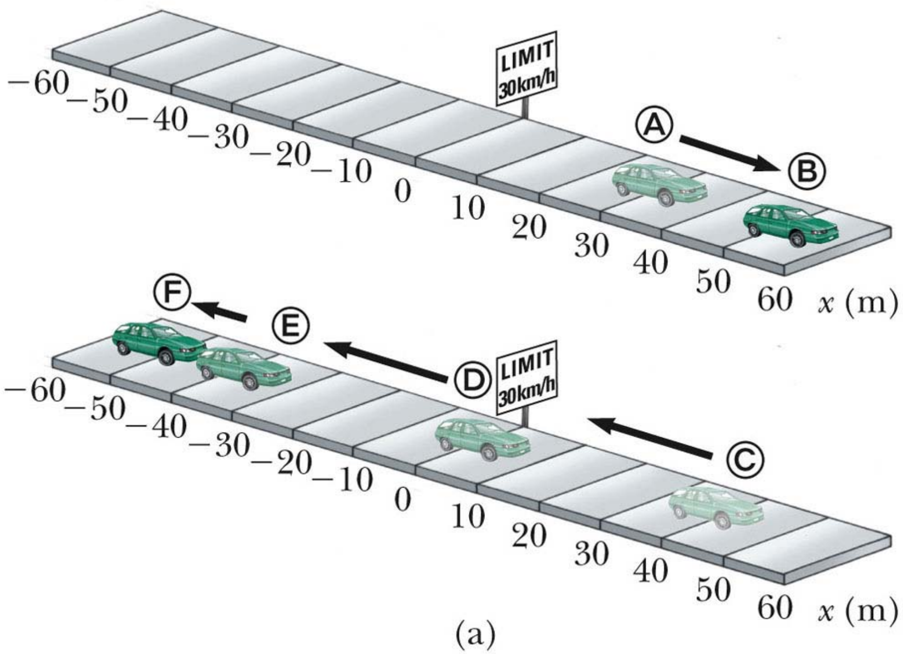
Motion in One Dimension

Kinematics

- Describes motion while ignoring the agents that caused the motion
- For now, will consider motion in one dimension
  - Along a straight line
- Will use the particle model
  - A particle is a point-like object, has mass but infinitesimal size

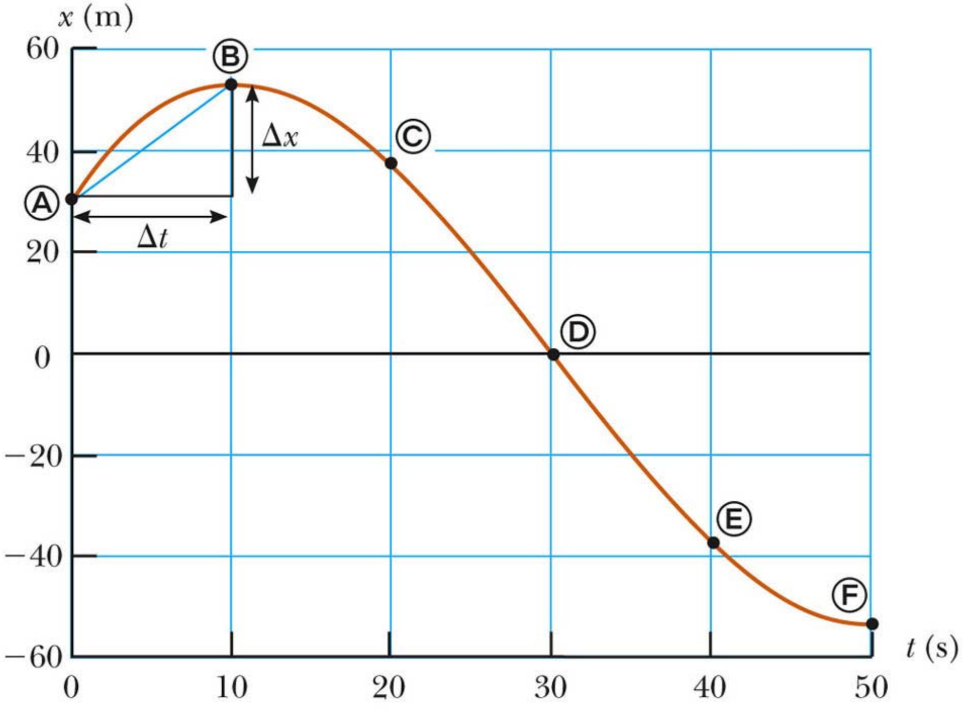
Position

- 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
- In the diagram, allow the road sign to be the reference point



Position-Time Graph

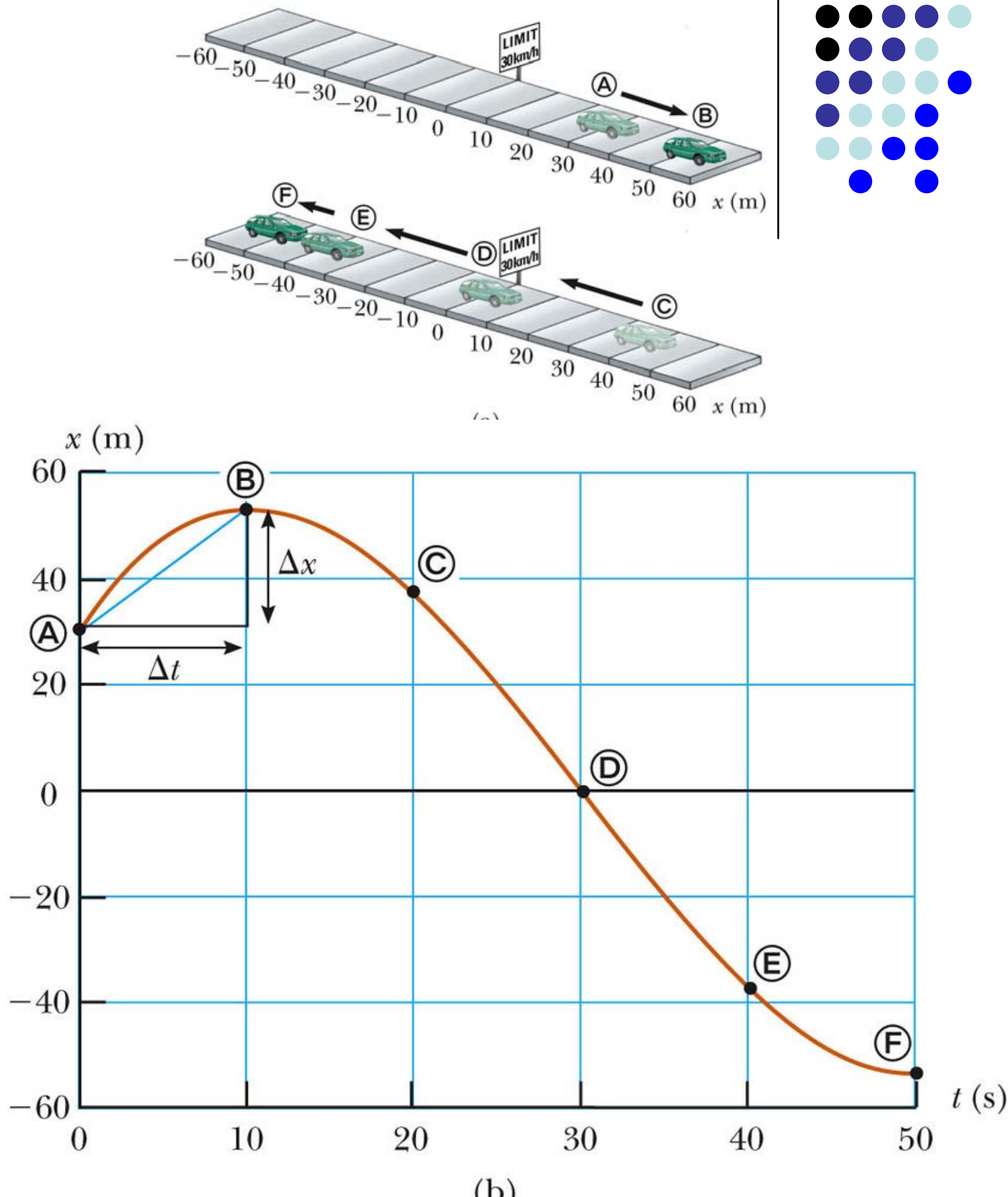
- The position-time graph shows the motion of the particle (car)
- The smooth curve is a guess as to what happened between the data points



(b)

Motion of Car

- Note the relationship between the position of the car and the points on the graph
- Compare the different representations of the motion



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

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

- 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 – 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 $x_f = x_i$

TABLE 2.2

Kinematic Equations for Motion of a Particle Under Constant Acceleration

Equation Number	Equation	Information Given by Equation
2.13	$v_{xf} = v_{xi} + a_x t$	Velocity as a function of time
2.15	$x_f = x_i + \frac{1}{2}(v_{xi} + v_{xf})t$	Position as a function of velocity and time
2.16	$x_f = x_i + v_{xi}t + \frac{1}{2}a_x t^2$	Position as a function of time
2.17	$v_{xf}^2 = v_{xi}^2 + 2a_x(x_f - x_i)$	Velocity as a function of position

Note: Motion is along the x axis.

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
- 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

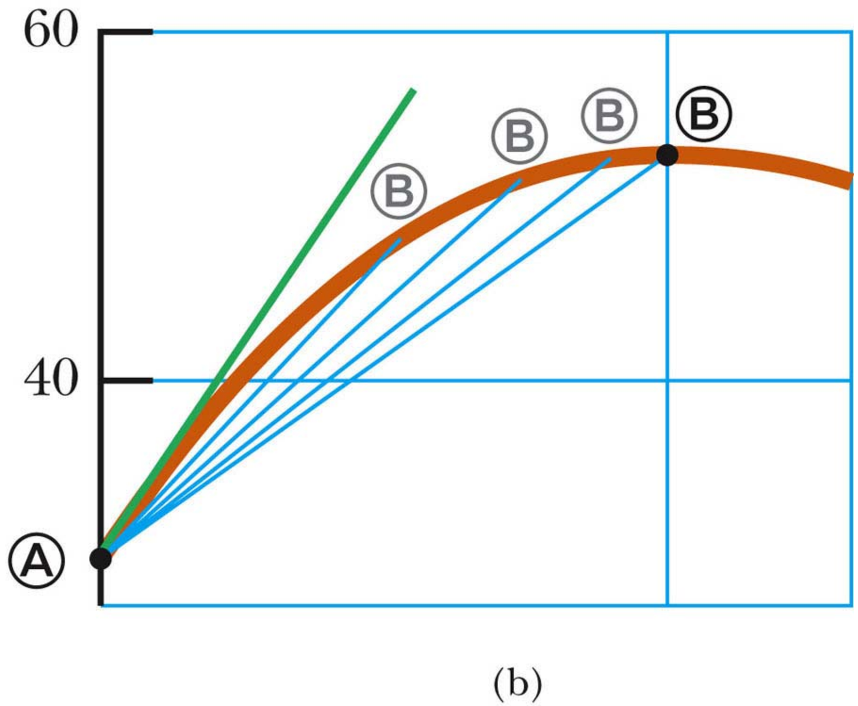
- Speed is a scalar quantity
  - same units as velocity
  - total distance / total time: $v_{avg} \equiv \dfrac{d}{t}$
- The speed has no direction and is always expressed as a positive number
- Neither average velocity nor average speed gives details about the trip described

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



Instantaneous Velocity, equations

- The general equation for instantaneous velocity is

$$v_x = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$

- The instantaneous velocity can be positive, negative, or zero

Instantaneous Speed

- The instantaneous speed is the magnitude of the instantaneous velocity
- The instantaneous speed has no direction associated with it

Vocabulary Note

- "Velocity" and "speed" will indicate *instantaneous* values
- *Average* will be used when the average velocity or average speed is indicated

Homework 1
(from Physics for Scientists and Engineers, 7th edition)

Chapter 1
Questions: 3,7
Problems: 11, 28, 31

Chapter 2
Questions: 2, 3, 10
Problems: 1, 3, 6

Due date : August 27, 08 (in class)