Motion in One Dimension

Position, Velocity, and Speed

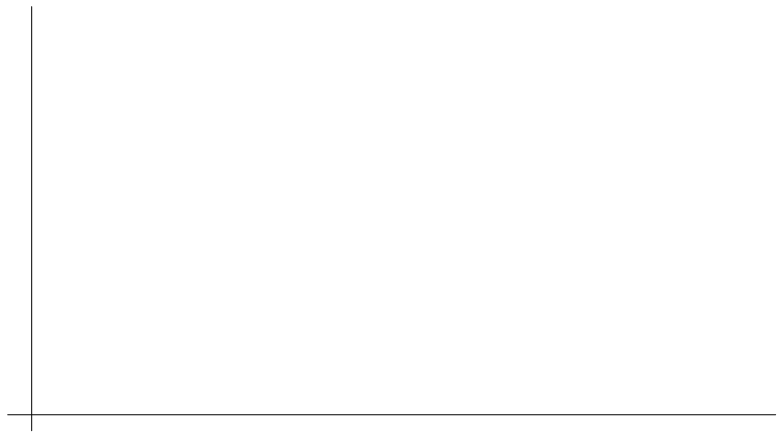
- Particle model – the moving object is described as point-like particle with mass m.
- Position x of the particle is its location at time t.
- Displacement $\Delta x = x_f - x_i$ is the change in position in a given time interval.
- Distance is the length of the path followed by the particle.

Position-time Graph

- Average velocity
- Average Speed

Running to the gate with a problem

- Running to your airport gate you miss the restroom…

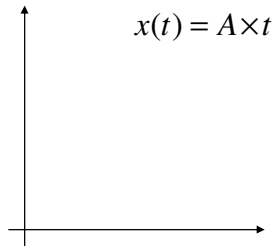


Instantaneous Velocity

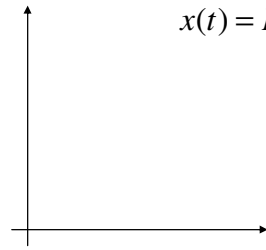
- Instantaneous velocity
- Instantaneous speed is the magnitude of the instantaneous velocity.

Some Calculus

$x(t) = A \times t$

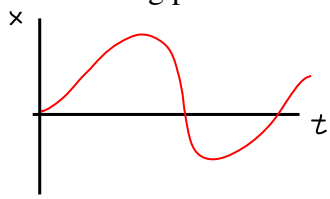


$x(t) = B \times t^2$

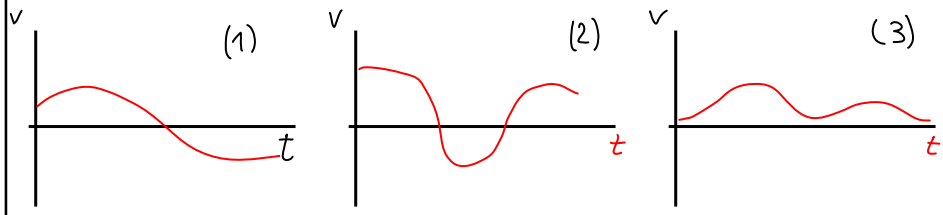


Question for You

- Analyze the following position-time graph for a particle



- Which of the following velocity-time graphs describes the motion of the particle best?

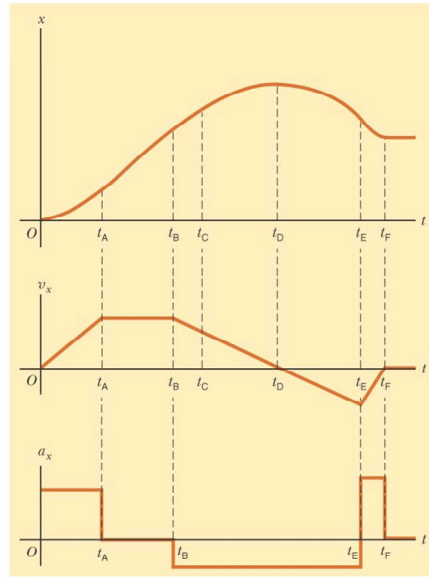


Velocity-time Graph

- Average acceleration
- Instantaneous acceleration

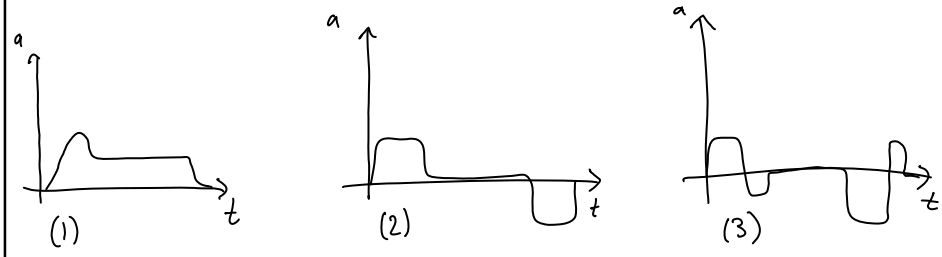
Negative Acceleration

- Velocity and acceleration have same direction – object is speeding up.
- Velocity and acceleration have opposite direction – object is slowing down.
- Rationalize by considering force proportional to acceleration.



Question for You

- Which of the following graphs describes the acceleration of a metro between two stations best ?

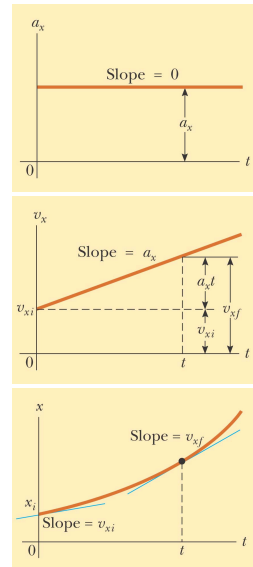


Some Calculus

- Acceleration is the second derivative of position with respect to time.
- How to calculate derivatives?

$$a_x = \frac{dv_x}{dt} = \frac{d}{dt}\left(\frac{dx}{dt}\right) = \frac{d^2x}{dt^2}$$

Motion with Constant Acceleration



Motion with Constant Acceleration (cont'd)

Question for You

- Which is the average acceleration as you drive up the entrance ramp to a highway ?
  a) 0.2 m/s^2
  b) 2 m/s^2
  c) 20 m/s^2

Freely Falling Objects

- A freely falling object is moving under the influence of gravity alone.
- Objects thrown upward or downward and those released from rest are all falling freely once they are released.
- Any freely falling object experiences an acceleration directed downward, regardless of its initial motion.
- The acceleration a_y is $a_y = -g = -9.80\ m/s^2$.
- Pitfall Prevention: Never mix up g and g (for gram)!
- Neglecting air resistance, the free fall is motion in one dimension under constant acceleration.

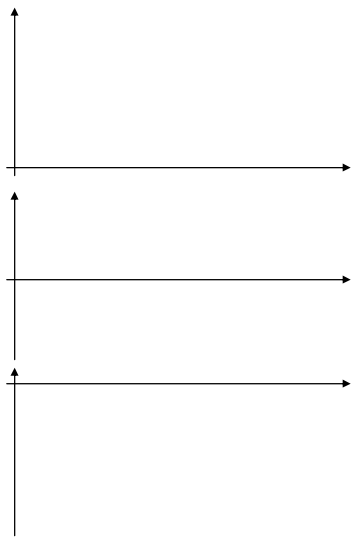
Free-fall Acceleration is Independent of Mass

- Movie time !

Experiment

- Free fall of two cubes of same size but different weight on earth: Which one is reaching ground earlier?
  - 1) the lighter one
  - 2) the heavier one
  - 3) both reach ground at the same time

The Bouncing-Ball Graphs



Question for You

- A ball is thrown upward. While the ball is in free fall, does its acceleration

a) increase
b) decrease
c) increase and then decrease
d) decrease and then increase
e) remain constant

Problem Solving 1

- A ball is thrown upward with a velocity of 15 m/s. It is released from the hand at a height of 1.5 m. What will be the maximum height of the ball? After what time will it touch the ground for the first time? Neglect air resistance.
- *Conceptualize* *Categorize*

Problem Solving 2

- A ball is thrown upward with a velocity of 15 m/s. It is released from the hand at a height of 1.5 m. What will be the maximum height of the ball? After what time will it touch the ground for the first time? Neglect air resistance.
- *Analyze* *Finalize*