Falling Balls

Question:

Suppose that I throw a ball upward into the air. After the ball leaves my hand, is there any force pushing the ball upward?

Observations About Falling Balls

- A dropped ball:
  - Begins at rest, but acquires downward speed
  - Covers more and more distance each second
- A tossed ball:
  - Rises to a certain height
  - Comes briefly to a stop
  - Begins to descend, much like dropped ball

Type of Force

- Weight – earth's gravitational force on object

Weight and Mass

- An object's weight is proportional to its mass
  - weight $\propto$ mass
  - weight = constant $\cdot$ mass
- On the Earth's surface, that constant is
  - 9.8 newtons/kilogram
  - called *acceleration due to gravity*

Acceleration Due to Gravity

- Why this strange name?
  - force = mass$\cdot$ acceleration (Newton's 2nd law)
  - 1 newton $\equiv$ 1 kilogram-meter/second^2 (definition)
  - 9.8 newtons/kilogram = 9.8 meter/second^2
  - 9.8 meter/second^2 is an acceleration!
  - *Acceleration due to gravity* actually is an acceleration!
- On Earth's surface, all falling objects accelerate downward at *the acceleration due to gravity*!

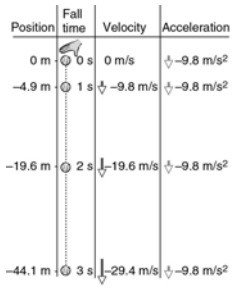
Why Things Fall Together

- Increasing an object's mass
  - increases the downward force on it
  - makes it need more force to accelerate
- These effects balance out perfectly

A Falling Ball

- Falling ball accelerates steadily downward
  - Acceleration is constant and downward
  - Velocity increases in the downward direction
- Falling from rest (stationary):
  - Velocity starts at zero and increases downward
  - Altitude decreases at an ever faster rate

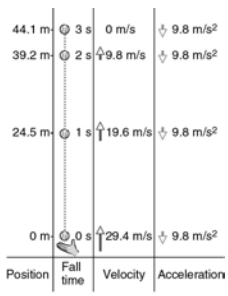
Falling Downward



A Falling Ball, Part 2

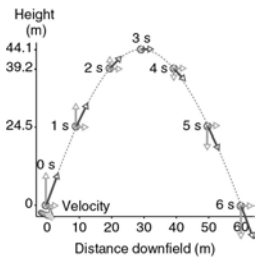
- A falling ball can start by heading upward!
  - Velocity starts in the upward direction
  - Velocity becomes less and less upward
  - Altitude increases at an ever slower rate
  - At some point, velocity is momentarily zero
  - Velocity becomes more and more downward
  - Altitude decreases at ever faster rate

Falling Upward First



Throws and Arcs

- Gravity only affects vertical motion
- A ball can coast horizontally while falling vertically



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Summary About Falling Balls

- A free ball experiences only gravity
  - Its inertia tends to make it go straight
  - But its weight makes it accelerate downward
  - Its velocity becomes increasingly downward
- Whether going up or down, it's still falling
- Horizontal motion is independent of falling