Falling Balls

Turn off all electronic devices

Observations about Falling Balls

- When you drop a ball, it
  - begins at rest, but acquires downward speed
  - covers more and more distance each second
- When you tossed a ball straight up, it
  - rises to a certain height
  - comes momentarily to a stop
  - and then descends, much like a dropped ball
- A thrown ball travels in an arc

6 Questions about Falling Balls

1. Why does a dropped ball fall downward?
2. How differently do different balls fall?
3. How would a ball fall on the moon?
4. How does a falling ball move after it is dropped?
5. How can a ball move upward and still be falling?
6. How does a ball's horizontal motion affect its fall?

Question 1

Q: Why does a dropped ball fall downward?

A: Earth's gravity exerts a force on the ball

- That force is the ball's weight
- That weight points toward earth's center
- Its weight causes the falling ball to accelerate downward—toward earth's center

Question 2

Q: How differently do different balls fall?

A: Not differently. They all fall together!

A ball's weight is proportional to its mass:

$$\frac{\text{weight of ball}}{\text{mass of ball}} = 9.8 \ \frac{\text{newtons}}{\text{kilogram}}$$

That ratio is equivalent to an acceleration:

$$\frac{\text{weight of ball}}{\text{mass of ball}} \rightarrow \frac{\text{force}}{\text{mass}} \rightarrow \text{acceleration}$$

Acceleration Due to Gravity

- That ratio is the acceleration of a falling object!
- It is called the acceleration due to gravity

$$\text{accel. grav.} = 9.8 \ \frac{\text{newtons}}{\text{kilogram}} = 9.8 \ \frac{\text{meters}}{\text{second}^2}$$

- Near earth's surface, all falling balls accelerate downward at 9.8 meter/second^2

Question 3

Q: How would a ball fall on the moon?
A: It would fall more slowly.

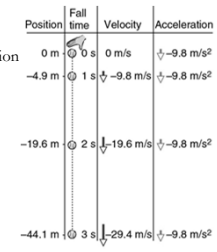
Moon's acceleration due to gravity is $1.6 \frac{\text{meters}}{\text{second}^2}$

Question 4

Q: How does a falling ball move after it is dropped?
A: It accelerates downward, covering more distance each second

A falling ball experiences only its weight
- Its acceleration is constant and downward
- Its velocity increases in the downward direction

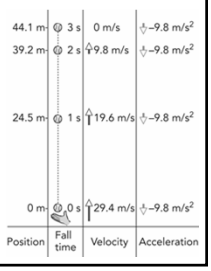
- When dropped from rest,
  - the ball's velocity starts at zero and increases in the downward direction
  - the ball's altitude decreases at an ever faster rate



Question 5

Q: How can a ball move upward and still be falling?
A: It may be moving upward, but it is still accelerating downward!

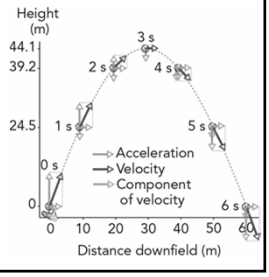
A falling ball accelerates downward, but its initial velocity can be anything, even upward!
- When thrown upward,
  - ball's velocity starts upward but increases downward
  - ball's altitude increases at an ever slower rate until…
  - velocity is momentarily zero
  - and then ball falls downward…



Question 6

Q: How does a ball's horizontal motion affect its fall?
A: It doesn't. The ball falls vertically, but coasts horizontally.

- Ball's acceleration is purely vertical (downward)
- It falls vertically
- It coasts horizontally
- Its path is a parabolic arc



Summary About Falling Balls

- Without gravity, an isolated ball would coast
- With gravity, an isolated ball
  - experiences its weight,
  - accelerates downward,
  - and its velocity becomes increasingly downward
- Whether going up or down, it's still falling
- It can coast horizontally while falling vertically