5.4~6.1 GRAVITY

7th Physical Science

WHAT IS GRAVITY?

- Why we don't fly off into space
- Why Earth is a Goldilocks planet
- How we control satellites
- (2 minutes)

http://www.grindtv.com/outdoor/blog/34091/new+video+offers+a+remarkable+space+trip+for+those+grounded+by+reality/

http://vimeo.com/44801709

- How we "slingshot" our way through the solar system.
  - Here's a clip of Cassini (2:32)
  - http://www.tecca.com/news/2011/03/15/saturn-fly-by-video/
- Have you heard of Voyager 1 and 2?

WHAT IS GRAVITY?
AN ELEGANT EQUATION SAYS IT ALL!

- Law of Universal Gravitation

$$F_g = G\frac{m_1 m_2}{d^2}$$

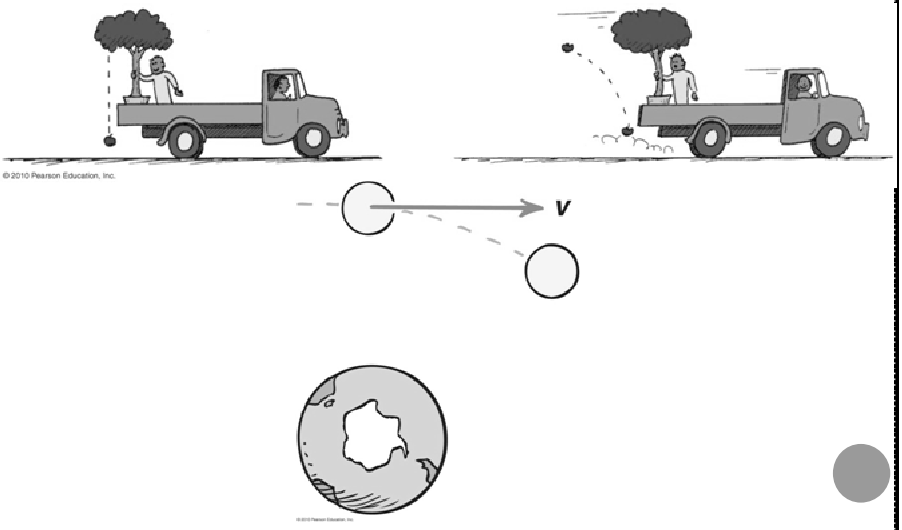
$$G = 6.67428\times10^{-11}\,\mathrm{m^3kg^{-1}s^{-2}}$$
$$= 6.67428\times10^{-11}\,\mathrm{N(m/kg)^2}$$

- Bigger Mass → _____ gravity
- Bigger distance → _____ gravity
- Does the bigger mass pull harder on the smaller mass?

5.4

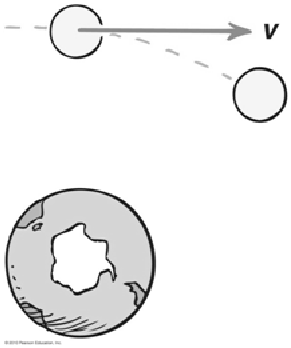
- Gravity = force of attraction between 2 masses

THE APPLE IS FALLING.
THE MOON IS FALLING!



7.1 THE MOON IS FALLING!

- The curvature of the fall matches the Earth's



5.4 Newton's Law of Universal Gravitation

- Gravity is a FORCE
- Law of Universal Gravitation

$$F_g = G\frac{m_1 m_2}{d^2}$$

$$G = 6.67428\times10^{-11}\,\mathrm{m^3kg^{-1}s^{-2}}$$

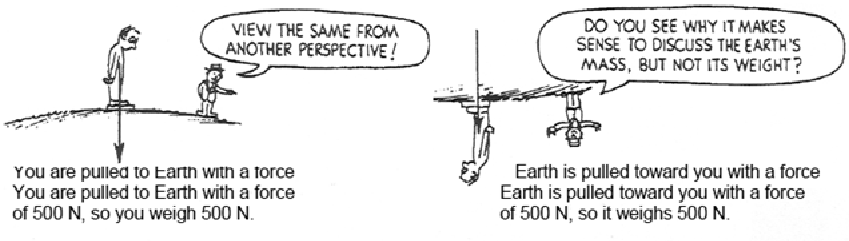
$$= 6.67428\times10^{-11}\,\mathrm{N(m/kg)^2}$$

- Bigger Mass → _____ gravity
- Bigger distance → _____ gravity
- Does the bigger mass pull harder on the smaller mass?

5.4 Newton's Law of Universal Gravitation

- If the Earth pulls a person down with 500N, how hard does the person pull the Earth up?

- Why does the person fall down instead of the Earth falling up?



5.4 Universal Constant of Gravitation G

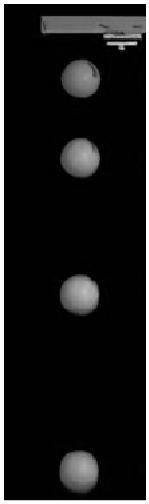
$$F_g = G\frac{m_1 m_2}{d^2}$$

$$G = 6.67428 \times 10^{-11}\,\mathrm{m^3 kg^{-1} s^{-2}}$$

$$= 6.67428 \times 10^{-11}\,\mathrm{N(m/kg)^2}$$

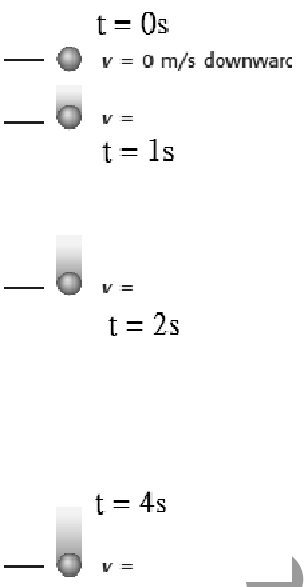
- Calculate the gravitational acceleration on the surface of the Earth.

6.1 Why does the ball drop more and more distance?



6.1 Gravity and Motion

- Positive Acceleration means that _____
- Acceleration on Earth:
  g = _____
- Speed after t seconds:
  v = _____
- Distance fallen in t seconds
  x = _____
- Why does the ball fall more distance every second?



MATH FOCUS

Calculating the Velocity of Falling Objects A stone at rest is dropped from a cliff, and the stone hits the ground after a time of 3 s. What is the stone's velocity when it hits the ground?

Step 1: Write the equation for change in velocity.

$$\Delta v = g \times t$$

Step 2: Replace g with its value and t with the time given in the problem, and solve.

$$\Delta v = 9.8 \frac{\text{m/s}}{\text{s}} \times 3\,\text{s}$$
$$= 29.4 \text{ m/s}$$

To rearrange the equation to find time, divide by the acceleration due to gravity:

$$t = \frac{\Delta v}{g}$$

Now It's Your Turn

1. A penny at rest is dropped from the top of a tall stairwell. What is the penny's velocity after it has fallen for 2 s?
2. The same penny hits the ground in 4.5 s. What is the penny's velocity as it hits the ground?
3. A marble at rest is dropped from a tall building. The marble hits the ground with a velocity of 98 m/s. How long was the marble in the air?
4. An acorn at rest falls from an oak tree. The acorn hits the ground with a velocity of 14.7 m/s. How long did it take the acorn to land?

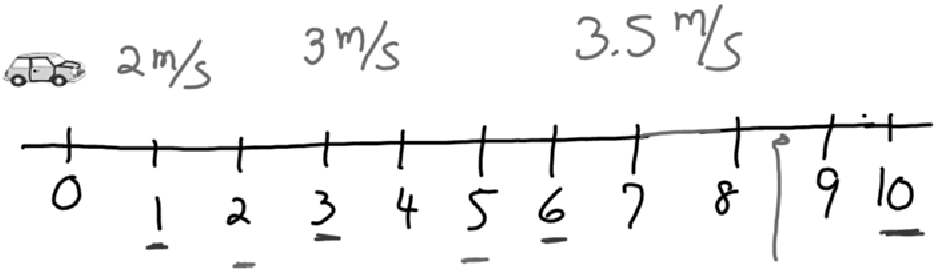
6.1 GRAVITY AND MOTION

- Reinforcement: Falling Fast

6.1 THE DIFFERENCE BETWEEN DECREASING ACCELERATION AND DECREASING SPEED

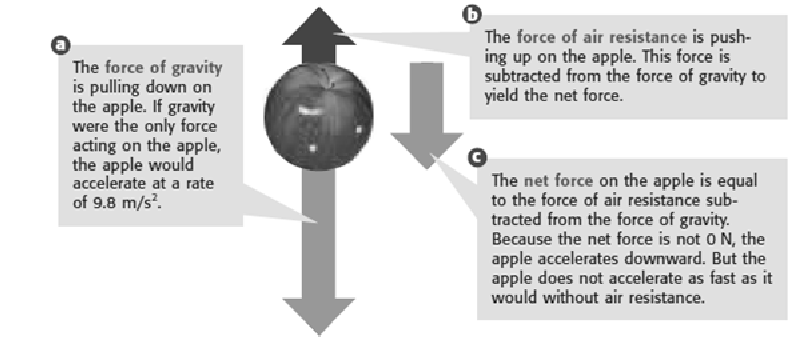
Acceleration is increasing/same/decreasing

Speed is increasing/same/decreasing



6.1 Air Resistance

Figure 3 Effect of Air Resistance on a Falling Object



6.1 Air Resistance


0 m/s

- The faster it falls, the more air resistance
- Until
  - Air resistance =
  - Net Force =
  - Velocity =


faster

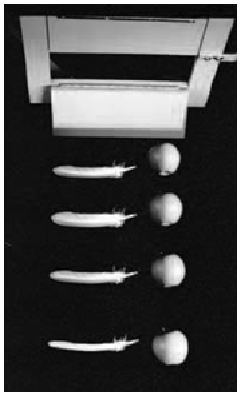

Even faster


Even faster


Terminal velocity

6.1 Gravity and Motion

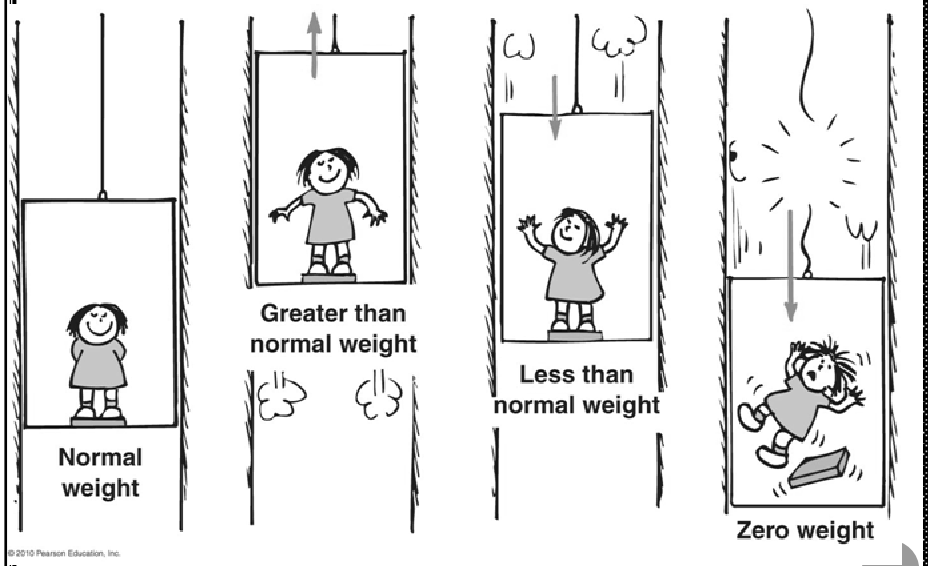
- Free Fall = the only force is gravity (no air resistance)



6.1 Weight and Weightlessness

6.1 Weight and Weightlessness

- What makes you feel "heavy"?
  - The support from the floor
  - Newton's 3rd Law: I push floor down (due to gravity), so floor pushes me up.
- Draw the force arrows on the next page.

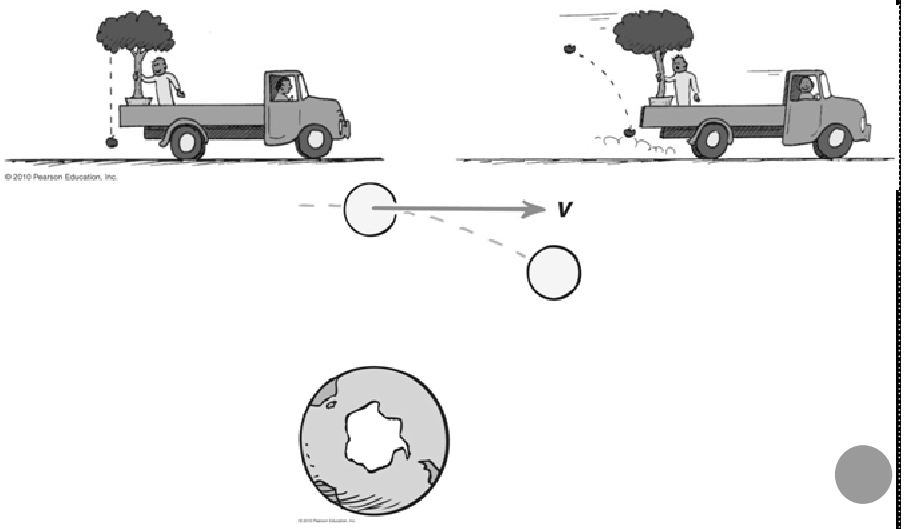


6.1 Weight and Weightlessness

- Weightlessness is not really the absence of gravity but the absence of _____

- There is still gravity in space. (It is 90% as strong as on the Earth!). But why do astronauts float?

The apple is Falling.
The Moon is Falling!



THE MOON IS FALLING!

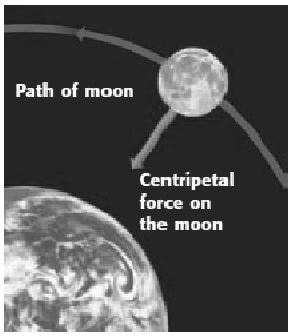
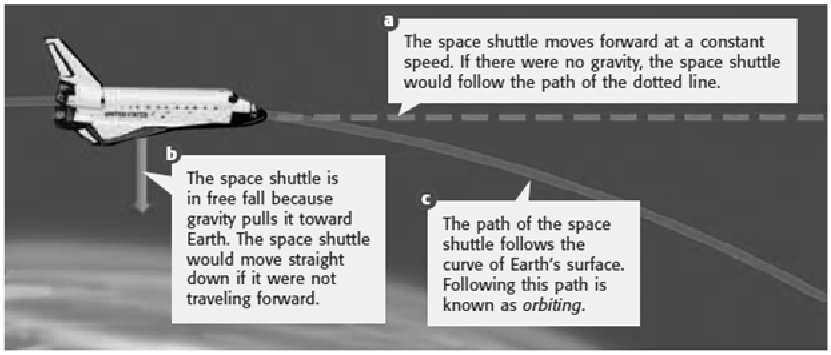


Figure 8 *The moon stays in orbit around Earth because Earth's gravitational force provides a centripetal force on the moon.*

THE SPACE SHUTTLE IS FALLING!

Figure 7 How an Orbit Is Formed



6.1 Weight and Weightlessness

- http://www.youtube.com/watch?v=qtQchbUgeLE (parabolic flight)
- http://www.youtube.com/watch?v=coX1u2_KBsQ&feature=related (fun in space)
- http://www.youtube.com/watch?v=NkXrpbOEWC4&feature=related (parabolic flight)

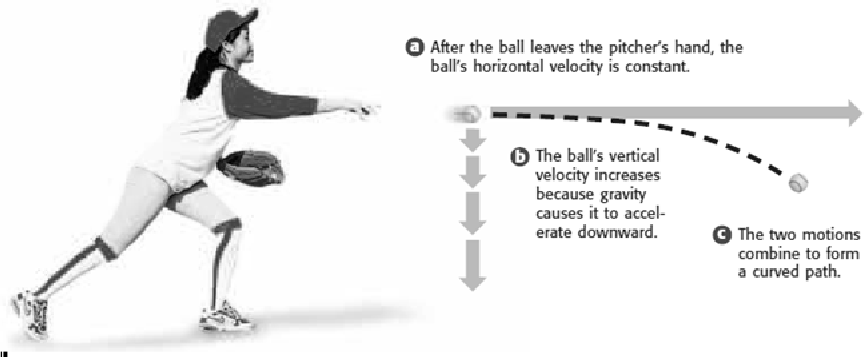
- Weightlessness is not really the absence of gravity but the absence of _____

6.1 Projectile Motion

- Which will reach the ground first?
- http://www.youtube.com/watch?v=z24_ihikEqQ&feature=related

6.1 PROJECTILE MOTION

- Projectile = an object moving only due to gravity (no air resistance)
  - Moves in a parabola
  - There are 2 components: horizontal and vertical

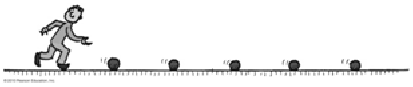


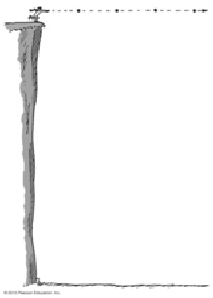
6.1 PROJECTILE MOTION

- Projectile Motion
  - Horizontal component

  is/ is not affected by gravity.

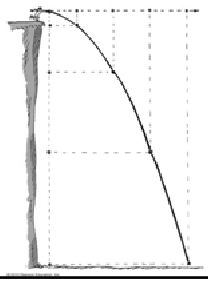
  Inertia?





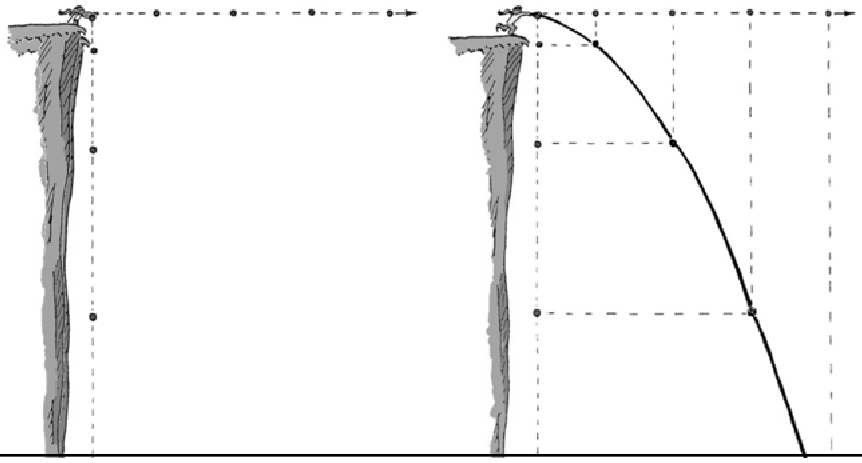
  - Vertical component

  is/ is not affected by gravity



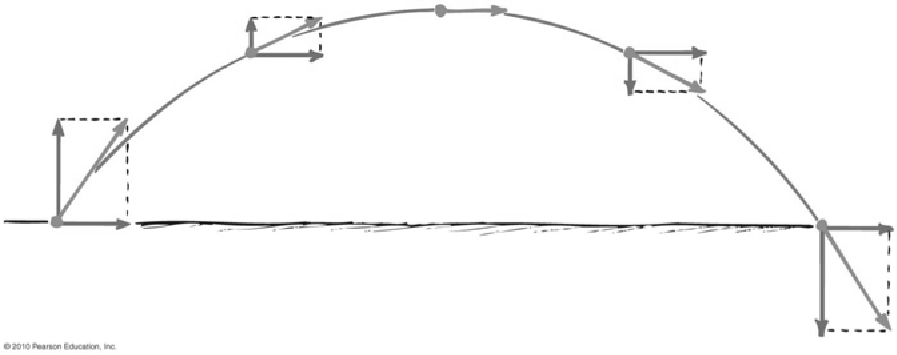
6.1 PROJECTILE MOTION

- Put the vertical and horizontal components together and the path is a parabola



6.1 PROJECTILE MOTION

- The curved path of any projectile is a combination of horizontal and vertical motions.

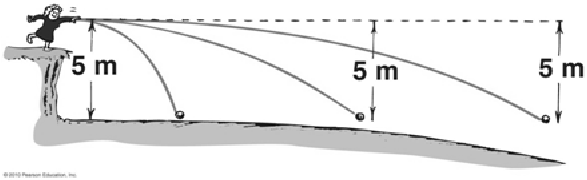


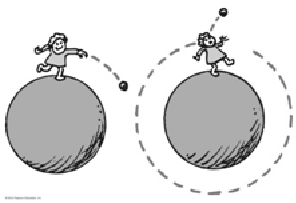
6.1 Satellite Motion

- Read the Comic

6.1 Satellites: Fast-Moving Projectiles

- Satellite = projectile that falls fast enough to fall around (not into) Earth.
- Read Practice Book Pg. 33





6.1 COMPLETE THE WORKSHEETS