Regents Physics

Free Fall
and
Projectile Motion

APlusPhysics

Objectives

- Use kinematic equations to solve problems for objects moving at a constant acceleration in free fall.
- Sketch the theoretical path of a projectile.
- Recognize the independence of the vertical and horizontal motions of a projectile.
- Solve problems involving projectile motion for projectiles fired horizontally and at an angle.

Air Resistance

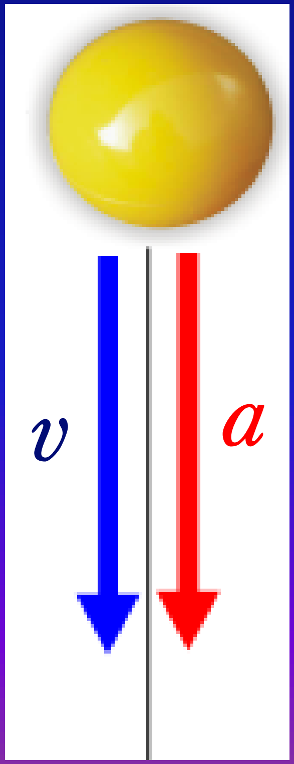
- If we drop a ball <u>and</u> a sheet of paper simultaneously from the same height, it is obvious that they don’t fall at the same rate.
- If we could remove all the air from the room, however, we would find that they fall at the same rate.
- We will analyze the motion of objects by neglecting air resistance (a form of friction) for the time being.

Acceleration Due to Gravity

- Near the surface of Earth, objects accelerate downward at a rate of 9.8 m/s^2.
- We call this acceleration the acceleration due to gravity (*g*).
- More accurately, it is called the gravitational field strength.
- As you move further away from Earth, *g* decreases.

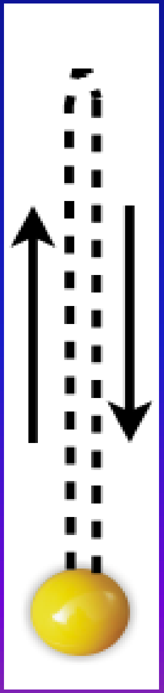
What is free fall?

- A free falling body is any object whose motion is affected upon only by gravity and moves vertically.



Objects Falling From Rest

Objects Launched Upward



What is a projectile?

- A projectile is an object that is acted upon only by gravity.
- In reality, air resistance plays a role, but similar to free fall, we will neglect air resistance in this course.
- Typically, projectiles are objects launched at an angle.
- Projectiles launched at an angle move in parabolic arcs.

Sample Problem - falling

How far will a brick starting from rest fall freely in 3.0 seconds?

[Neglect air resistance.]

Independence of Motion

- Projectiles launched at an angle have motion in two dimensions
  - Vertical – like free fall
  - Horizontal – 0 acceleration
- Vertical motion and horizontal motion can be treated separately!

Sample – Horizontal Launch

- Fred throws a baseball 42 m/s horizontally from a height of 2.0 m. How far will the ball travel before it reaches the ground?

$\downarrow Vert$

$v_i =$

v_f

$d =$

$a =$

$t = FIND$

$$d = v_i t + \frac{1}{2}at^2$$

$$d = \frac{1}{2}at^2$$

$$t = \sqrt{\frac{2d}{a}} =$$

$$=$$

$\rightarrow Horz$

$v_i =$

$v_f =$

$d = FIND$

$a =$

$t =$

$d = \bar{v}t$

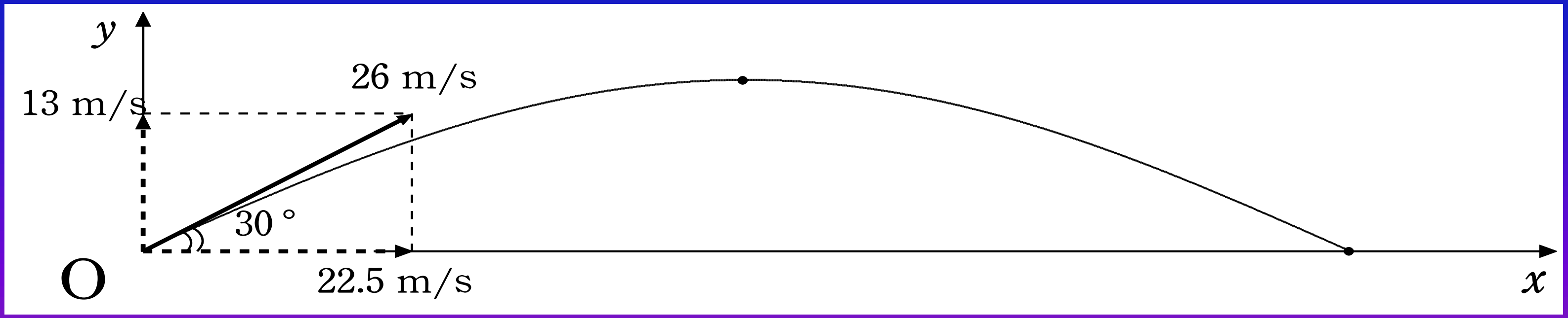
$d =$

$=$

Sample Problem – Human Cannonball

Herman the human cannonball is launched from level ground at an angle of 30º above the horizontal with an initial velocity of 26 m/s.

How far does Herman travel horizontally before reuniting with the ground?



Herman is launched from level ground at an angle of 30º above the horizontal with an initial velocity of 26 m/s. How far does Herman travel horizontally before reuniting with the ground?

$$\uparrow Vert$$

$$v_i =$$

$$v_f =$$

$$d = ?$$

$$a =$$

$$t_{up} = FIND$$

$$v_f = v_i + at$$

$$t = \frac{v_f - v_i}{a}$$

$$t =$$

$$t_{TOT} = 2t =$$

$$\rightarrow Horz$$

$$v_i =$$

$$v_f =$$

$$d = FIND$$

$$a =$$

$$t =$$

$$d = v_i t + \frac{1}{2} a t^2$$

$$d = \bar{v} t$$

$$d =$$