Goal for Immaculata Week

As a new member of CSI you will use your knowledge of physics to solve three crimes:

- ❑ Hotel Jumper: Homicide or Accident?
- ❑Mob Shooting
- ❑Road Rage

Goal for Immaculata Week

You will use your knowledge of the following physics topics to solve the crimes

- ❑ Measurements & Units
- ❑ Linear Motion
- ❑ Projectile Motion
- ❑ Newton's Laws
- ❑ Gravity

Review of SI Units

	International System of Units	British
Length	meter	foot
Mass	kilogram	slug
Time	second	second
Force	Newton	pound
Energy	Joule	foot-pound
Power	Watt	horsepower

THE CONVERSION OF UNITS

1 ft = 0.3048 m

1 mi = 5280 ft

1 mi = 1.609 km

1 hr = 3600 s

There are about 3 feet in a meter.

There are about 1 ½ miles in a kilometer

Sound travels about 1 mile in 5 seconds

Interstate Speed Limit

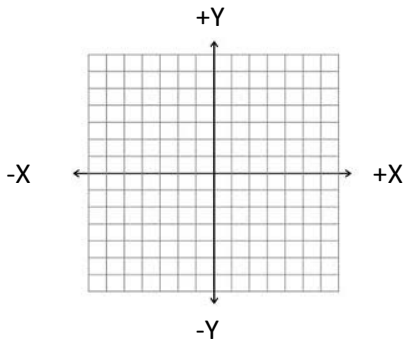
Express the speed limit of 65 miles/hour in terms of feet/second and then meters/second.

Use 5280 feet = 1 mile and 3600 seconds = 1 hour and 3.281 feet = 1 meter.

The muzzle speed of a bullet is 400 meters per second. How many miles per hour is that?

1 Mile = 1607 meters

Linear Motion in 2-Dimensions



Pract Prob 1

Average Speed and Velocity

Speed is how far an object travels in a given time interval:

$$\text{average speed} = \frac{\text{distance traveled}}{\text{time elapsed}}.$$

Velocity includes directional information:

$$\text{average velocity} = \frac{\text{displacement}}{\text{time elapsed}}.$$

Toward the East

First Important Equation:

x ⟶

Distance = velocity times time

$x = v\,t$

We have constant speed in x-direction

No acceleration

Constant Velocity

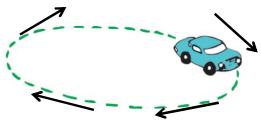
$x = v\,t$

Calculate the distance you will travel if you maintain an average speed of 10 m/s for 40 s.

Acceleration

Involves a

- change in speed, or
- change in direction, or
- both.



$$\text{average acceleration} = \frac{\text{change of velocity}}{\text{time elapsed}}.$$

Second Important Equation:

Acceleration = change in velocity divided by time

$$a = \Delta v / t = (v_f - v_i)/t$$

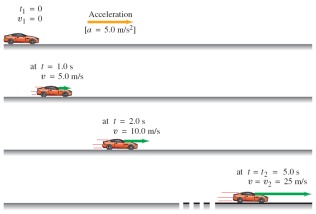
We have increasing speed in the x-direction

Units for acceleration: m/s^2

Acceleration

$$\text{average acceleration} = \frac{\text{change of velocity}}{\text{time elapsed}} = V_2 - V_1 \,/\, \text{time}$$

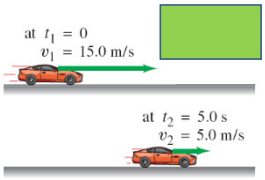
A police car begins to accelerate from rest to 90 km/h in 5.0 s. What is its acceleration in m/s²?



Acceleration Can Reduce Speed!

Car slowing down.

An automobile is moving to the right along a highway when the police car pulls up behind. Then the driver puts on the brakes. If the initial velocity (when the driver hits the brakes) is v_1 = 15.0 m/s, and it takes 5.0 s to slow down to v_2 = 5.0 m/s, what was the car's average acceleration?



One Type of Acceleration: Acceleration due to the Force of Gravity

Figure 4.12

Acceleration (Free Fall) to Gravity

Objects accelerate as they fall

$a = \Delta v / t$

$g = \Delta v / t$

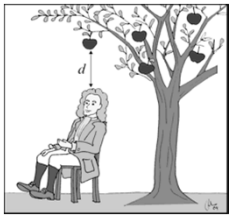
or

$\Delta v = g\ t$

$g = 9.8\ m/s^2$

Free Fall—How Fast?

An apple falls freely from a tree and accelerates for 1.5 seconds? At what velocity will it hit Newton's head?



Free Fall under Acceleration due to Gravity

Distance = ½ acceleration due to gravity X (time)²

$y = \frac{1}{2}\ g\ t^2$

$g = 9.8\ m/s^2$

Free Fall—How Far?

An apple falls freely from a tree. It hit Newton's head in 1.5 seconds. How far did the apple fall?

$y = \frac{1}{2} g t^2$
$y = \frac{1}{2} (9.8\ m/s^2)\ (1.5\ s)^2$
$y = 11$ meters

Free Fall
$y = \frac{1}{2} g t^2$

A skydiving dog steps from a high-flying helicopter. In the absence of air resistance, how far has she fallen at the end of a 12 second jump?

Important Physics Equations

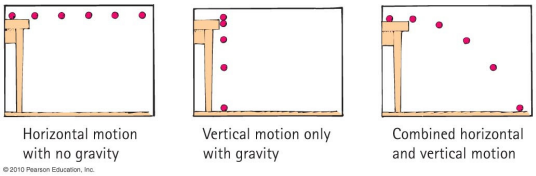
Velocity = Change in Distance /Time
$v = \Delta x/t$
Acceleration = Change in Velocity/ Time
$a = \Delta v/t$

With gravity:

Velocity = $v = g t$
Distance fallen: $y = \frac{1}{2} g t^2$

Figure 10.3

Superposition of Horizontal and Vertical Motion



Constant Velocity
$x = vt$

Free Fall
$y = \frac{1}{2} g t^2$

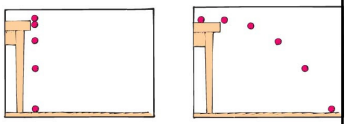
Projectile Motion

Figure 10.3

Use Information from one type of Motion to learn about the other

Constant Velocity
$x = vt$

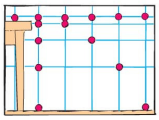
Free Fall
$y = \frac{1}{2} g t^2$



Both balls impact the floor at the same time when they start from the same height

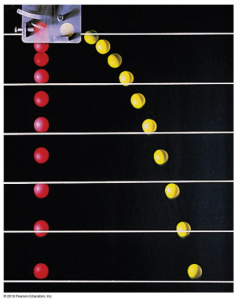
Figure 10.3

Use Information from one type of Motion to learn about the other



A ball with a horizontal speed of 1.25 m/s rolls off a bench 1.00 m above the floor. How long will it take to hit the floor?

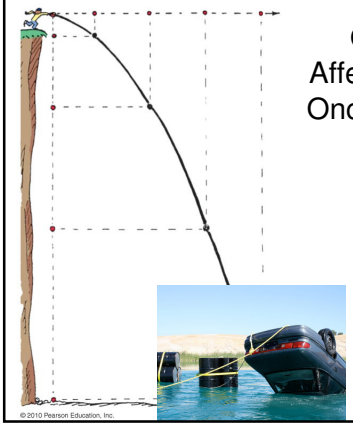
How far from the bench will it land?



Velocity of ball in Y-direction is changing due to gravity

Each motion is independent of the other

Velocity of ball in X-direction is constant



Only Gravity Affects a Projectile Once It Leaves the Ground

Crime Scene #1 Hotel Jumper
Homicide or Accident

Crime Scene #2
Mob Shooting?

Crime Scene #3
Road Rage