Chapter 9: Momentum

9.1
Impulse and Momentum

Example: Golf Ball is a projected. What factors are important in the collision between club and ball?

Momentum

Momentum = _____

- Momentum is _____.
- Momentum is a _____, the _____ is the same as the _____.

Newton's 2nd Law Rearranged:

In football, the defensive player applies a force for a given amount of time to stop the momentum of the offensive player with the ball.

Impulse – Momentum Theorem

- The impulse on an object _____ _____ is equal to the _____ that it causes.

- Cause –and –effect relationship: _____ is the cause and a _____ is the effect.

Impulse

- Direction of impulse is in the _____ _____.
- For _____ impulses, there can be a _____:
  - _____ force acting over a _____ time.
  - _____ force acting over a _____time.

Impulse Examples

Impulse Examples

https://www.youtube.com/watch?v=s6QR0KdyTFY

Units

Momentum = Mass x Velocity

=

Impulse = Force x Time

=

EX:

A 50 g golf ball on a tee is hit by a 500 g golf club. After the collision, the golf ball leaves with a velocity of 50 m/s.

a) Find the impulse imparted to the ball.

b) If the club is in contact with the ball for 0.5 ms, find the average force acting on the golf ball.

Example:

- An 2200 kg SUV traveling at 26 m/s can be stopped in 21 s by gently applying the brakes or in .22s if it hits a concrete wall. What is the average force exerted on the SUV in each case?

9.2 Momentum on Collisions

- When two objects collide, they exert _____ on each other _____
- These forces are applied _____.
- Meaning:
  - The _____ imparted by both balls are _____.
  - The _____ for each object is _____.
  - The momentum _____ by one object is equal to the momentum _____ by the other object.

Conservation of Momentum Proof:

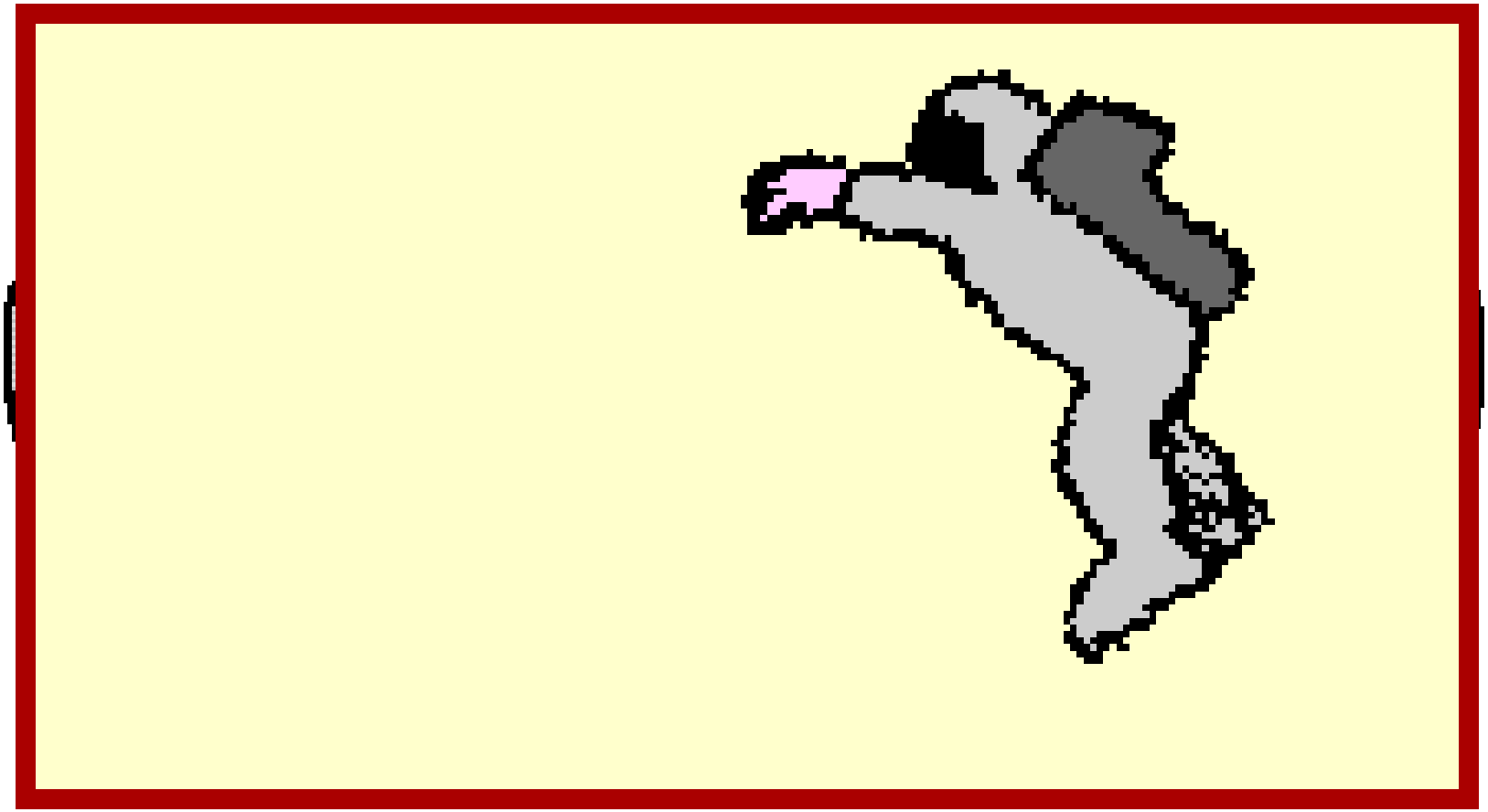
Law of Conservation of Momentum:

For a collision occurring between two objects, the _____ of the two objects is _____ to the _____of the two objects.

$$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$$

http://www.youtube.com/watch?v=4IYDb6K5UF8

Astronaut Catch



Conditions for Conservation of Momentum

1) _____ system – a system that does not _____.

2) Isolated system – when the _____ _____ on a closed system is _____.

* Meaning the only forces involved are _____. No forces are acting on the system by objects _____.

A 35.0-g bullet moving at 475 m/s strikes a 2.5-kg wooden block. The bullet passes through the block, leaving at 275 m/s. The block was at rest when it was hit. How fast is it moving when the bullet leaves?

A 75-kg fullback moving eastward with a speed of 8 m/s collides head-on with a 100-kg lineman moving westward with a speed of 4 m/s. The two players collide and *stick together*. Determine their velocities after.

Initial Momentum of Zero

- When two objects are at rest before a force is applied between them, there _____ _____:

- EX: Shooting a gun.
- EX: Two people on ice pushing each other.
- http://www.youtube.com/watch?v=KL8-PbdRYY0

EX:

An astronaut at rest in space fires a thruster pistol that expels 35 g of hot gas at 875 m/s. The combined mass of the astronaut and the pistol is 84 kg. How fast and in what direction is the astronaut moving after firing the pistol?

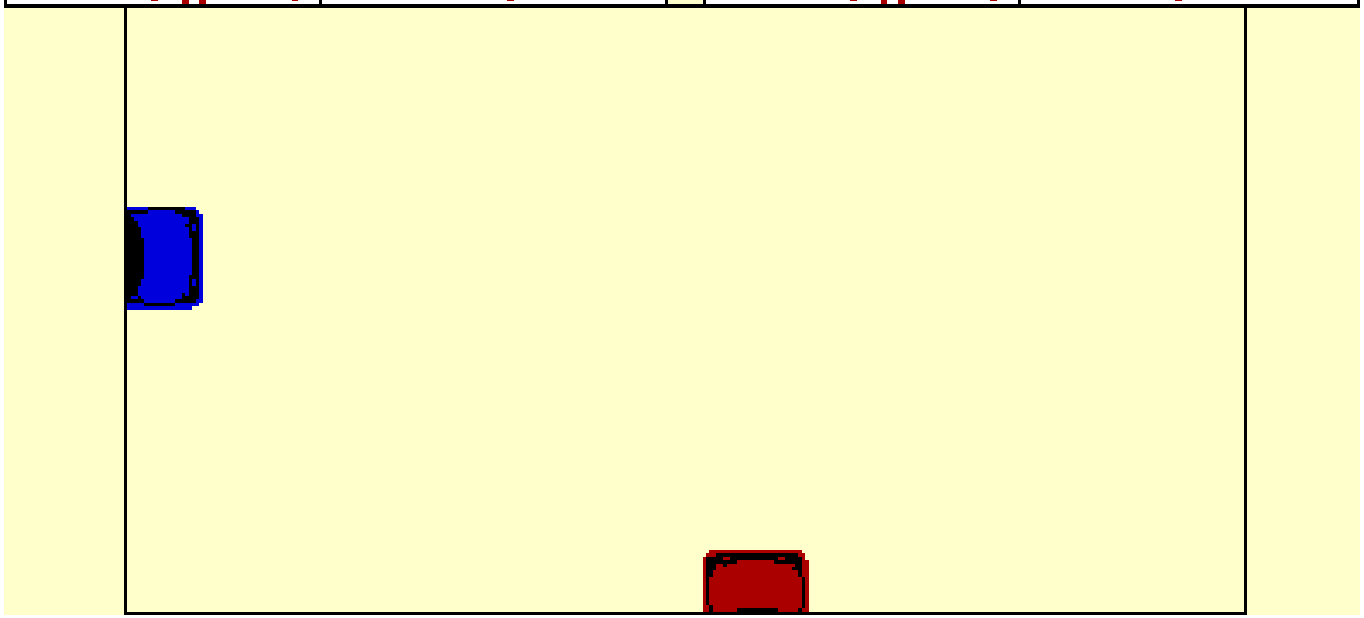
Two-Dimensional Collisions

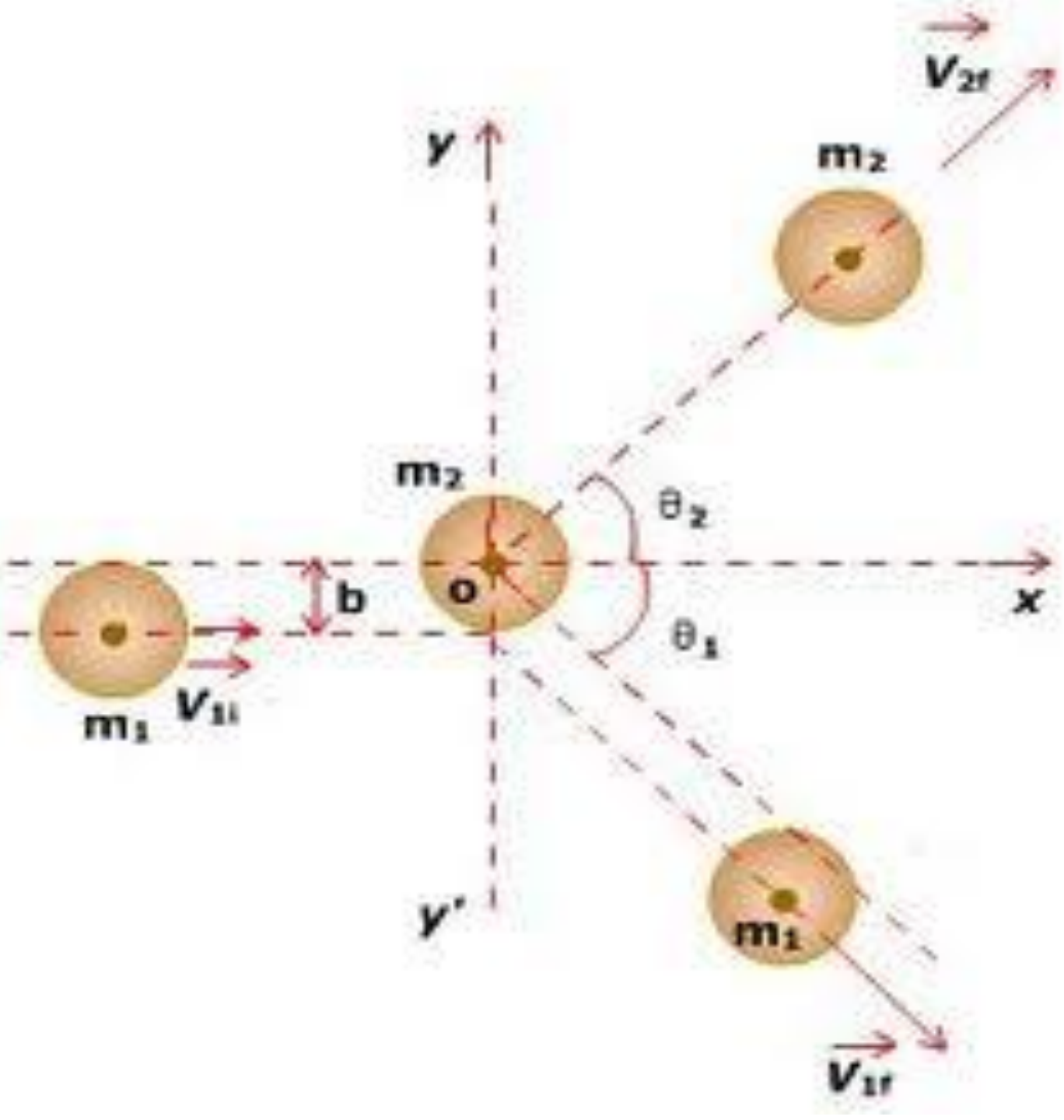
- Law of _____ still holds for two-dimensional collisions as long as it is a _____ system.
- The momentum vectors must be broken up into components:
  - The _____ of the _____ x-components must equal the _____ of the _____ x-components.
  - The _____ of the _____ y-components must equal the _____ of the _____ y-components

Two-Dimensional Collisions

Blue Car	
mass (kg)	1000
vel. (m/s)	20.0, East
mom. (kg m/s)	20 000, East

Red Car	
mass (kg)	1000
vel. (m/s)	10.0, North
mom. (kg m/s)	10 000, North



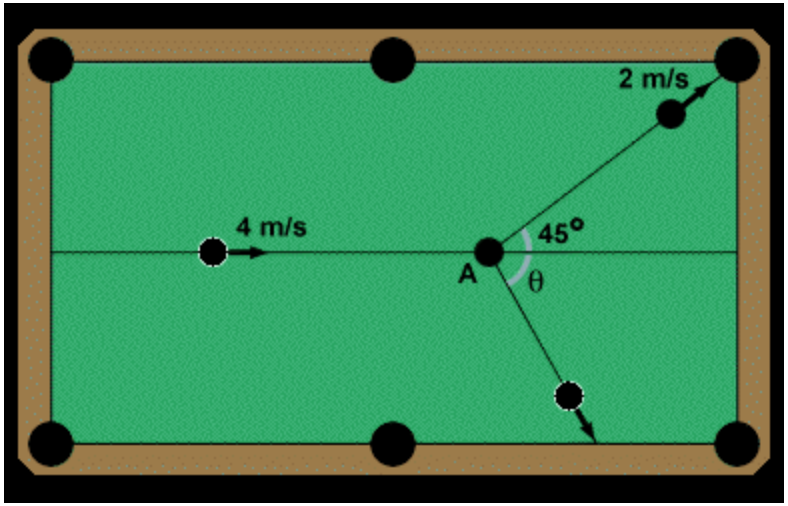

$\vec{V}_{2f}$
y
m_2
m_2
θ_2
b
o
x
θ_1
m_1
$\vec{V}_{1i}$
y'
m_1
$\vec{V}_{1f}$

EX:

A 975 kg car moving south at 22.5 m/s collides with a 2165 kg truck moving west at 17.5 m/s. They stick together. In what direction and with what speed do they move after the collision?

EX:

A common pool shot involves hitting a ball into a pocket from an angle. In the picture, the cue ball hits a stationary ball at an angle of 45^{o}, such that it goes into the corner pocket with a speed of 2 m/s. Both balls have a mass of 0.5 kg, and the cue ball is traveling at 4 m/s before the collision. Calculate the angle with which the cue is deflected by the collision.


2 m/s
4 m/s
45°
A
θ