# Recoil & Propulsion



#### Recoil

#### Action/Reaction principle applies to recoil.

The action force that accelerates the bullet results in a matched reaction force in opposite direction, recoiling the gun.



Recoil Speed = (Bullet/Gun Weight Ratio) x (Bullet Speed)

#### Recoil from a Gun

#### High recoil speed is cause by either: \* Large Bullet/Gun Weight Ratio \* High Bullet Speed



Shooting an elephant gun

http://www.youtube.com/watch?v=FWxYM\_dVD-c

### Recoil & Wile E. Coyote



Unexpected recoil is another common gag in animated cartoons.

http://www.youtube.com/watch?v=7H6Pwzdw7oQ



Guided Muscle (1955)

#### Wall-E, Propelled

based on using recoil, alar taiter ) as when Wall-E uses a fire extinguisher.

**Rocket propulsion is** 

#### Fire Extinguisher Bike

## Fire Extinguisher on a Tricycle MIT Department of Physics Technical Services Group

#### **Balanced Forces**

A pair of forces balance each other when they are:

- Equal in Magnitude
- Opposite in Direction
- Act on the Same Object

Downward force of gravity is balanced by the upward pull of the rope's tension. Both forces are *on the sack*.



#### **Action / Reaction Pairs**

The two forces of an Action / Reaction pair NEVER balance each other because they always act on different objects or characters!



#### **Forces & Propulsion**

Miss A pushes the cart (action); cart pushes back on her (reaction). Do these forces cancel?

No, the two forces act on different objects.

- Force on Miss A is to the left; how can she move forward (to the right)?
- Miss A pushes back on the ground with her feet (action) reaction of ground on her is to the right.
- What if ground had zero friction (like ice)?

Then Miss A can't move forward.



#### **Internal Propulsion**

Mr. B also pushes from the inside of cart but obviously he can't move the cart alone. In terms of Newton's laws, why not? Because the *total* force exerted by Mr. B on the cart is zero.

What other force does Mr. B exert on the cart besides his hands? His butt pushes back on the cart and the floor of the cart pushes back on him.

The two action forces balance each other and the two reaction forces balance each other.



## Wile E., Propelled (Part 1)



Would using an outboard motor in a tub for propulsion, as done by Wile E. Coyote, actually work?

#### **Internal Propulsion**

No. Internal propulsion is not possible because the impulse from one force is balanced due to another internal action force.





## Wile E., Propelled (Part 2)



Would using a strong fan and a big sail for propulsion, as done by Wile E. Coyote, actually work?

#### **Internal Propulsion**

No. Internal propulsion is not possible because the impulse from one force is balanced due to another internal action force.

Propeller

**Action/Reaction Pairs** 

pushes air

air

Air pushes

propeller



sail

#### Fan Cart

http://www.youtube.com/watch?v=KKLmAYiyd3M



#### Summary

- Principle of Action / Reaction explains recoil.
- Recoil is the basis for rocket propulsion.
- The two forces of an Action / Reaction pair NEVER balance each other because they always act on different objects or characters!
- Internal propulsion doesn't work because there are *two* Action / Reaction pairs; each force in the first pair is balanced by a force in the other Action / Reaction pair.