

Newton's second law of motion: A force will cause an object to accelerate in the direction of the force.

FORMULA:

$$F = m \times a$$

$$m = 10 \text{ kg}$$

$$F = 100 \text{ N}$$

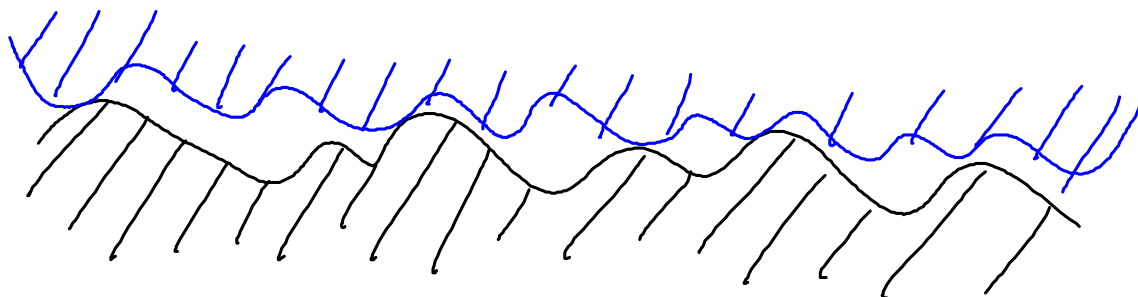
$$a = ?$$

$$\frac{(100 \text{ N})}{10 \text{ kg}} = \frac{(10 \text{ kg}) * a}{10 \text{ kg}}$$

$$10 \frac{\text{N}}{\text{kg}} = a = 10 \frac{\text{m}}{\text{s}^2} = 10 \frac{\text{m}}{\text{s}^2}$$

Friction: a force that opposes motion between two objects that are touching.

FRICION IS A STOPPING FORCE



Static Friction: The force needed to start an object moving.

MORE FORCE

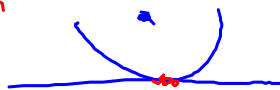
OBJECT ISN'T MOVING

Sliding Friction: The force needed to keep an object moving.

LESS FORCE

OBJECT IS MOVING

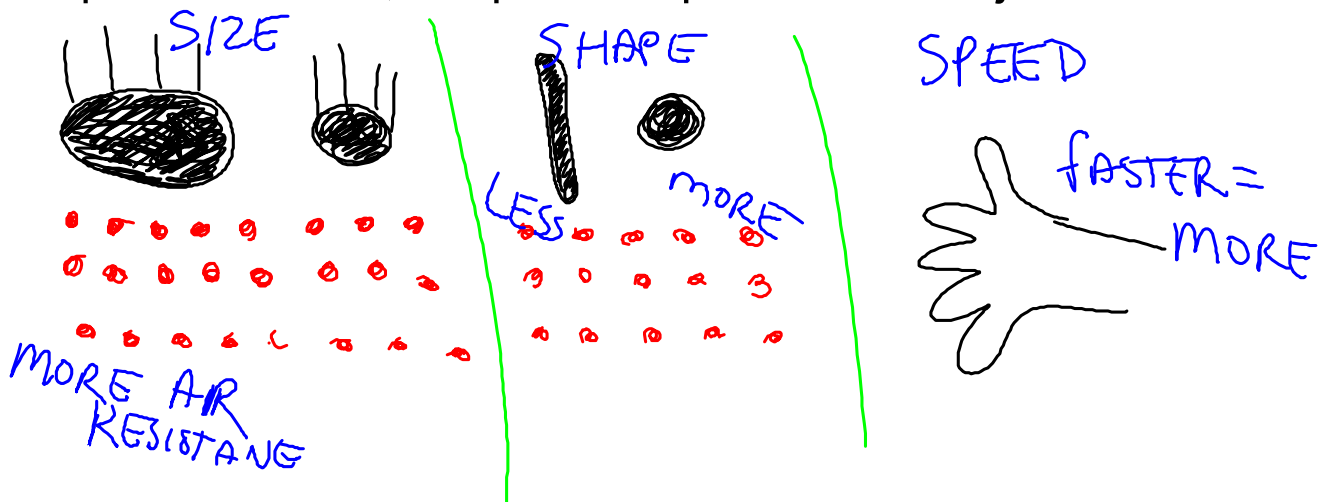
Rolling Friction: Similar to sliding, but less.



OBJECT IS MOVING

Air Resistance: The force air exerts on a moving object.

Depends on size, shape and speed of the object.



GRAVITY - ATTRACTIVE FORCE  
BETWEEN TWO OBJECTS  
DEPENDS ON MASSES  
AND DISTANCE BETWEEN  
OBJECTS.

## GRAVITY FORMULA

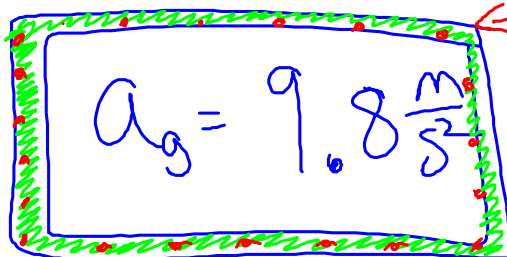
$$F_g = \frac{G m_1 m_2}{d^2}$$

GRAVITY CONSTANT  
MASS OBJECT 1  
MASS OBJECT 2  
DISTANCE  
FORCE OF GRAVITY

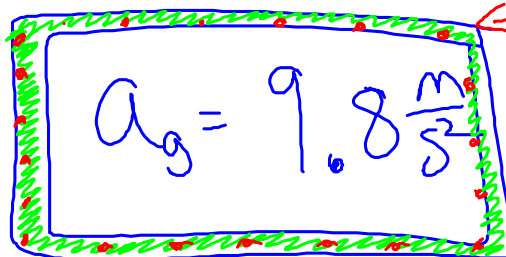
$$G = 6.67 \times 10^{-11}$$

SIMPLE FORMULA  
FOR GRAVITY (ON EARTH)

$$F_g = m \cdot a_g$$



SIMPLE FORMULA  
FOR GRAVITY (ON EARTH)


$$a_g = 9.8 \frac{\text{m}}{\text{s}^2}$$

$$F_g = m \cdot a_g$$
$$F_g = (45 \text{ kg}) (9.8 \frac{\text{m}}{\text{s}^2})$$
$$F_g = 441 \text{ N} = 441 \frac{\text{kgm}}{\text{s}^2}$$



Video: Hammer and Feather on Moon

Video: Walking on the Moon

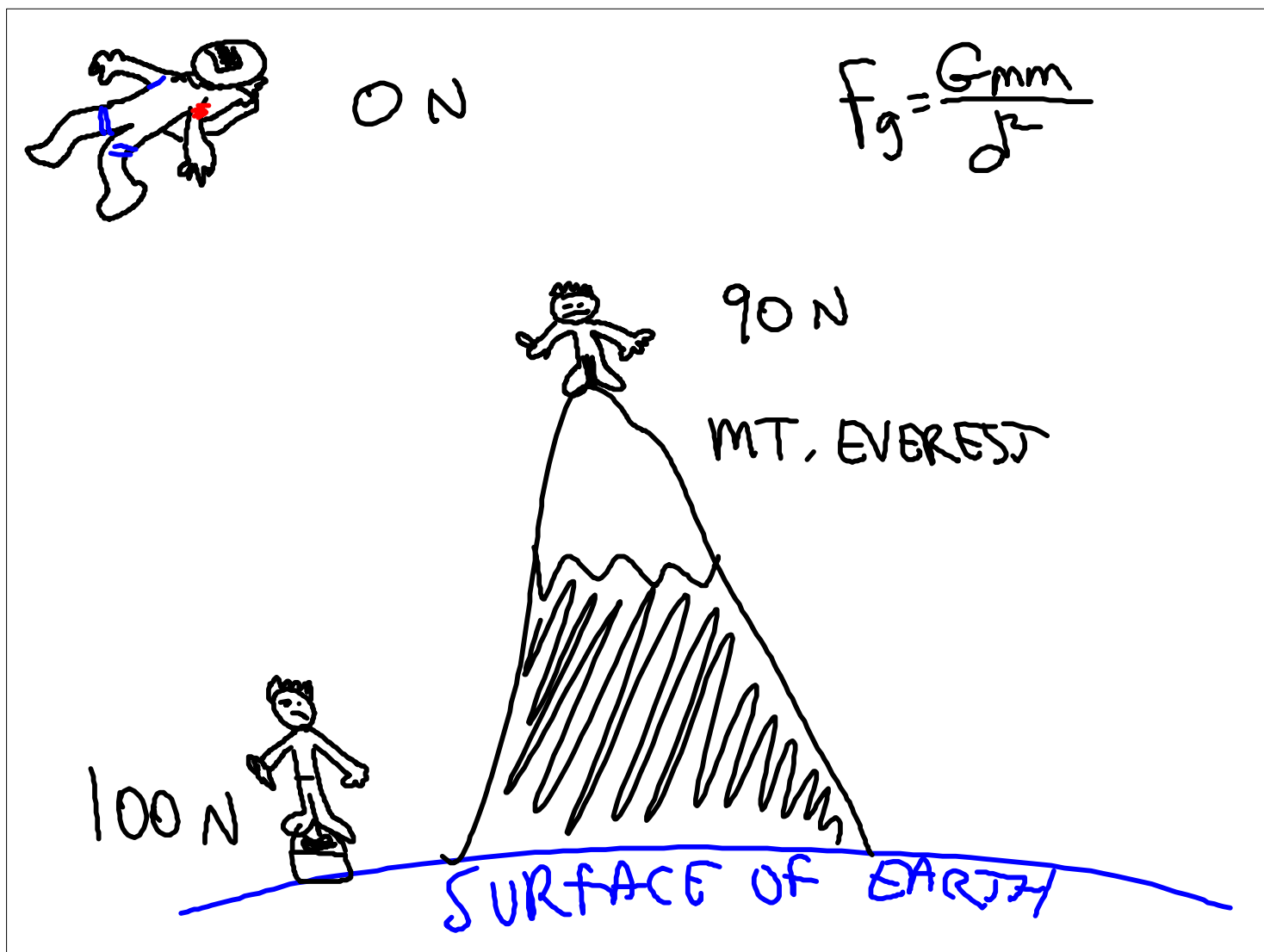


GRAVITY IS LESS.

WEIGHT IS  $\frac{1}{6}$  OF EARTH



GRAVITY IS GREATER




$T=0$   
 $S=0 \frac{m}{s}$

$t=1s$   
 $S=9.8 \frac{m}{s}$

$t=2s$   
 $S=19.6 \frac{m}{s}$

$t=3s$   
 $S=29.4 \frac{m}{s}$



The diagram illustrates the motion of a falling person. On the left, a person is shown at the edge of a ledge, with a red arrow pointing downwards labeled '441 N', representing the force of gravity. To the right, a stick figure is shown in mid-air, representing the person's position at a later time.



Terminal Velocity: The fastest speed reached by a falling object. Gravity equals Air resistance.



BALANCED FORCES  
NO NET FORCE  
NO ACCELERATION  
CONSTANT SPEED

Terminal velocity without a parachute is much greater than terminal velocity WITH a parachute.



Video: Skydiving



Freefall give a **FEELING** of weightlessness.



Video: Group of Skydivers



Video: Car skydive

Astronauts FEEL in space weightlessness because they are constantly falling.



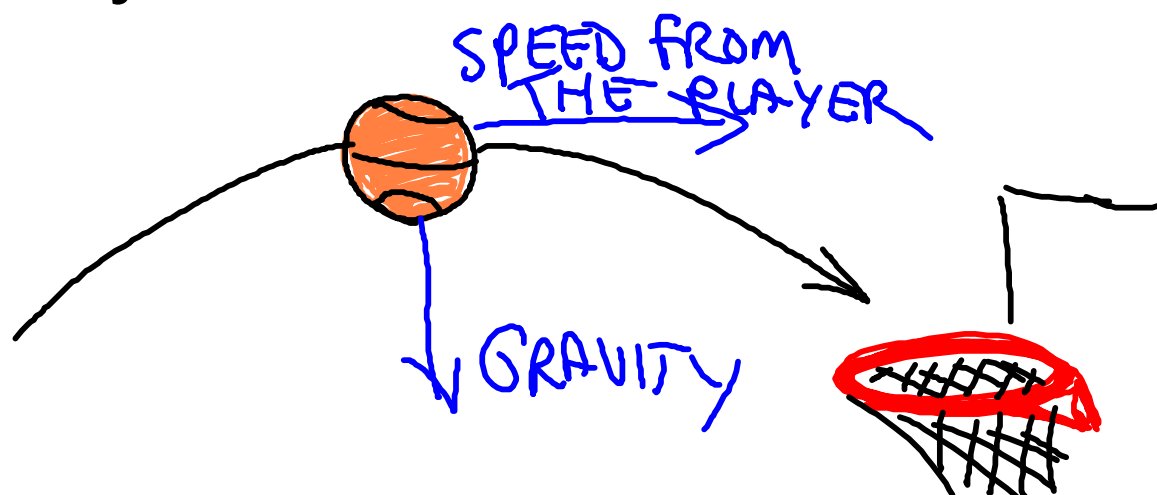
Projectile Motion: A projectile is anything that is thrown or shot through the air.

Baseball, rock, bullet, arrow, spear, etc.

PROJECTILES FOLLOW A  
CURVED PATH

Projectiles move in TWO (2) directions.

They move horizontally and vertically.



## Horizontal Motion



Projectiles are pushed sideways and then continue moving sideways at this constant velocity (remember Newton's 1st law).



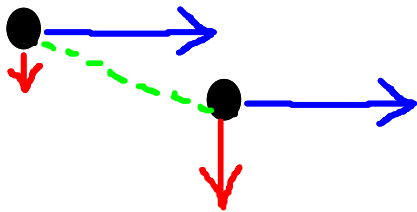
## Vertical Motion

Vertically, the projectile is falling due to gravity. Gravity will accelerate the projectile at  $9.8 \text{ m/s}^2$ .

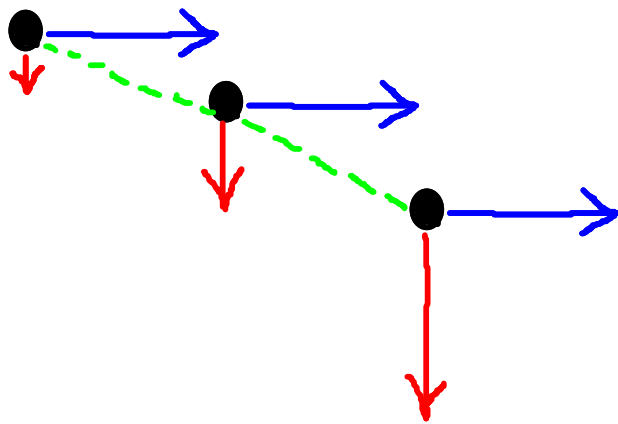
Projectiles follow a curved path.



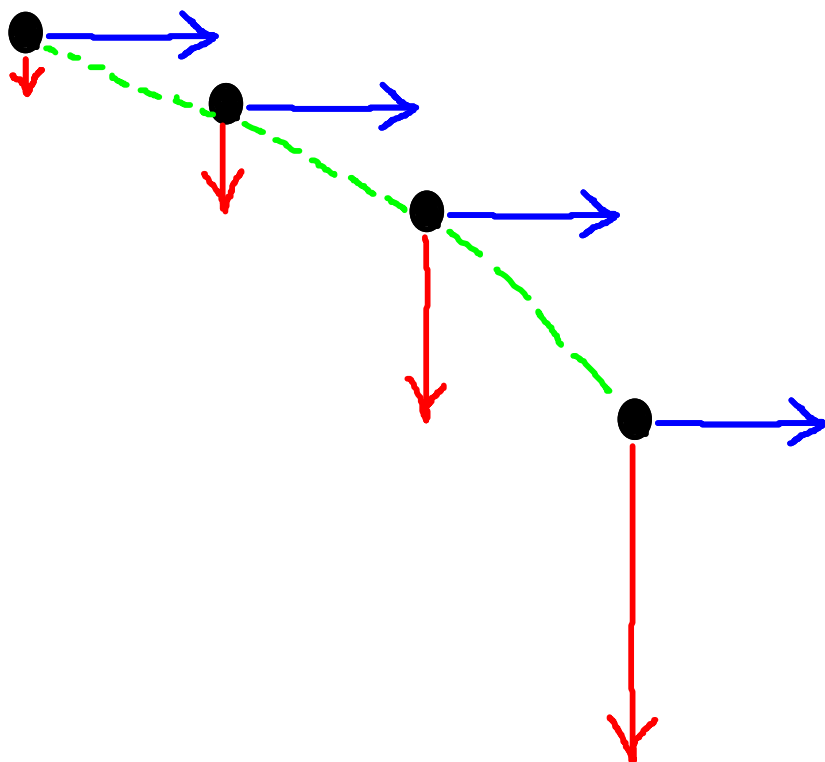
Projectiles follow a curved path.



Projectiles follow a curved path.

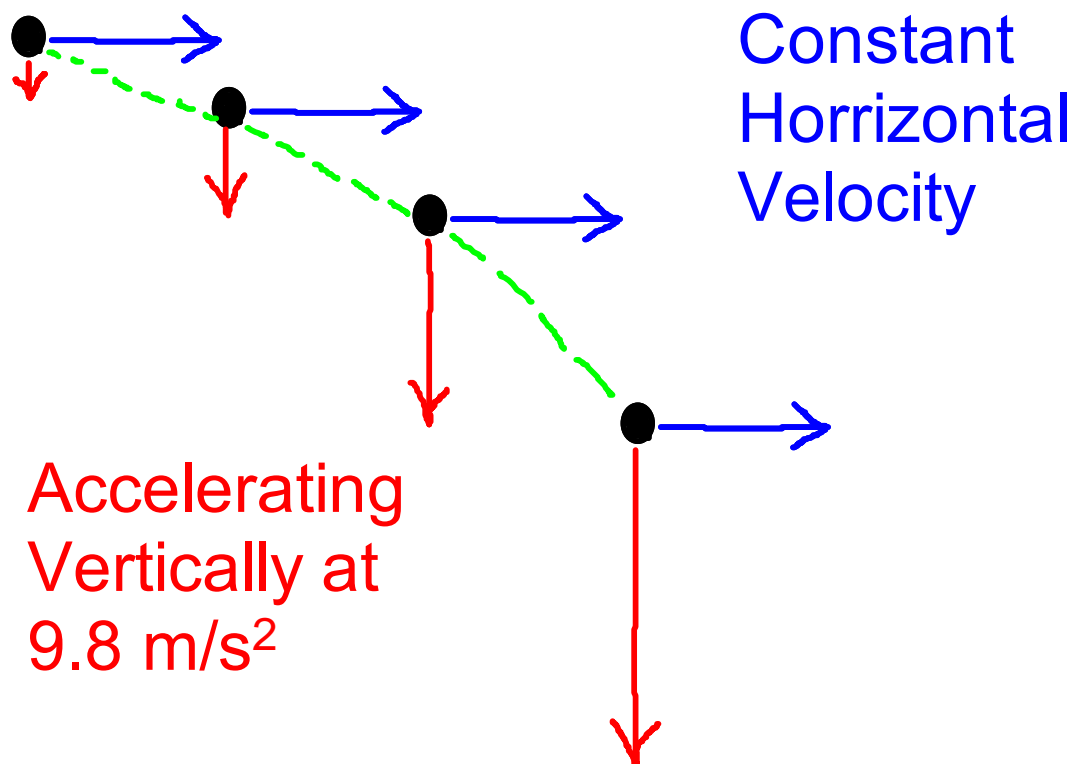


Projectiles follow a curved path.





# Projectiles follow a curved path.

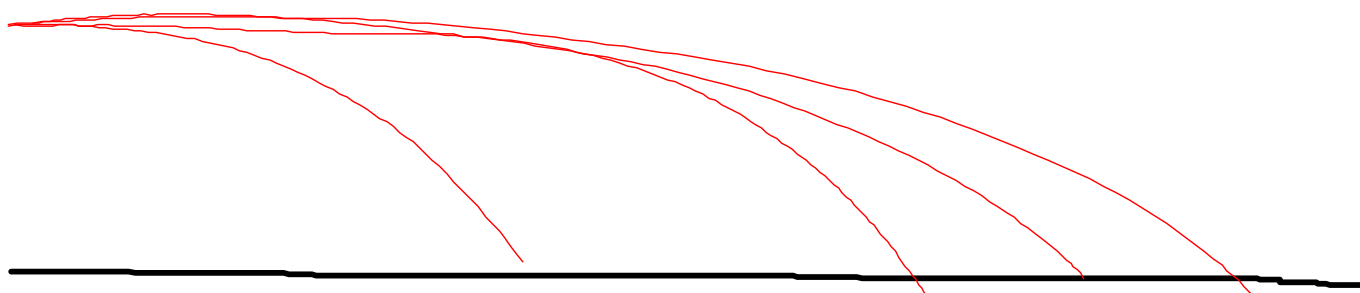




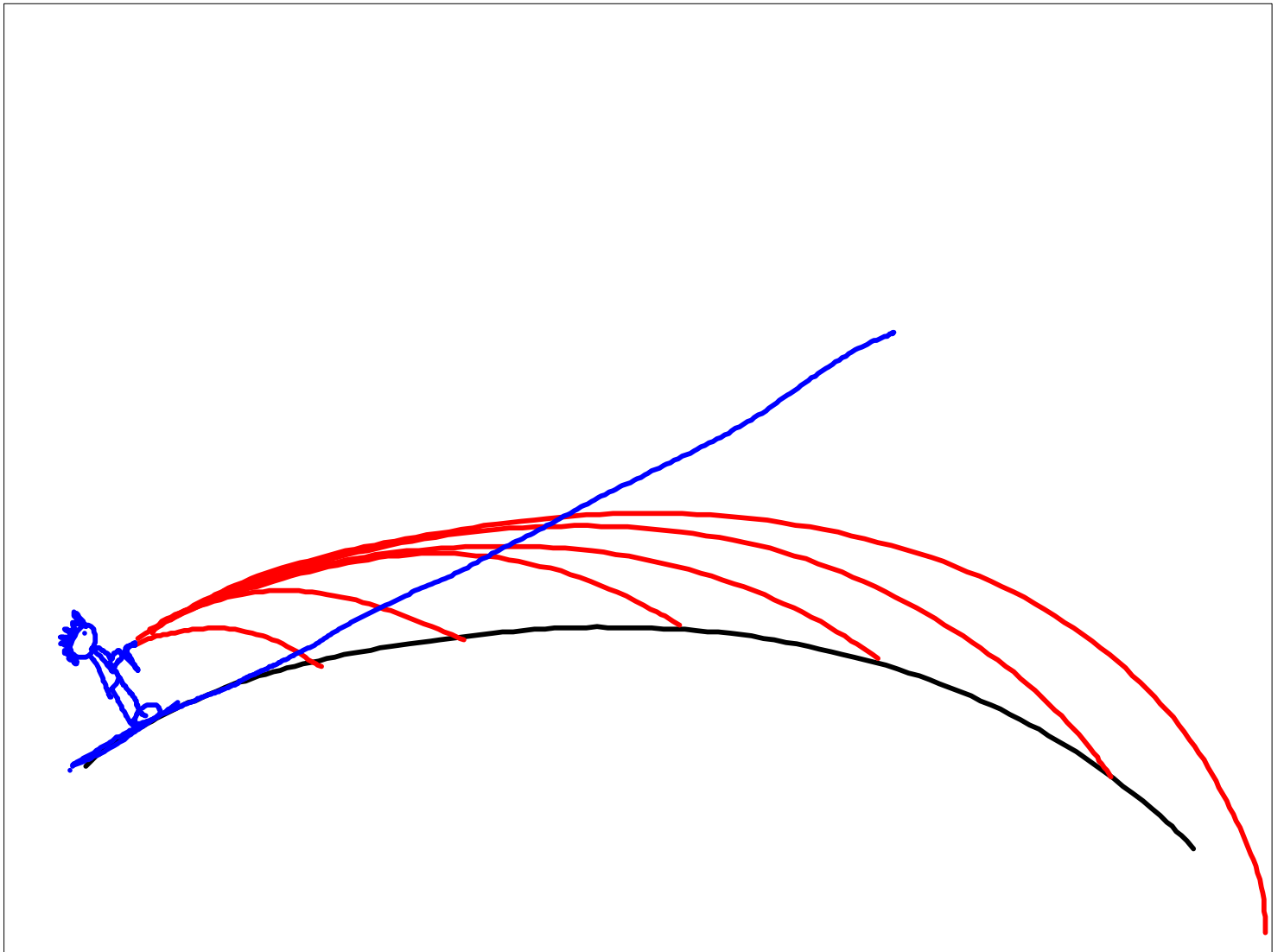
# Shoot the Monkey

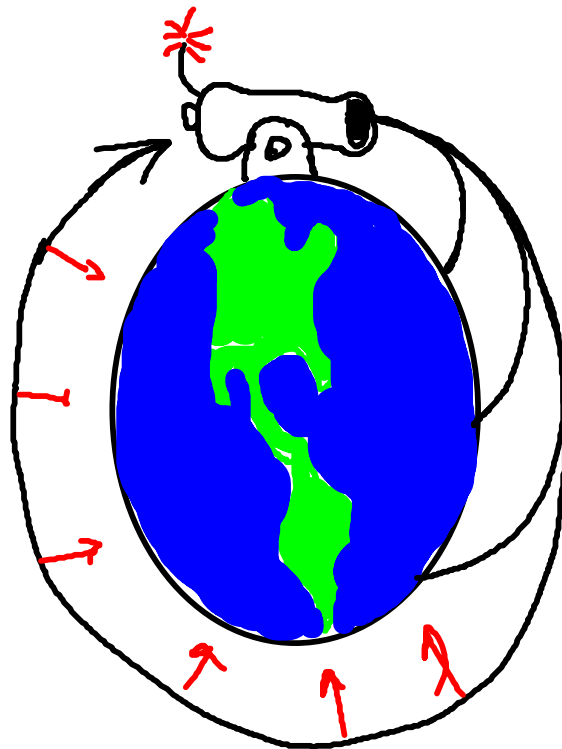


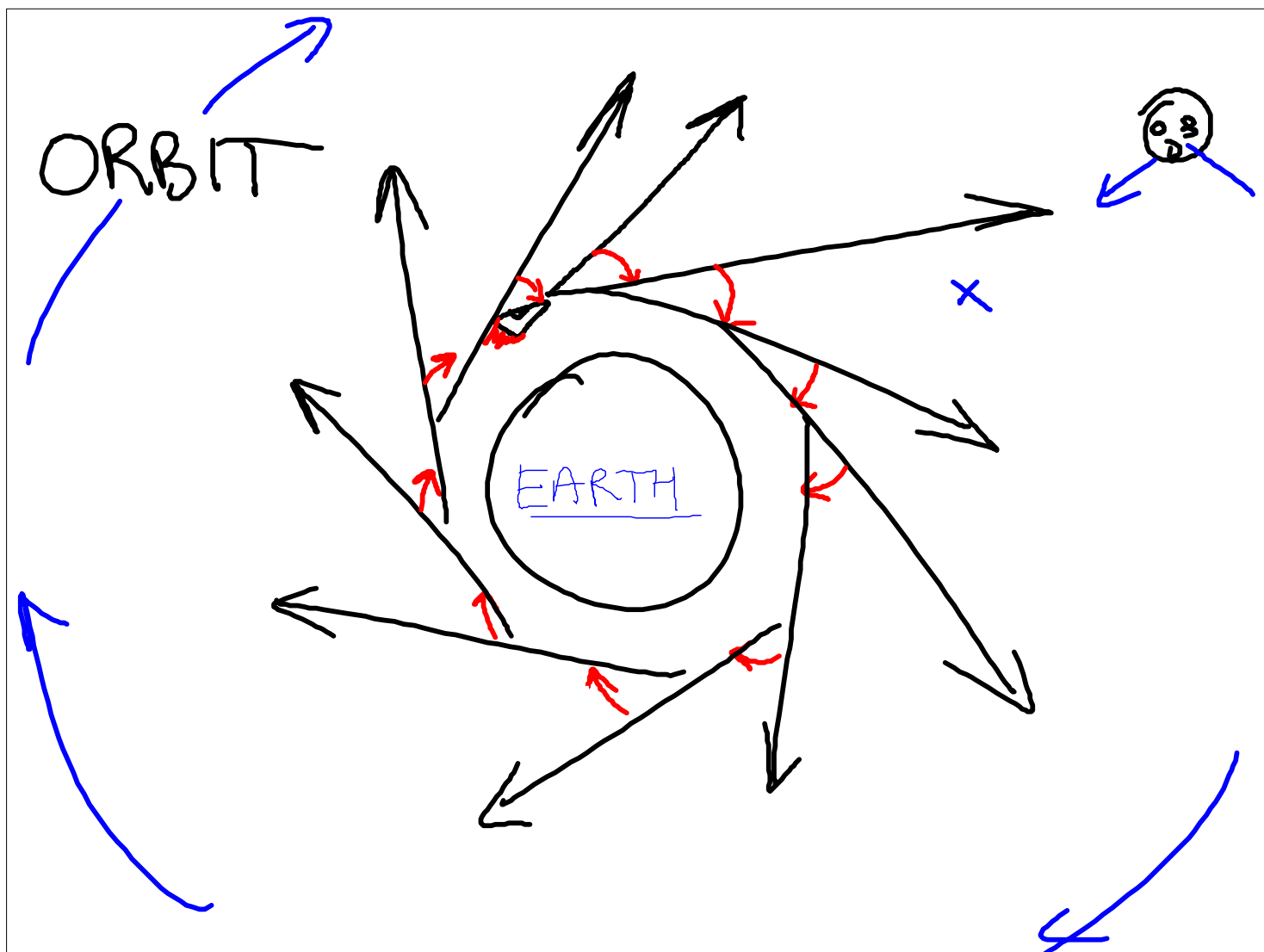
All Objects follow this curved path.

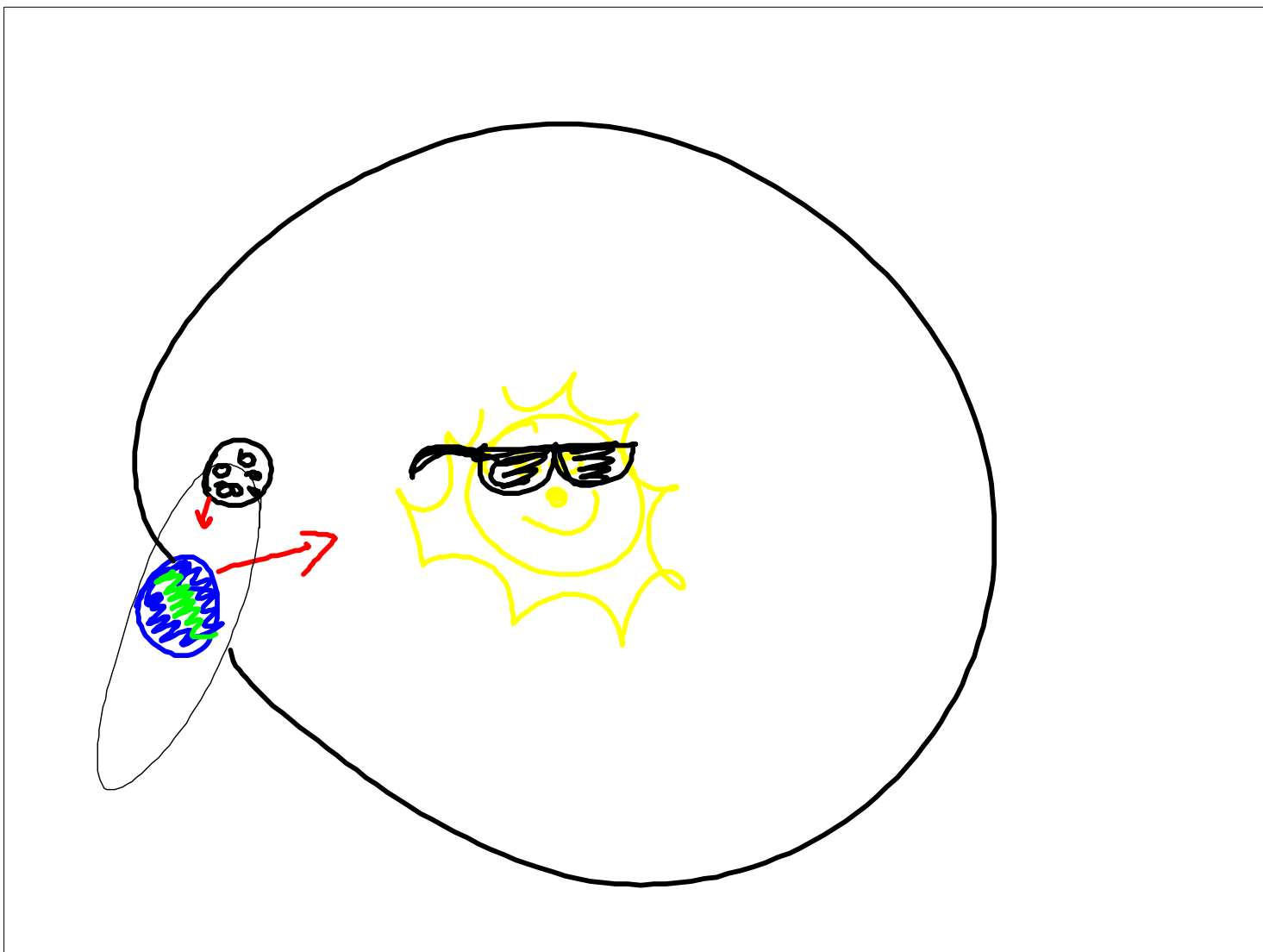


Imagine shooting a bullet so fast that it never hit the ground.











CENTRIPETAL FORCE - FORCE THAT

KEEPS MOVING OBJECTS  
IN A CIRCULAR PATH

- THINGS IN ORBIT - GRAVITY
- CARS - FRICTION
- ROLLER COASTER - TRACK

Links:

MIT Shoot Monkey

[http://www.youtube.com/watch?](http://www.youtube.com/watch?v=cxvsHNRXLjw)

[v=cxvsHNRXLjw](http://www.youtube.com/watch?v=cxvsHNRXLjw)

Aim: Define Newton's Third Law of Motion.

Do Now: Define Newton's first and second laws.

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Newton's First Law of Motion:

Newton's Second Law of Motion:

Aim: Define Newton's Third Law of Motion.

Do Now: Define Newton's first and second laws.

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Newton's First Law of Motion: **Objects moving with constant velocity continue at that velocity unless a force acts.**

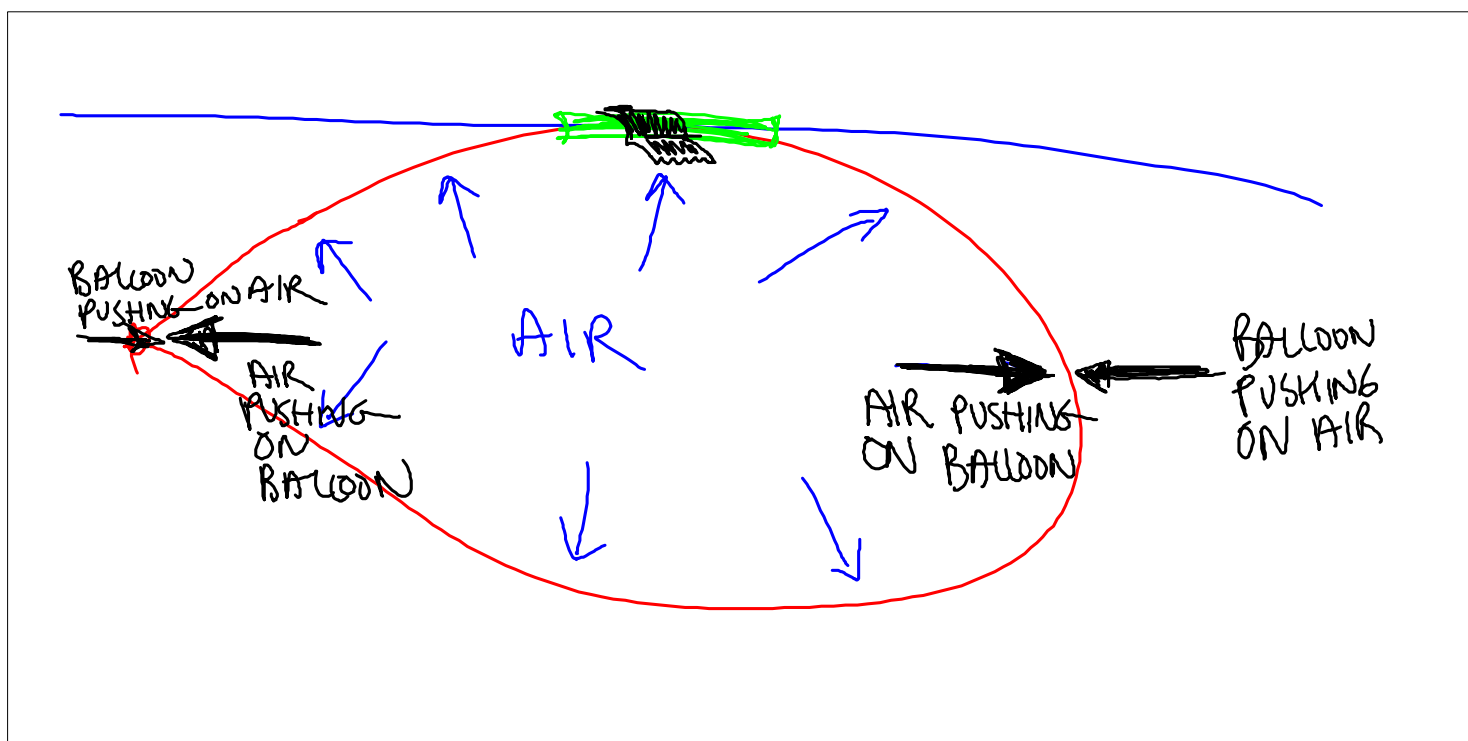
Newton's Second Law of Motion: **A force causes an object to accelerate in the direction of the force.**

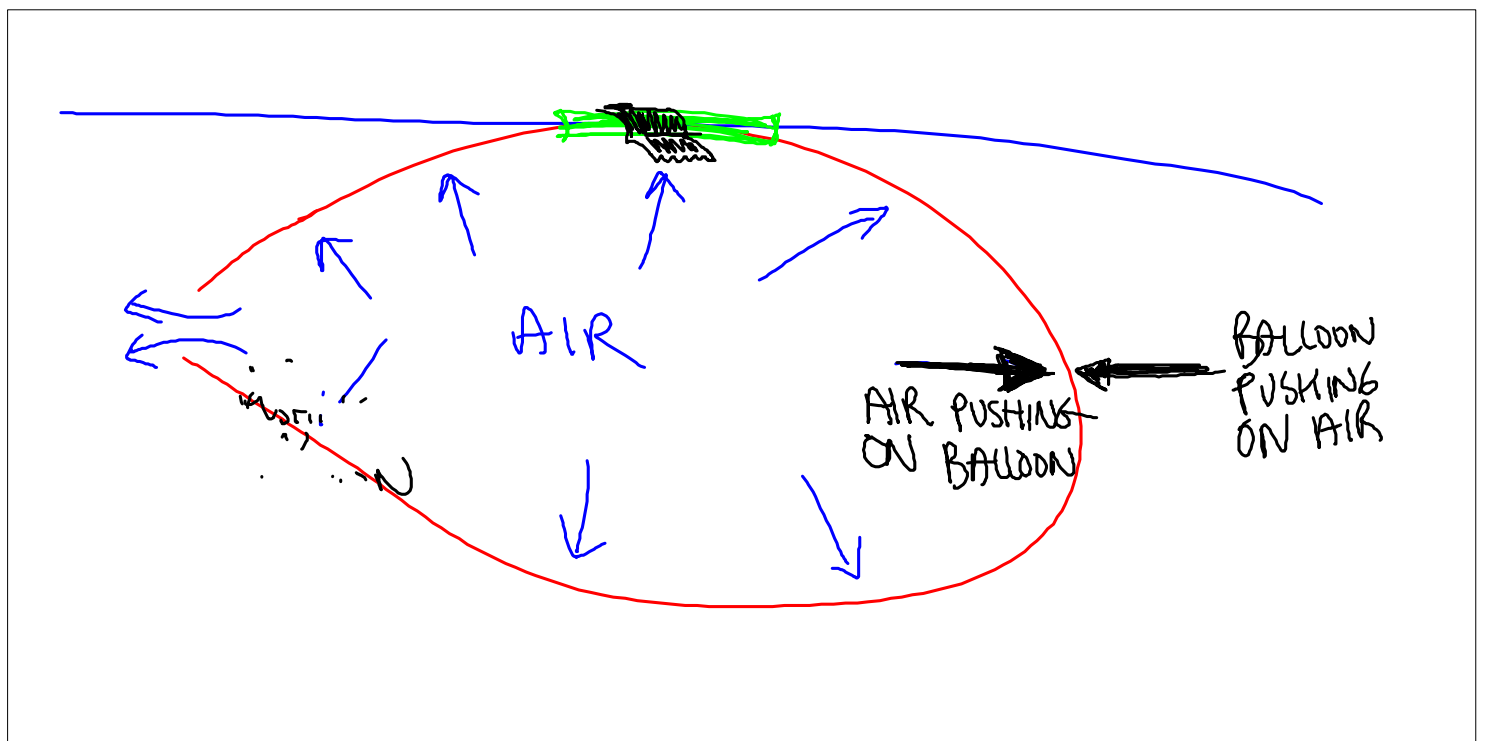
Newton's Third Law of Motion: When **one object** exerts a force on **second object**, the **second** object exerts an equal and opposite force on the **first**.

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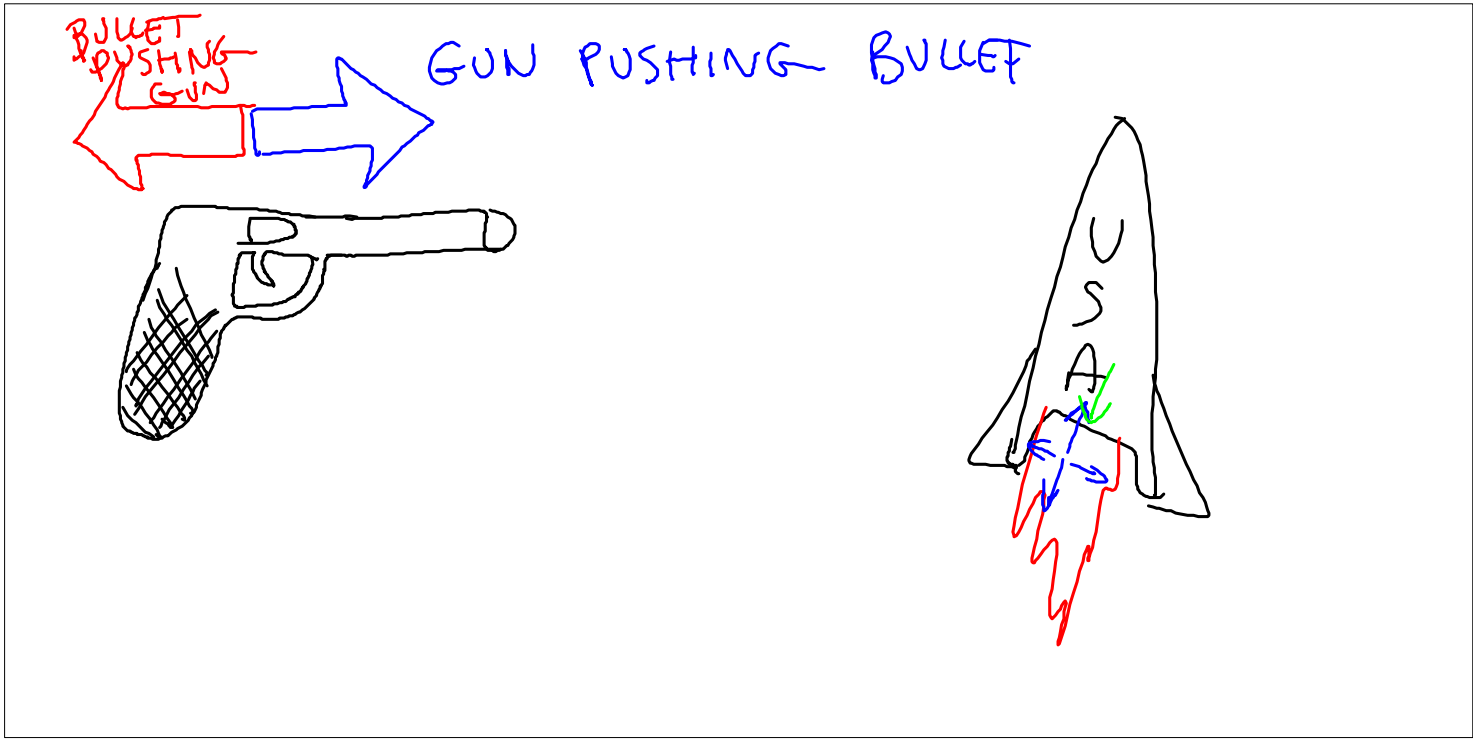
ACTION - REACTION PAIRS











Momentum: A property an object has because of its mass and velocity. It is related to how much force is needed to change its motion.

$$p = m \times v$$

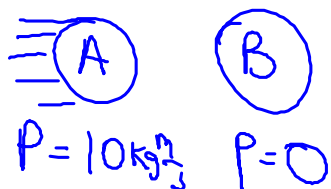
$$p = 10 \text{ kg} \times 5 \frac{\text{m}}{\text{s}}$$

$$p = 50 \frac{\text{kg} \cdot \text{m}}{\text{s}}$$

Law of conservation of momentum: The total momentum of all objects doesn't change.

WHEN 2 OBJECTS COLLIDE THEY TRANSFER MOMENTUM

BEFORE



AFTER

