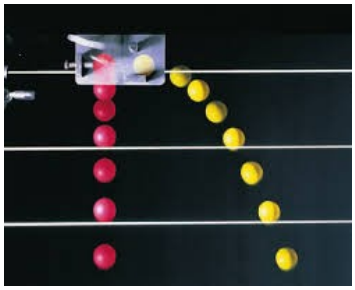
Gravity and Projectiles

- A **projectile** is an object that is both flying forward and falling, with only gravity pulling on it
- **Time of flight:** how long the projectile flies before hitting the ground.
- **Projectile range:** how far the projectile goes horizontally before hitting ground.



Part 1: Rate of Fall

Let's consider the rate of fall of different objects.

1. Compare a Lego piece and a stone by holding them in your hands.
The stone is: heavier lighter about the same

Which of the objects feels a stronger force of gravity?
Stone Lego they feel about the same pull of gravity

Recall that objects with more mass have more inertia. They need a bigger force to change their motion.

Which of the objects has more inertia? Stone Lego about the same

2. Make a prediction.
If we drop the Lego and stone simultaneously, which one will fall faster and will hit the ground first?
Stone Lego they will hit the ground at about the same time

3. Test your prediction. Have an adult (or kid standing on a chair) simultaneously drop the Lego and the stone. Have the kids crouch down near the ground to observe.
Which hit the ground first?
Stone Lego they hit the ground at about the same time

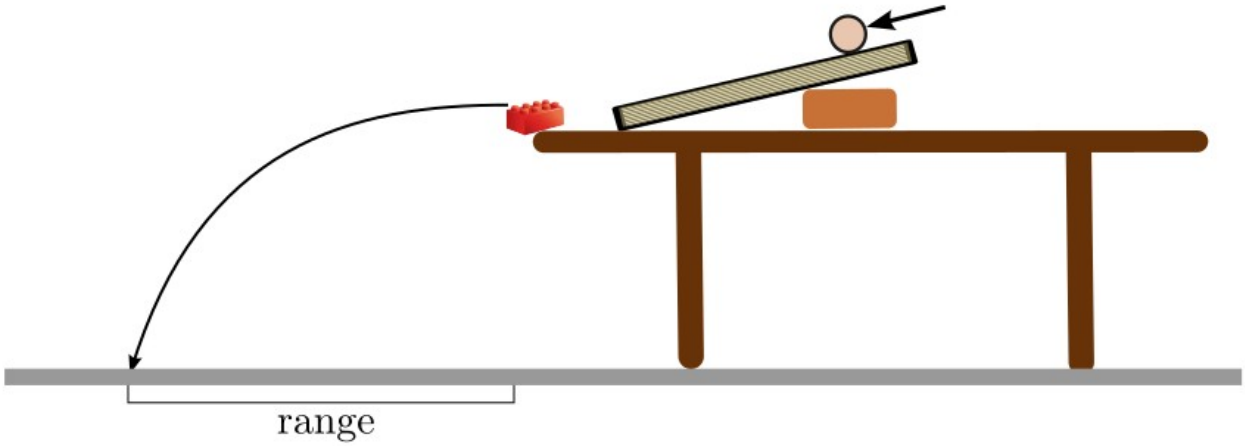
Discuss: using what you know about forces, weight, and inertia, can you explain your observation?
Can you write a sentence describing a general rule for the rate of fall for freely falling objects?

_____

_____

Part 2: Projectiles

A projectile is an object that is both falling (under the pull of gravity) and moving forward with no other forces acting on it (except air resistance). A basketball (after it is thrown) and a cannon-ball (after it is shot) are both projectiles.



1. Use a book with a block beneath one end to make a ramp near an edge of the table.

2. Place a Lego block and a stone near each other, as close as possible to the edge of the table. You will roll a cylinder down the ramp, hitting the Lego and stone, which will fly off the table as projectiles.

3. Make some predictions.
The **time of flight** is the time until the projectiles first hit the ground.
Which do you think will have the longest time of flight?

Stone Lego both will have a similar time of flight

The **range** of a projectile is how far it goes horizontally before hitting the ground.
Which do you think will have the longest range?

Stone Lego both will fly a similar distance

4. To test your hypotheses, designate one child to release the cylinder, and the others to watch near the landing spots. Do a few trials to make sure you always see approximately the same outcome

Which has the longest time of flight?
Stone Lego approximately the same

Which landed farthest from the table (longest range)?
Stone Lego approximately the same

If you're not sure, you may find it helpful to take a video near the landing zone and then watch it frame-by-frame or in slow motion.

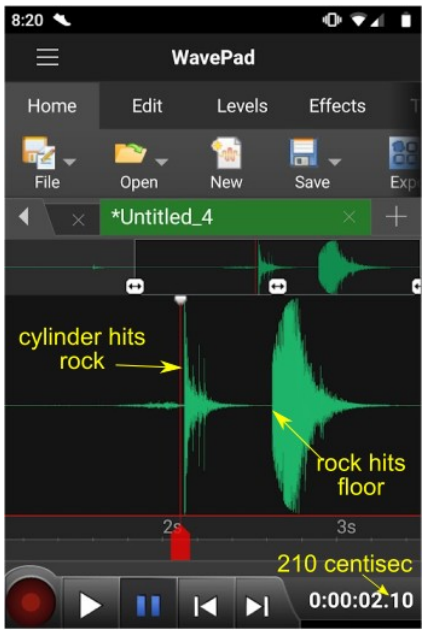
Discuss:
Using what you know about gravity and forces, can you explain your observations?

Do you think the forward motion of the Lego and rock had any effect on their time of flight?

If you have extra time….

Discuss: Do you think the time of flight will change if you hit the rock hard (so it has a lot of forward motion) or if you hit it only a little? What about its range?

6. Use the WavePad app (or go to https://audiomass.co/) to record the sound of the cylinder hitting the rock and the rock hitting the floor.



Look at the recorded sound to find the time of flight:
Time when cylinder hit rock: _____
Time when rock hit floor: _____
Time of flight for rock: _____

7. Balance the Lego with its end hanging off the edge of the table. Hit it with the cylinder directly to push it off the table with barely any forward motion. Record the sounds again to get the time of flight:
Time when cylinder hit rock: _____
Time when rock hit floor: _____
Time of flight for rock: _____

Which had the bigger time of flight?
Lego flying forward Lego falling straight down about the same