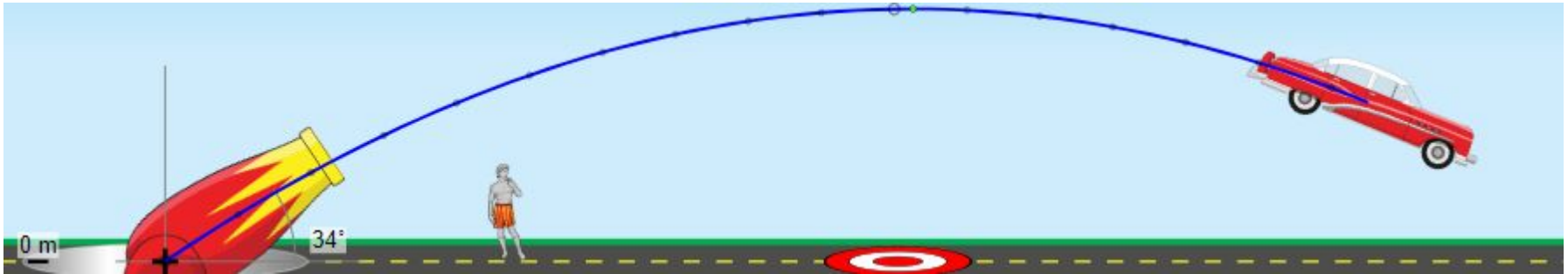
# PHYSICS

April 8th, 2020

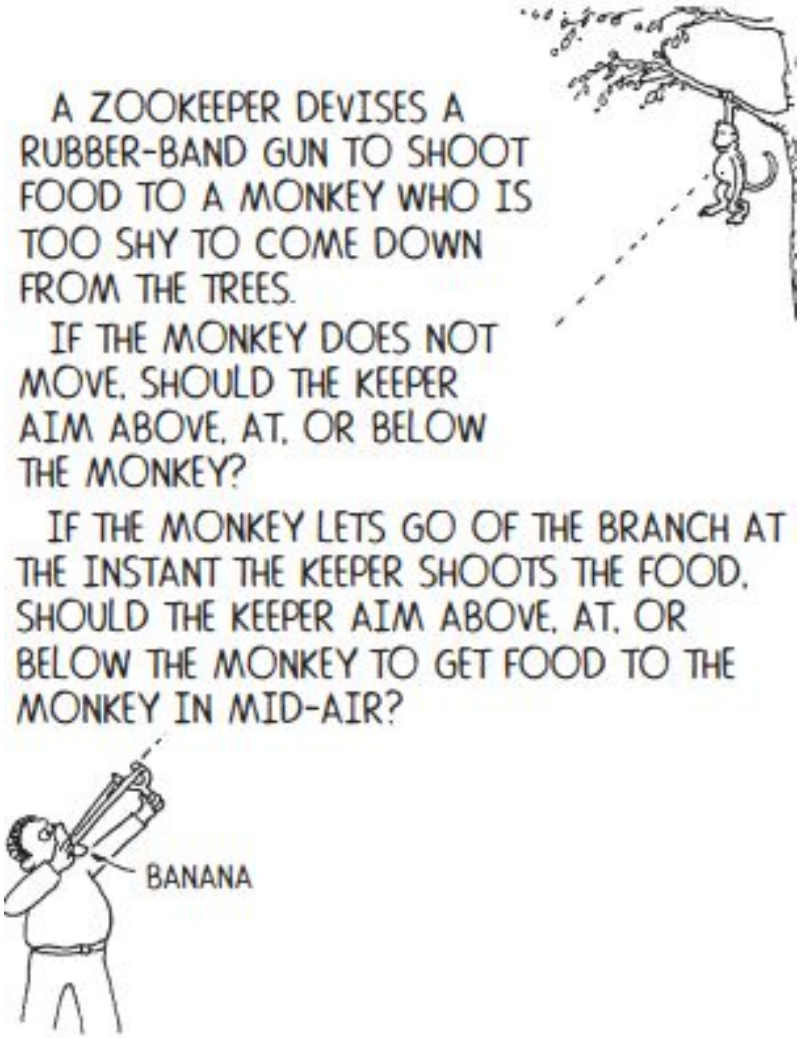
# Projectile Motion

LESSON GOALS

Students will use a simulation to evaluate projectile motion and the variables that affect how a that projectile moves.

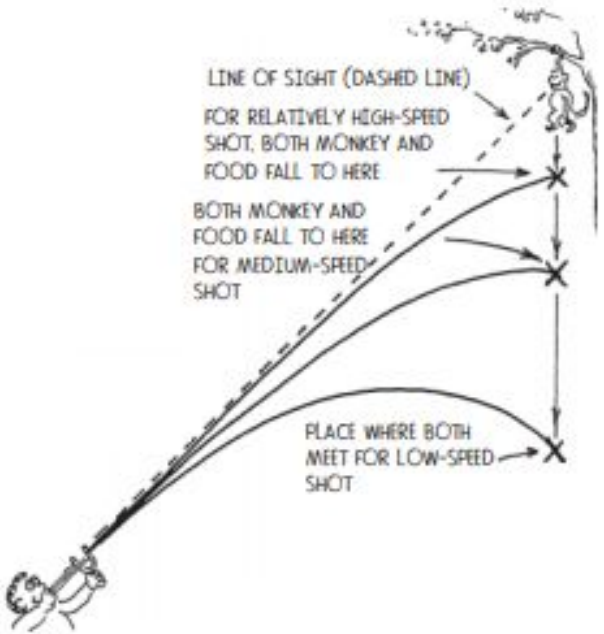


# Quick Review



# Quick Review Answers

WHEN THE MONKEY REMAINS AT REST, THE KEEPER SHOULD AIM ABOVE THE MONKEY TO COMPENSATE FOR GRAVITY. BUT WHEN THE MONKEY DROPS, THE KEEPER SHOULD AIM DIRECTLY AT THE MONKEY. BECAUSE OF GRAVITY, THE FOOD (LIKE ANY PROJECTILE) WILL FALL BELOW THIS DIRECT STRAIGHT LINE. HOW FAR BELOW? AS FAR BELOW AS THE MONKEY FALLS IN THE SAME TIME. SO THE MONKEY AND THE FOOD WILL FALL THE SAME VERTICAL DISTANCE IN THE SAME TIME, AND MID-AIR CONTACT IS MADE.

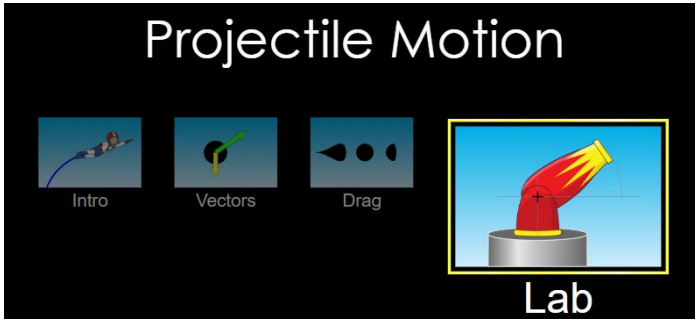


# PROJECTILE MOTION

Introduction – You will use the same computer simulation today as yesterday to reinforce your ideas of Projectile Motion. Since this is “inquiry based”, you’re not supposed to know everything going in, but learn as we walk through the lesson. **You must read all instructions carefully to get full credit.** Let’s get started!

Website : https://phet.colorado.edu/en/simulation/projectile-motion

Click on the “play” icon, then double click on “Lab”




Make sure to use HTML 5 version.

# PROJECTILE MOTION - SPEED & ANGLE

**Starting with the pumpkin as your projectile, gather data and answer the following questions.**

a. With an initial speed of 18m/s, target distance of 20m and no air resistance, what angle must the cannon be at to hit the target ?

b. Clear your results from part a. Now add air resistance and answer the same question.

c. Clear your results from part b and remove the air resistance. Collect data to figure out how the angle must be changed to hit the bull's eye as the initial speed increases.

| Initial speed | Angle |
| --- | --- |
| 14m/s | |
| 18m/s | |
| 22m/s | |
| 26m/s | |

**Conclusion:** As the speed increases the angle _____.

# PROJECTILE MOTION - MASS & ANGLE

**Now, using different projectiles, collect data to figure out how the angle must be changed as the mass of the projectile changes. Use 18m/s as your speed and 20M as the range.**

| Projectile | Mass | Angle |
| --- | --- | --- |
| Football | | |
| Cannon ball | | |
| Adult Human | | |
| Piano | | |
| Car | | |

**Conclusion:** As the mass of the object increases, the angle _____ as long as the speed is constant.

# PROJECTILE MOTION - MASS & SPEED

**Now, repeat the experiment  Mass and Angle from the previous slide, only keep the angle constant at 65, range at 20m, and determine what happens to the initial speed needed to hit the bull's eye as the mass of the projectile changes.**

| Projectile | Mass | Initial speed |
|---|---|---|
| Football | | |
| Cannon Ball | | |
| Adult Human | | |
| Piano | | |
| Car | | |

**Conclusion:**  As the mass of the object increases, the initial speed_____ as long as the angle is constant.

# PROJECTILE MOTION - AIR DRAG

**Repeat the experiment, except set the speed based on your results from the mass and speed from the previous slide, add air resistance and record the drag coefficient and whether the object hits the bull's eye or not in the last two columns.**

| Projectile | Initial speed (from mass & speed) | Drag coefficient | Hit bull's eye? |
|---|---|---|---|
| Football | | | |
| Cannon ball | | | |
| Adult Human | | | |
| Piano | | | |
| Car | | | |

**Conclusion:** How does the air resistance relate to whether the object could still hit the bull's eye or not?

# Simulation Answers

## SPEED AND ANGLE

a) 71 degrees
b) 66 degrees

| Initial speed | Angle |
|---|---|
| 14m/s | 50 degrees |
| 18m/s | 71 degrees |
| 22m/s | 78 degrees |
| 26m/s | 83 degrees |

As the speed increases the angle increased.

## MASS AND SPEED

| Projectile | Mass | Initial speed |
|---|---|---|
| Football | 0.41kg | 16m/s |
| Cannon Ball | 17.60kg | 16m/s |
| Adult Human | 70.0kg | 16m/s |
| Piano | 400kg | 16m/s |
| Car | 2000kg | 16m/s |

As the mass of the object increases, the initial speed remains the same as long as the angle is constant.

## MASS AND ANGLE

| Projectile | Mass | Angle |
|---|---|---|
| Football | 0.41kg | 71 degrees |
| Cannon Ball | 17.6kg | 71 degrees |
| Adult Human | 70.0kg | 71 degrees |
| Piano | 400kg | 71 degrees |
| Car | 2000kg | 71 degrees |

As the mass of the object increases, the angle remains the same as long as the speed is constant.

## AIR DRAG

| Projectile | Speed | Drag Coefficient | Hit bull's eye? |
|---|---|---|---|
| Football | 16m/s | 0.05 | yes |
| Cannon Ball | 16m/s | 0.47 | yes |
| Adult Human | 16m/s | 0.60 | yes |
| Piano | 16m/s | 1.20 | no |
| Car | 16m/s | 0.55 | yes |

How does the air resistance relate to whether the object could still hit the bull's eye or not?
The higher the air drag the less likely to hit the target, like with the piano.

# FURTHER EXPLORATION

Try other variables to see how they might affect the flight.

Try Changing the angle but nothing else.

Try changing the launch height.

Or any other combinations that you would like.