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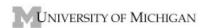
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Catapults and Angry Birds

Josh Bon and Jake Moline

Introduction: Names, Engineering Students/Majors (Josh)

- Question: What is Engineering?
- Engineers are problem solvers, individuals who use knowledge of science, mathematics and economics to solve technical problems that confront society!
- Question: How many have taken a physics class already?

(Show Angry Birds Video)

Question: Who has played Angry Birds before?

Question: What physics concepts can you see at work in Angry Birds?

The Physics of Angry Birds: (Jake)

- Projectile Motion
- ***Collisions and Momentum
- Kinetic and Potential Energy
- Spring/Elastic Physics
- Explosive Physics

Newton's Laws (Josh) (Jake writes important vocab and definitions)

- Sir Isaac Newton Apple story
 - He came up with the 3 fundamental laws of physics by thinking about an apple that fell on his head
 - We can do the same thing looking at Angry Birds (open the floor for what they observed in the video)
- Angry Birds: Fortresses will stay standing until the birds knock them down
 - Newton took credit for being the first to say something really obvious:
 - 1st Law: Inertia An object at rest will stay at rest, and an object in motion will stay in motion unless something else happens.
 - Question: Which block will be move the easiest?
 - Chair demonstration Moving
- Angry Birds: Birds hitting the structure knocks it down
 - Newton observed that when something hits something else, it tends to move
 - o 2nd Law: Force=mass x Acceleration
 - Question: How do we make the object move?
 - Definition of acceleration, leading to definition of force
 - Force needs "effort"
- Angry Birds: When the birds hit the structure, they stop moving

- Newton recognized that there was a balance
- o 3rd Law: Equal and Opposite Reactions
 - Block demonstration Pushing on block
 - No Acceleration
 - Question: Why?

Physics Equations (Jake)

- Displacement: Distance from starting point (x)
 - Angry Birds: The distance the birds travel
- Velocity: Speed or movement
 - Angry Birds: How fast the birds fly
- Acceleration: Adding or subtracting speed
 - Angry Birds: Catapult accelerates bird
- Mass: Similar to weight
 - Angry Birds: Size matters
- Force: Push
 - Force = Mass × Acceleration (F = ma)
 - o Angry Birds: Pushing blocks over
- Momentum: A measure of motion of a body
 - Will be discovered later

Catapult Activity (Both)

- Questions to ask during/after activity (incorporated in next sections)
 - O Which projectiles did the most damage?
 - O Which projectiles flew the furthest?
 - Which projectiles work best?
 - o Did anyone launch multiple small marshmallows at once?
 - O Which catapult type did you like the best and why?
 - How far back did you pull the arm on the catapult back?
 - Same every time or different?
 - Why? What effect did it have?

Physics of Catapult: (Josh)

- Overall goal question: How can we increase projectile displacement/damage?
- What did you notice that was different about the three types of catapults?
 - Write students answers on board
 - Try to set up groups
 - Moment/Force Related
 - Energy related
 - Other design criteria
 - Optional: Move to topics below as they answer—topic relation in ()
- Moments (2x spoon length = Increase arm)

- Rotational Motion: Force → Moments
 - Moments = Force × Arm
 - Point of Rotation
- Example: Tipping over vs. sliding water bottle
- o Example: Door
- Energy (Increased windings = Higher spring constant, increased pullback = Higher displacement)
 - o Question: After we load the spoon, where does the launch force come from?
 - Potential Energy: Storage of force
 - Relate to Slingshot (Angry Birds)
 - Spring Potential Energy = $\frac{1}{2}$ × Spring Constant × Displacement (E = $\frac{1}{2}$ kx²)
 - Units: Joules (J)
 - O Question: Where does the energy go after the launch?
 - o Energy transfer from potential to kinetic-like the rock
 - Relate to Pull-back displacement (Angry Birds)
 - Relate to Impact Force
- Increasing Distance (summary and extrapolation)
 - O Question: How can we increase the projectile displacement?
 - Give more energy
 - Increase lever displacement
 - Increase the spring constant
 - o Give it more force
 - Increase arm length
 - Other Types of Catapults
 - Four Bar Linkage
 - Mechanical Advantage = Force Out / Force In

Physics of Projectiles: (Jake)

- To have momentum, you must be a body, and have motion
- To break through the fortress, the birds must have a high momentum (Create chart)
- Question: How does each bird knock down the fortress?
- Angry Birds Projectiles
 - Red Bird: momentum, body, motion
 - Question: What characteristics of this bird give it an increase in momentum?
 - The Red Bird does not change its body or motion, has a low momentum
 - The Red Bird is the "control" bird (We compare other birds to this one)
 - Yellow Bird: momentum(个), body, motion(个)
 - Question: What characteristics of this bird give it an increase in momentum?
 - The Yellow Bird increases its motion, and therefor increases its momentum
 - Jumbo Red Bird: momentum(\uparrow), body(\uparrow), motion
 - Question: What characteristics of this bird give it an increase in momentum?
 - The Dark Red Bird has a bigger body, and therefor increase its momentum

- o Blue Bird: momentum(\uparrow), body(\uparrow), motion
 - Question: What characteristics of this bird give it an increase in momentum?
 - The Blue Bird increases its body and therefor increases its momentum
 - Blue Bird also creates a force over a larger area
 - (Diagram of force over larger area on a block)
- o Black Bird: momentum(\uparrow), body, motion(\uparrow)
 - Question: What characteristics of this bird give it an increase in momentum?
 - The Black Bird creates an explosion
 - The explosive force causes an increase in momentum
 - (Draw Explosion Diagram)
- White Bird: momentum(个), body, motion(个)
 - Question: What characteristics of this bird give it an increase in momentum?
 - The White Bird also creates an explosion
 - The explosive force causes an increase in momentum
 - (Draw White Bird/Bomb diagram)
- Question: Which definitions of physics do body and motion apply to?
- Write momentum equation: p=mv

Question: Anymore questions from the audience?