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Author(s): Josh Bon, Jake Moline

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The Physics of Angry Birds

Introduction: Names, Engineering Students/Majors (Josh)

- Question: What is engineering?
- Scientists that want to build/make things, Creative and innovative technology, Interact with things on a daily basis

(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)

- 1st Law: Inertia – An object at rest will stay at rest, and an object in motion will stay in motion unless acted on by a force.
    - Question: Which block will be move the easiest
    - Block demonstration - Moving
- 2nd Law: Force and Acceleration
    - Question: How do we make the object move?
    - Definition of acceleration, leading to definition of force
    - Force needs "effort"
- 3rd Law: Equal and Opposite Reactions
    - Block demonstration – Pushing on block
        i. No Acceleration
        ii. Question: Why?

Physics Equations (Jake)

- Displacement: Distance from starting point (x)
- Velocity: Speed or movement
    - Velocity = Displacement / Time ($v = x/t$)
    - Units: $m/s = m / s$
- Acceleration: Adding or subtracting speed
    - Acceleration = Velocity / Time ($a = v/t$)
    - Units: $m/s^2 = (m/s) / s$

- Force: Push
    - Force = Mass × Acceleration ($F = ma$)
    - Units: $N = kg \times m/s^2$
- Momentum: Quantity of mass and velocity
    - Momentum = Mass × Velocity ($p = mv$)
    - Units: $kg \times m/s$
- Kinetic Energy: Movement energy
- Kinetic Energy = 1/2 × Mass × Velocity^2 ($E_k = ½mv^2$)
    - Units: Joules (J)
- Potential Energy: Stored Energy
- Potential Energy = Mass × Acceleration of Gravity × Height ($E_P = mgh$)
    - Units: Joules(J)
    - Draw rock & cliff diagram to compare E_k and E_p

Physics of Catapult: (Josh)

- Moments
    - Rotational Motion: Force →Moments
        - Moments = Force × Arm
            - Point of Rotation
    - Example: Door
- Energy
    - <u>Question:</u> 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 = ½ × Spring Constant × Displacement ($E = ½ kx^2$)
        - Units: Joules(J)
    - <u>Question:</u> Where does the energy go after the launch?
    - Energy transfer from potential to kinetic
        - Relate to Displacement (Angry Birds)
        - Relate to Impact Force
- Increasing Distance
    - <u>Question:</u> How can we increase the projectile displacement?
    - Give more energy
        - Increase lever displacement
        - Increase the spring constant
        - Increase arm length
    - Other Types of Catapults
        - Four Bar Linkage
            - Mechanical Advantage = Force Out / Force In

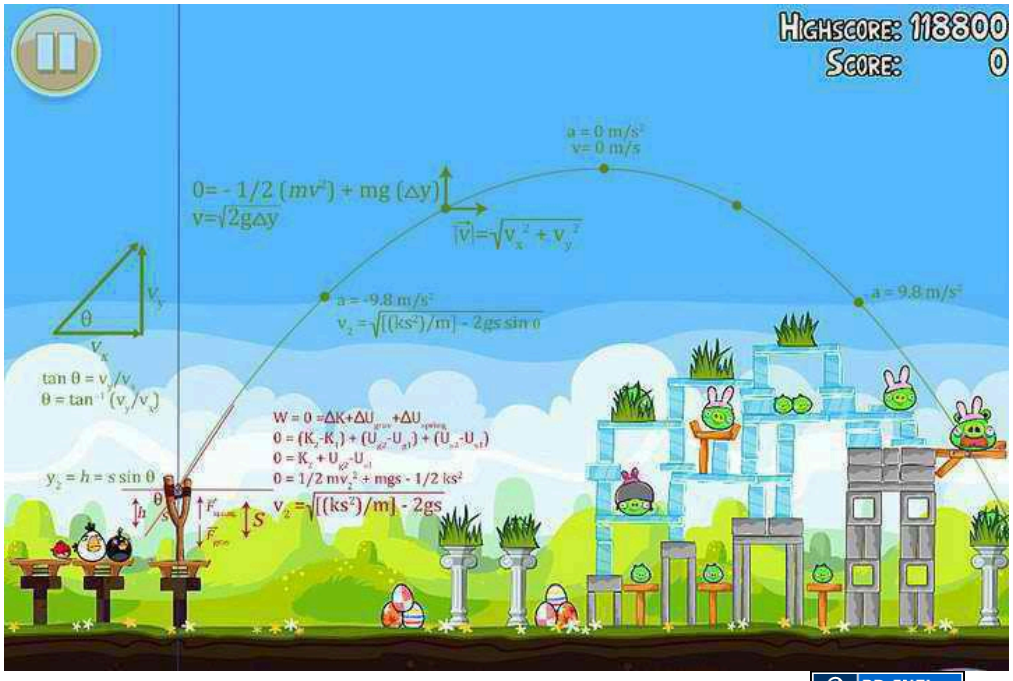
Physics of Projectiles: (Jake)

- To break through the fortress, the birds must have a high momentum
- A high momentum can be achieved by increasing mass, velocity, or both
- Angry Birds Projectiles
    - (Box momentum equation)
    - Red Bird: p=mv
        - Question: What characteristics of this bird give it an increase in momentum?
        - The Red Bird does not change speed or mass, and therefor as a low momentum
        - The Red Bird is the "control" bird (We compare other birds to this one)
    - Yellow Bird: p (↑) = mv(↑)
        - Question: What characteristics of this bird give it an increase in momentum?
        - The Yellow Bird increases its speed, and therefor increases its momentum
    - Dark Red Bird: p(↑) = m(↑)v
        - Question: What characteristics of this bird give it an increase in momentum?
        - The Dark Red Bird has a greater mass, and therefor increase its momentum
    - Orange Bird: p(↑) = m(↑)v (optional)
        - Question: What characteristics of this bird give it an increase in momentum?
        - The Orange Bird rapidly increases its mass, and therefor suddenly increases momentum
    - Blue Bird: p(↑) = m(↑)v
        - Question: What characteristics of this bird give it an increase in momentum?
        - The Blue Bird increases its mass and therefor increases its momentum
        - Blue Bird also creates a force over a larger area
        - (Diagram of force over larger area on a block)
    - Black Bird: p(↑) = mv(↑)
        - 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: p(↑) = mv(↑)
        - 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)
    - Not all birds have abilities that deal with momentum
        - Green and Pink birds

Question: Anymore questions from the audience?

Distance Question/Activity (Josh)

Catapult Activity (Both)



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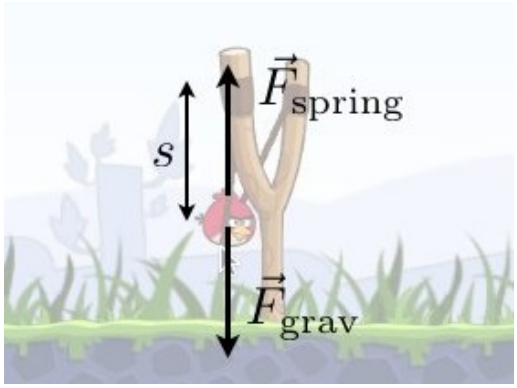

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