

Interactive Web Physics

Physics Animations that Run in a Web Browser

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NCS-AAPT Workshop

November 16, 2019

Workshop Agenda

1. Origin story, connectivity, and tour of IWP6 - **Taylor**, 10m
2. Creating a simple animation with projectile motion - **Jon**, 10m
3. Using the IWP6 library of built-in functions to create more complex animations, specifically elastic collision - **Ben** 10m
4. Simulation with Euler's method with IWP + orbital motion challenge - **Andy** 20m
5. Q&A and Discussion about ways to use IWP - **Everybody** 10m

IWP Origin Story

1. Open Source! Founded in 1998, Java Version 1.1, 25+ Students
2. “Designer” is a key differentiator that empowers everyone to author new content. Embrace competition and evolution
3. Tech transition starting 4 years ago from Java Applet to Web, with a priority of preserving our content library of animations
4. Integration with online student systems like WebAssign
5. NCSSM Physics instructors, Winters, Bennett. Used for 10+ years in Online, AP Physics 1, Hybrid, Practice & Review, Waves & Optics

Interactive Web Physics 6

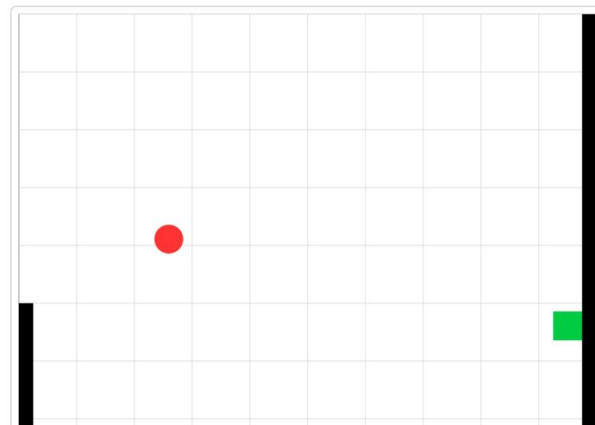
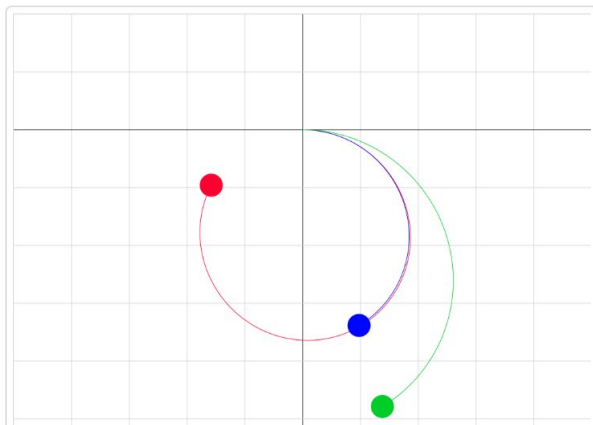
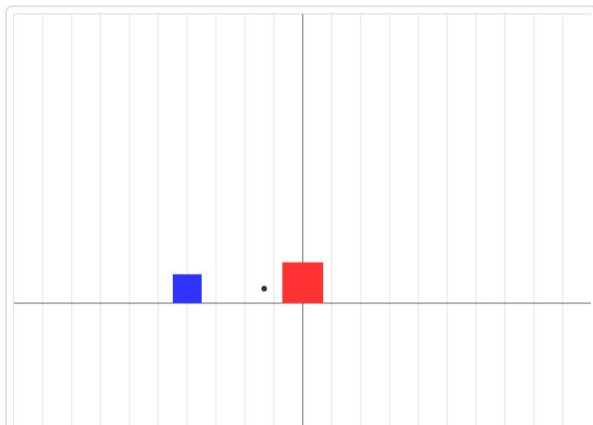
www.iwphys.org

Physics animations that run in your web browser and tablets using HTML5

Packaged Animation Collections

[Charged Particle Motion](#)[Electrostatics](#)[Forces](#)[Kinematics](#)[Momentum, Collisions, KE](#)[Optics](#)[Oscillations](#)

Popular Animations



IWP Animation Library

IWP ships with a complete library of physics animations developed over the past 20 years at NCSSM.

From the homepage www.iwphys.org, click any of the green buttons to view the best of four packaged animation collections:

Packaged Animation Collections

[Charged Particle Motion](#)[Electrostatics](#)[Forces](#)[Kinematics](#)[Momentum, Collisions, KE](#)[Optics](#)[Oscillations](#)

Connectivity

1. Wi-Fi: NCSSM Guest, Conference Specific Username + Password

2. Web: <https://www.iwphys.org/>, Sign In Top Right

 Sign In

3. IWP: Username = **ncptc1**, Password = **Peebles**
ncptc2...
ncptc70

IWP Successful Login 

4. Animate one of our popular animations from the home page on your own laptop. Great work, keep it up! Chrome or Firefox please.

Got Issues? You get a special visit from me while the show goes on.

Workshop Agenda 2

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Steps to Create a Simple Animation

1. Inputs
2. Solids
3. Time Range, Window and Graph Window Settings
4. Outputs
5. Save and Play

Setting up Inputs

Inputs

Add New Input

Input ↓		Remove
Input Name	<input type="text" value="vi"/>	
Input Text	<input type="text" value="Initial Speed"/>	
Initial Value	<input type="text" value="0"/>	
Units	<input type="text" value="m/s"/>	
Hidden	<input type="checkbox"/>	

Setting up Solids

Solids

Add New Solid

Solid ↑ Remove

Solid Name

X Path Parametric Euler
X =

Y Path Parametric Euler
Y =

Shape

Height Parametric Euler
H =

Width Parametric Euler
W =

Setting up Outputs

Outputs

Add New Output

Output ↓		Remove
Output Name	<input type="text" value="x-position"/>	
Text	<input type="text" value="x"/>	
Calculator	<input checked="" type="radio"/> Parametric <input type="radio"/> Euler	
	<input type="text" value="pumpkin.xpos"/>	
Units	<input type="text" value="m"/>	
Hidden	<input type="checkbox"/>	

Setting up Time, Window, Graph

Author Information

Username	<input type="text" value="anonymous"/>
Email	<input type="text"/>
Name	<input type="text"/>
Organization	<input type="text"/>

Description

This is a demo animation - a [punkin chunkin!](#)

Time Range

Start	<input type="text" value="0"/>
Duration	<input type="text" value="100"/>
Change	<input type="text" value="0.1"/>
Fps	<input type="text" value="20"/>

Window

X Min	<input type="text" value="-10"/>
X Max	<input type="text" value="10"/>
X Grid	<input type="text" value="2"/>
X Unit	<input type="text" value="meters"/>
Y Min	<input type="text" value="-10"/>
Y Max	<input type="text" value="10"/>
Y Grid	<input type="text" value="2"/>
Y Unit	<input type="text" value="meters"/>

Graph Window

X Min	<input type="text" value="0"/>
X Max	<input type="text" value="10"/>
X Grid	<input type="text" value="2"/>
Y Min	<input type="text" value="-5"/>
Y Max	<input type="text" value="5"/>
Y Grid	<input type="text" value="2"/>

Finished Animation !

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[Open Designer](#)

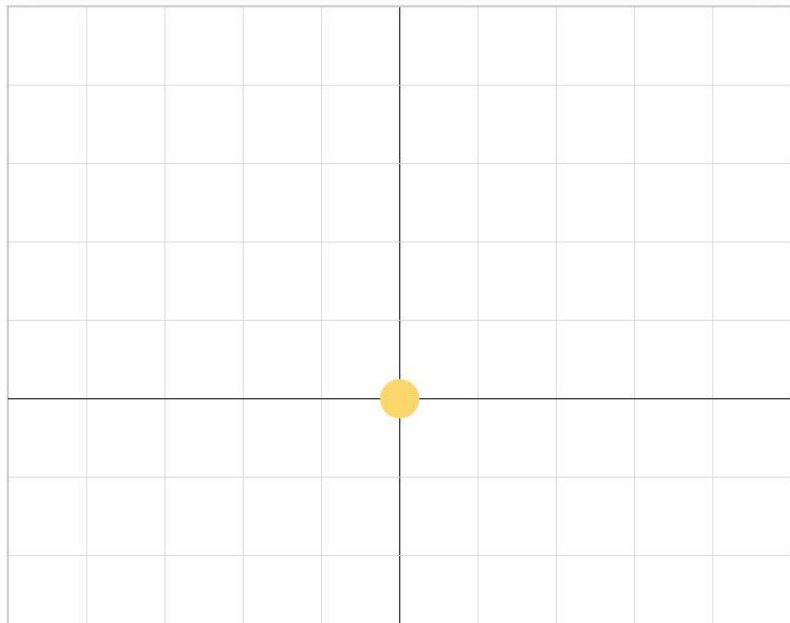
[Save Screenshot](#)

[Animator Guide](#)

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Animate Graph Time Axes



newAnimation.iwp.json

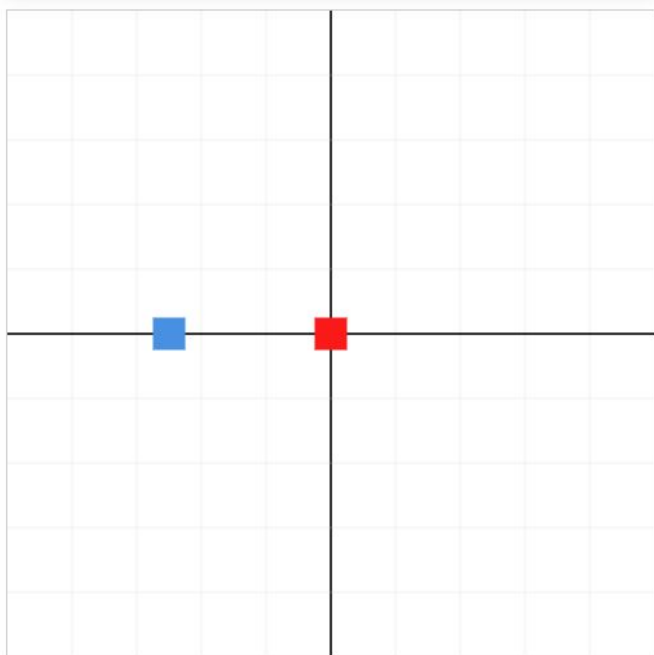
This is a demo animation - a punkin chunkin !

Inputs		Outputs	
Initial Speed	<input type="text" value="10"/> m/s	y	<input type="text" value="0.0000"/> m
Launch Angle	<input type="text" value="45"/> degrees	x	<input type="text" value="0.0000"/> m

Workshop Agenda 3

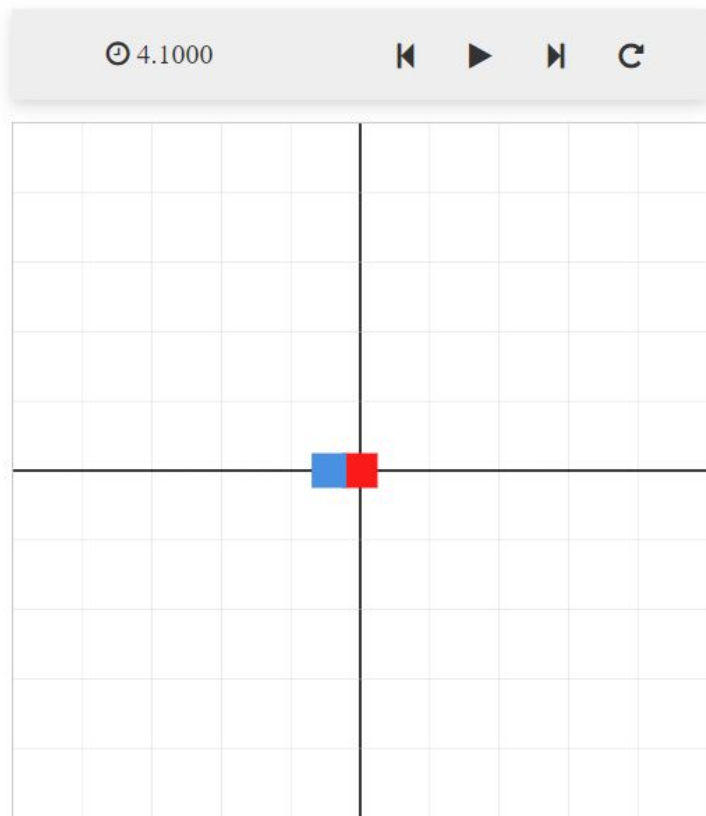
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Creating an Elastic Collision Animation (10m)



- GOAL: Animate an Elastic Collision between the blue box traveling to the right and the red box initially at rest
- Will make use of the parametric calculator and the step function

Example



- $\text{step}(x) = 0$ if $x \leq 0$
- $\text{step}(x) = 1$ if $x > 0$
- Boxes collide at $x = -0.9\text{m}$ and $t = 4.1\text{s}$
- Using the step function we can parametrize the path for the boxes before and after the collision

Example, cont.

Solid ↓ Remove

Solid Name

X Path Parametric Euler

X =

Y Path Parametric Euler

Y =

- For $t < 4.1$ the blue box starts at -5.0 m and moves right at a speed of 1.0 m/s
- For $t \geq 4.1$ the blue box stays at the position -0.9 m where it collided with the red box

$$X = \text{step}(4.1-t)*(t-5.0) + \text{step}(t-4.0)*(-0.9)$$

Graphing, Trails, Vectors

Name:

Calculator: X Path
 Parametric X Path =

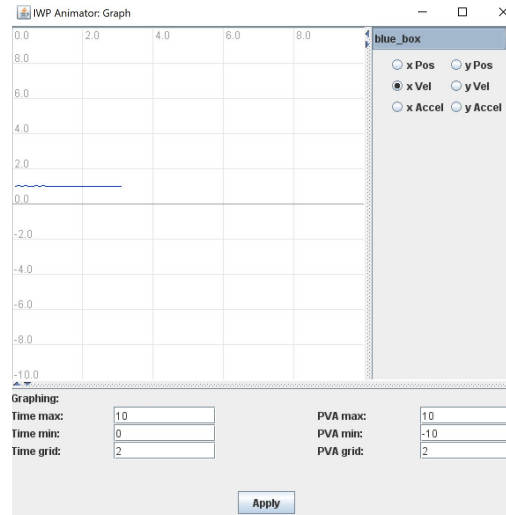
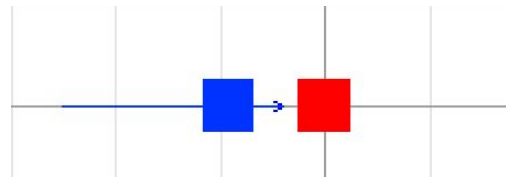
Calculator: Y Path
 Parametric Y Path =

Color

Shape
 Type =

Width =
 Height =
 Theta =

Draw Object Trails?
 Draw Vectors?
 x Vel x Accel
 y Vel y Accel
 Vel Accel
 Graphable?
 x Pos y Pos
 x Vel y Vel
 x Accel y Accel



Creating Inputs (mass)

Input ↓ Remove

Input Name	<input type="text" value="rm"/>
Input Text	<input type="text" value="mass of red box"/>
Initial Value	<input type="text" value="1"/>
Units	<input type="text" value="kg"/>
Hidden	<input type="checkbox"/>

Input ↓ Remove

Input Name	<input type="text" value="bm"/>
Input Text	<input type="text" value="mass of blue box"/>
Initial Value	<input type="text" value="1"/>
Units	<input type="text" value="kg"/>
Hidden	<input type="checkbox"/>

Making the Elastic Collision

$$v_{\text{blue},f} = \left(\frac{m_{\text{blue}} - m_{\text{red}}}{m_{\text{blue}} + m_{\text{red}}} \right) \cdot v_{\text{blue},i}$$

$$v_{\text{red},f} = \left(\frac{2 \cdot m_{\text{blue}}}{m_{\text{blue}} + m_{\text{red}}} \right) \cdot v_{\text{blue},i}$$

- Initial velocity of the blue box set to 1.0 m/s
- We can modify the step function to incorporate the formulas to the left

Making the Elastic Collision, cont.

Blue Box X-Path

- $\text{step}(4.1-t)*(t-5.0) +$
 $\text{step}(t-4.0)*(t*(bm-rm)/(bm+rm)-4.1*(bm-rm)/(bm+rm)-0.9)$

Red Box X-Path

- $\text{step}(t-4.0)*(t*(2*bm)/(bm+rm)-8.2*bm/(bm+rm))$

Making the Elastic Collision, cont.

The screenshot shows a simulation interface with a grid background. At the top left, there is a time display showing "10.000" and control buttons for play, pause, and reset. To the right of the grid are four icons: a list icon labeled "Animate", a graph icon labeled "Graph", a clock icon labeled "Time", and a document icon labeled "Axes". Below the grid, the text "newAnimation.iwp.json" is displayed. Underneath that, the text "Elastic Collision between blue box and red box" is shown. To the right of this text is a control panel with the heading "Inputs". It contains two input fields: "mass of red box" with a value of "10" and "kg", and "mass of blue box" with a value of "1" and "kg". On the grid, a blue square is positioned on the left side of the horizontal axis with a blue arrow pointing to the left. A red square is positioned on the right side of the horizontal axis with a red arrow pointing to the right. The two boxes are separated by a vertical line that represents the point of collision.

red box has greater mass than blue box

Making the Elastic Collision, cont.

8.8000

Animate Graph Time Axes

newAnimation.iwp.json

Elastic Collision between blue box and red box

Inputs

mass of red box kg

mass of blue box kg

blue box has greater mass than red box

Outputs

Output ↓ Remove

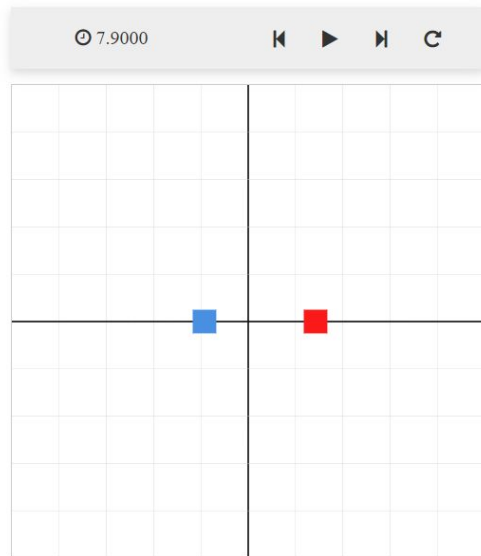
Output Name:

Text:

Calculator: Parametric Euler

Units:

Hidden:



Animate Graph Time Axes

newAnimation.iwp.json

Elastic Collision between blue box and red box

Inputs

mass of red box: kg

mass of blue box: kg

Outputs

center of mass: m

Workshop Agenda 4

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Animating Gravity with Explicit Methods (20m)

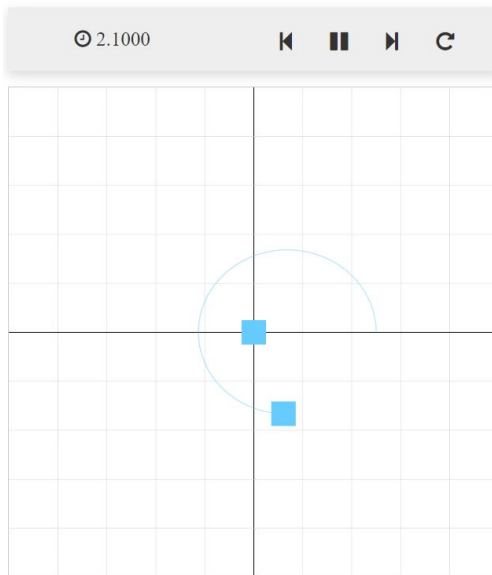
- GOAL: Experiment with an animation template of an object orbiting a fixed point

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Save Screenshot

Animator Guide

- New techniques:
 - Euler's Method
 - Object attributes



Part 3 Gravity - Template.iwp

A blue object orbits a large, fixed mass at the origin. The power of the gravitational force on each of the orbiting objects can be adjusted according to a number of parameters: the mass of each object; the gravitational constant G . In reality, the gravitational force is exactly inversely proportional to the square of the distance between the orbiting object and the origin. This animation replicates this force, but we might also be interested in the behavior of gravity at different powers. Using the designer, edit this animation to allow the user to input a gravitational power which changes the behavior of gravity. In order to compare this generalized gravitational scheme to reality, include two orbiting objects, each with inputtable parameters.

Inputs

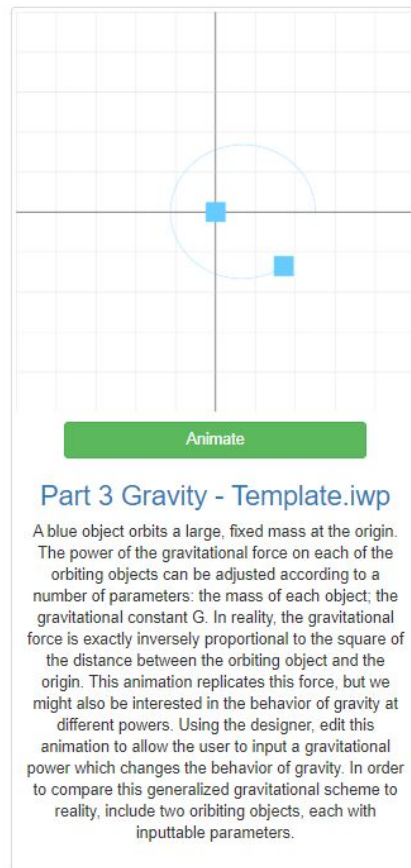
Gravitational Constant

ma

mb

Animating Gravity with Euler's

- Template Features:
 - Orbit and origin solids with trails
 - Mass and gravitational constant inputs
 - x- and y-acceleration for orbiting objects using Euler's





Euler's in IWP

Solids

Add New Solid

Solid ↓

Solid Name

X Path Parametric Euler

Init Disp =

Init Vel =

Accel =

Y Path Parametric Euler

Init Disp =

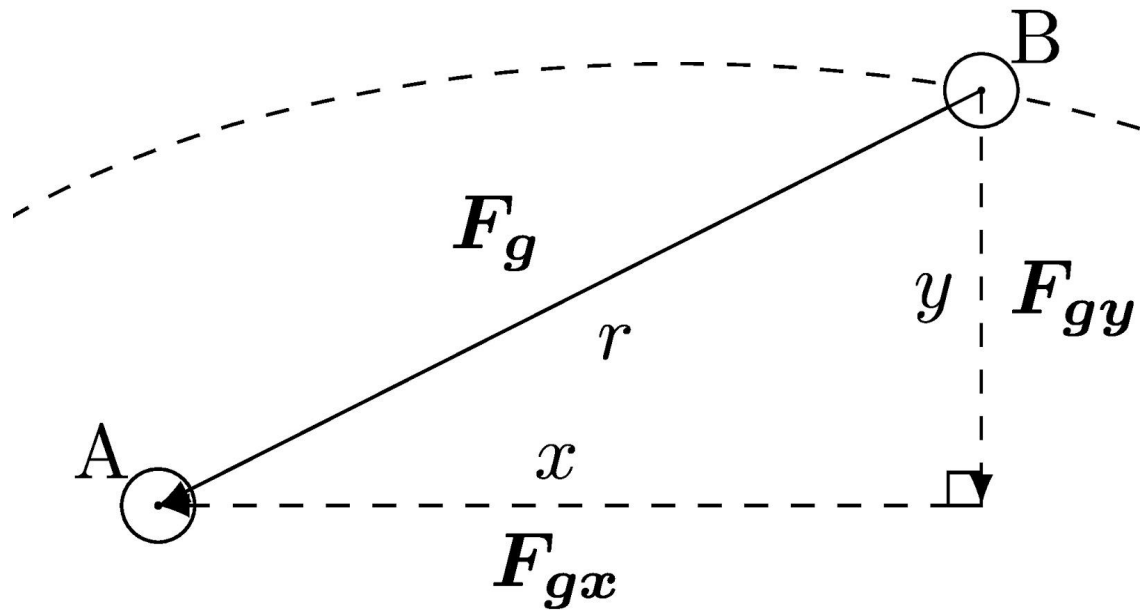
Init Vel =

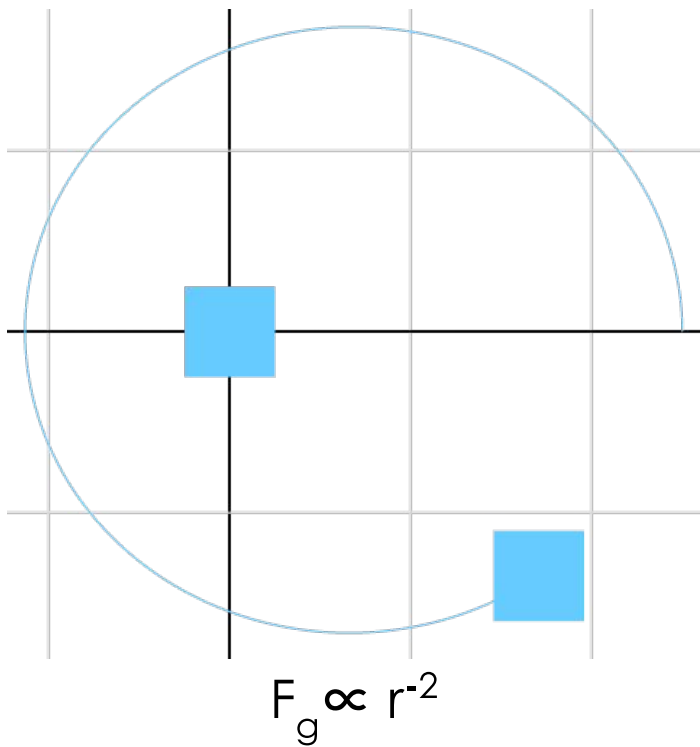
Accel =

- Euler's option available in defining x/y-path in solid
- Enables motion to be defined in terms of acceleration

Gravity Parameterization (B orbits A)

$$F_x = -\frac{Gm_A m_B}{r^2} \frac{x}{r} = -\frac{Gm_A m_B x}{(x^2 + y^2)^{1.5}} \quad F_y = -\frac{Gm_A m_B}{r^2} \frac{y}{r} = -\frac{Gm_A m_B y}{(x^2 + y^2)^{1.5}}$$





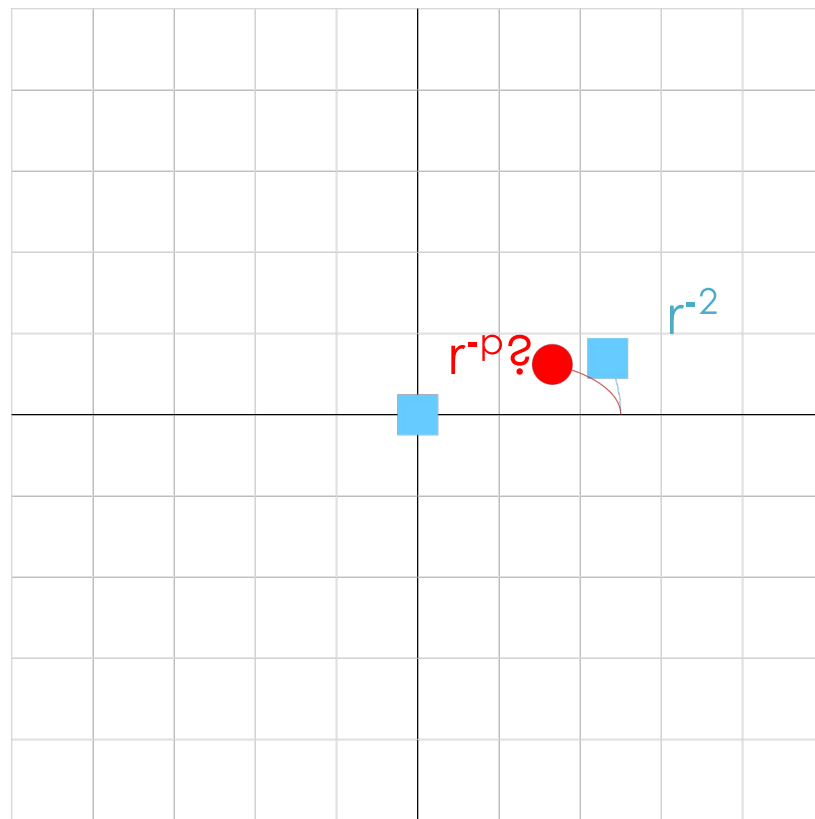
Template Results



CHALLENGE

Compare:

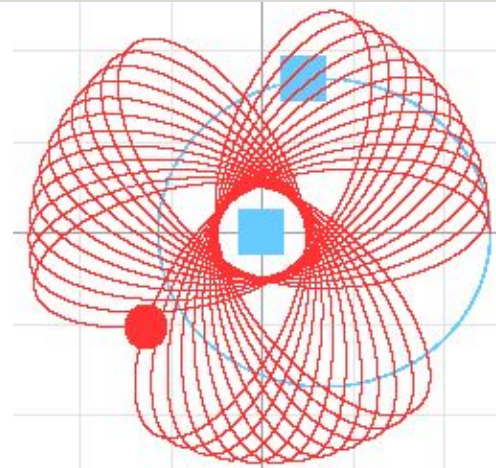
$$F_g \propto r^{-p} \quad \text{VS} \quad F_g \propto r^{-2}$$



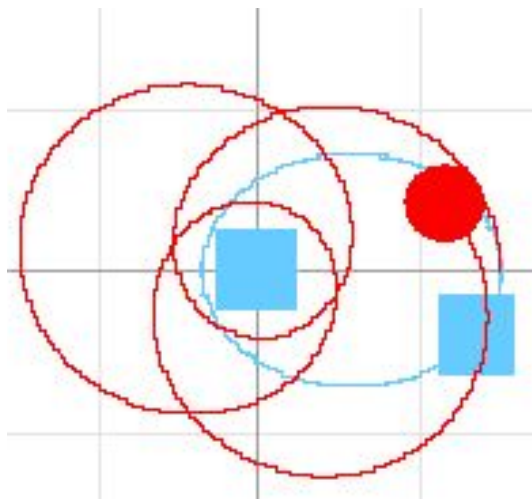


RESULT

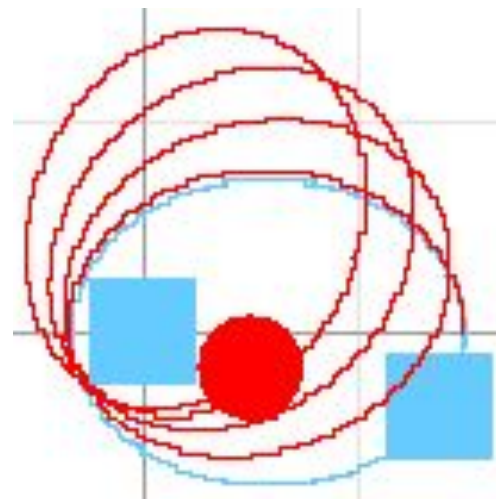
$$F \propto r^{-1}$$



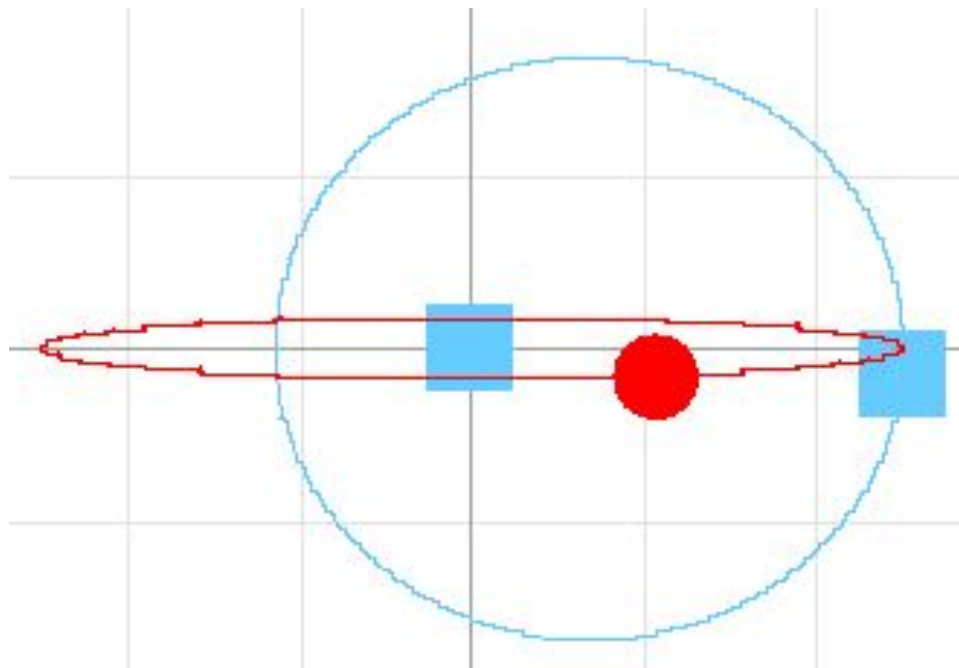
$$F \propto r^{-2.5}$$



$$F \propto r^{-2.1}$$



RESULT



Only closed cycles: Blue: $F \propto r^1$
Red: $F \propto r^2$

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Discussion

Question 1 / 3

How is IWP similar or different from other physics software?

Discussion

Question 2 / 3

How could students benefit from using IWP?

Discussion

Question 3 / 3

What content should we develop to enhance your curriculum?

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Physics Animations that Run in a Web Browser

THANK YOU !!

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