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Mr. Gates

AP Physics

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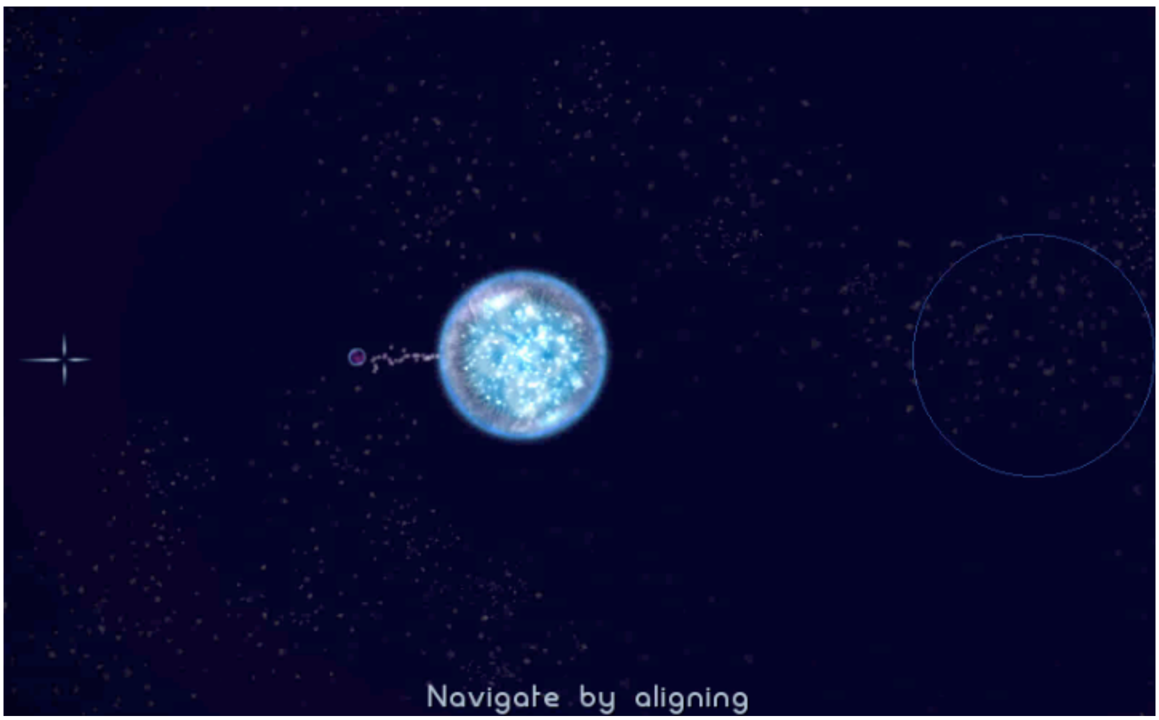
-Let's Get Physical-

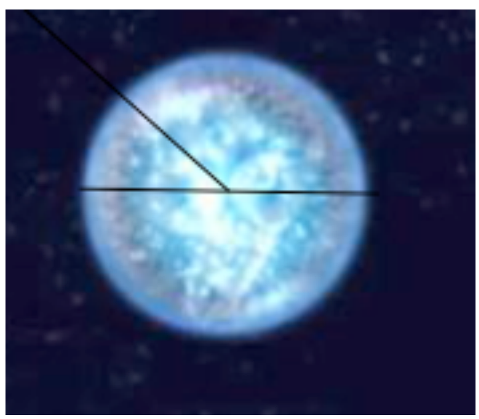
Osmos



In this paper I explore the physics of the computer game Osmos. It was my goal to see how accurately Newton's laws applied to this game. I captured video of the game and used Logger Pro to analyze the physics of how an object propels itself by expelling some of its mass in the opposite direction. I discovered that impacts between random objects have perfect conservation of energy; when the main mass controlled the player moves conservation is not conserved. In that situation, the player is given approximately four to five times the amount of energy dictated by Newton's laws to make the game easier.

In the game Osmos your goal is to absorb smaller masses and avoid larger masses. Movement is accomplished by 'throwing' part of your mass in the opposite direction. This concept is very physically sound. The game even hints to its physical accuracy by starting the game with the quote "for every action there is an equal and opposite reaction" Sir Isaac Newton. This got me interested in the physics of Osmos and I wanted to see if it was accurate. Newton's first seems to apply to this game, as once a mass is moving it doesn't slow down or stop. Newton's third is where I was concerned with the games physics. It appears that this game attempts to mirror Newton's law but I decided to see if it followed it to the letter.

My first step was to identify by what means the size of the masses were measured. I thought it was either measured by diameter, area, or volume. I used Logger Pro to get measurements measured in pixels. Here are the measurements I collected.



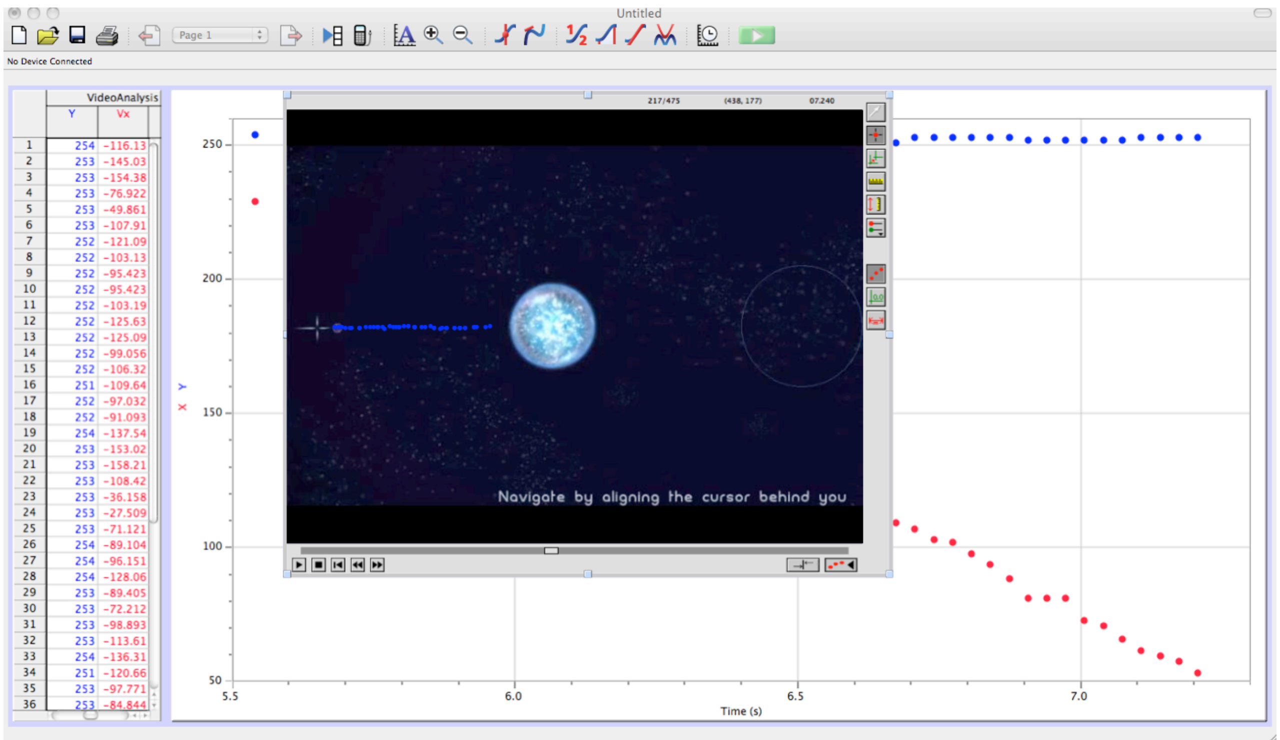
	Large mass before split	Large mass	Small mass
Diameter (pixels)	128	127	13
Area (π*pixels^2)	16,384	16,129	169
Volume (4π/3*Pixels^3)	2,097,152	2,048,383	2,197

To see whether diameter, area, or volume is more appropriate, I add the small mass and the large mass and see if it equals the original mass before the split.

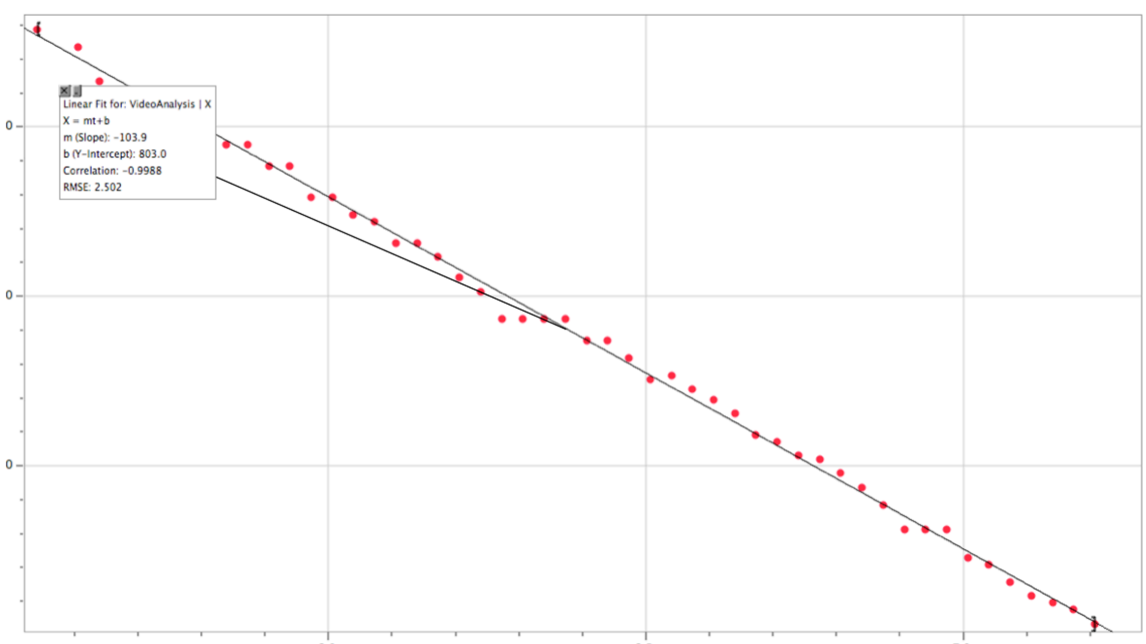
Diameter (127+13)/128 = 110% of original mass

Area	(16,129+169)/16,384	=	99.5% of original mass
Volume	(2,048,383+2,197)/2,097,152	=	97.7% of original mass

It appears that the game uses area for its physics. The 99.5% could actually be 100% because my measurements of pixels are not exact. It is also interesting to note that it appears that 1% of the original mass is thrown off every time. Now that I know the proportional masses of the objects I can test for conservation of momentum using Logger Pro. Here is a picture of how I tracked the smaller mass to test for velocity.



Now I took the position graph and fit a line to it. The slope of the line will give me the velocity because the derivative of the position graph is velocity.



Displayed below are the velocities I determined from each test.

	Before Split	Big mass	Small mass	After collision
Velocity (pixels/second)	0	4.8	-105.4	4.9

After collision*- This is after the small mass bounces off the wall and impacts the big mass again. At this point the small mass's velocity is positive.

I used conservation of momentum to see if these velocities were realistic. I tested the separation or 'throwing' first.

$$M(\text{before impact}) * (v\ \text{before}) = \text{Big } m\ (vb) + \text{Small } m\ (vs)$$

$$\text{Big } m(vb) = -\ \text{Small } m(vs)$$

$$16{,}129\pi(4.5) = -\ 169\pi(-105.4)$$

$$72{,}580\pi \text{ kgm/s} \neq 17{,}812\pi \text{ kgm/s}$$

It appears that conservation of momentum does not apply but to be sure I tested the secondary impact.

$$\text{Big } m\ (vb) + \text{Small } m\ (vs) = M(\text{after impact}) * (v\ \text{after})$$

$$16{,}129\pi(4.8)\ \ +169\pi(105.4) = 16{,}384\pi(5.1)$$

$$90{,}392\pi \text{ kgm/s} \approx 83{,}560\pi \text{ kgm/s}$$

This appears to be quite confusing. At first glance it appears that there is no physical sense to this game, as the amount of energy in each situation seems random. But as I review the results it starts to make sense to me. I believe that when the mass 'throws' itself, the game gives the user a little boost. They probably determined that using a correct conservation of momentum equation did not yield enough speed for the user to make the game easy enough. I believe that the creators of Osmos decided to give the players a boost and gave the user's mass four times the amount of speed when throwing part of its mass. This makes the game a little easier and probably more enjoyable. For the other collisions in the game (random particles hitting each other or the user's mass) it appears that conservation of momentum does apply as shown by the second impact equation above. It is amazing to me that a video game uses physical laws to dictate how it's played. I highly encourage this game to any fans of physics because it is a fun yet (semi) accurate physics based game.