

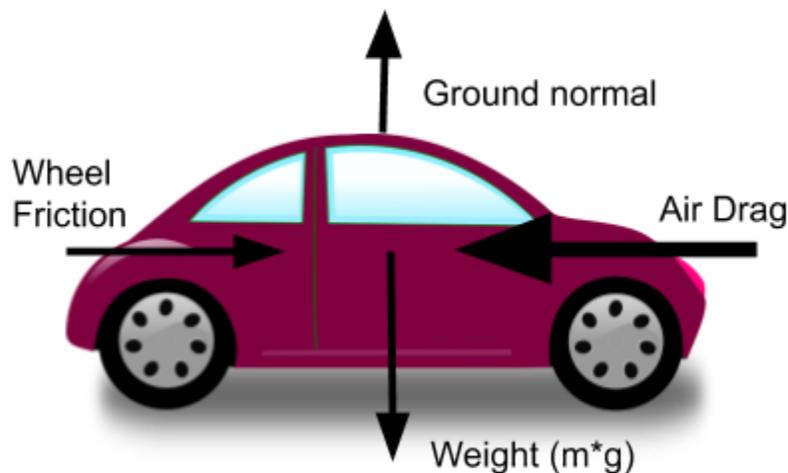
FORCE AND HOOKE'S LAW IN ALGODOO

The Hooke's law algodoo puzzle has users trying to find an object's weight, type the answer into a panel and if it's correct they get treasure. This is calculated by finding the spring constant of a spring and then working the formula on the unknown weight.

This puzzle doesn't require the user to know a lot of the algodoo software nor is there a lot of room to meaningfully experiment in this level. The puzzle can only be solved one way albeit an interactive way.

FORCES

Mechanics is one of the basic branches of physics that deals with the macroscopic motion of a body, that is the body's motion as a whole and not its individual particles. Two fundamental measurements that relate to mechanics are Force and Mass. A force is described as a push or pull on one object from another. For example you can describe the forces of a body in a *free body diagram* which shows only the forces acting on an object.



Example free body of a car.

Mass is defined as the resistance that a body of matter offers to a change in acceleration upon the application of this force. This leads to Isaac Newton's 3 famous laws of motion.

1. Every object in a state of uniform motion will remain in that state of motion unless an external force acts on it.
2. Force equals mass times acceleration $f = ma$
3. For every action there is an equal and opposite reaction.

Let us focus on the second one. It states that Force is Tied to mass and acceleration. If you increase the mass while keeping the acceleration the same; the force grows larger and if we increase the acceleration while keeping the mass constant the force will still grow. This means that *Force* Is DIRECTLY proportional to *Mass*.

WEIGHT

Weight is defined as the force exerted on a body by gravity. On earth this means it is the mass of an object multiplied by gravity (-9.81m/s). This is why we don't measure our mass, but measure our weight as it is easy to just measure the force exerted by our body due to gravity. The general formula for weight is

$$W = mg \quad (\text{is the same as } f = ma)$$

Where W is weight , m is mass and g is acceleration due to gravity on earth.

Hooke's Law

Hooke's Law is another form of Newton's second law. It similarly states that when we try to extend a spring the tension created by the spring is proportional to x (the distance that it has moved) by a constant k. That is to say $T = kx$ This is very similar to $f = ma$ expect k is a constant that is different for every spring. This value k is known as the spring constant. When you take controlled measurements of the Tension (Force) on a spring and its displacement we can calculate k.

(experiment instructions:

<http://www.batesville.k12.in.us/Physics/PhyNet/Mechanics/Newton3/Labs/SpringScale.html#:~:text=Conclusions%3A,is%20a%20constant%20of%20proportionality.>)

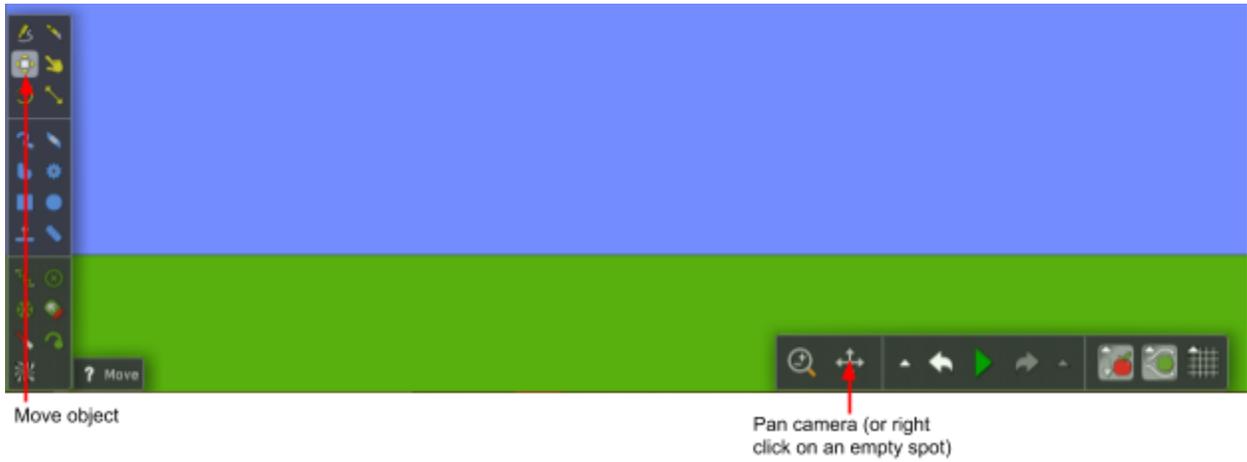
SAMPLE DATA SHEET TEMPLATE

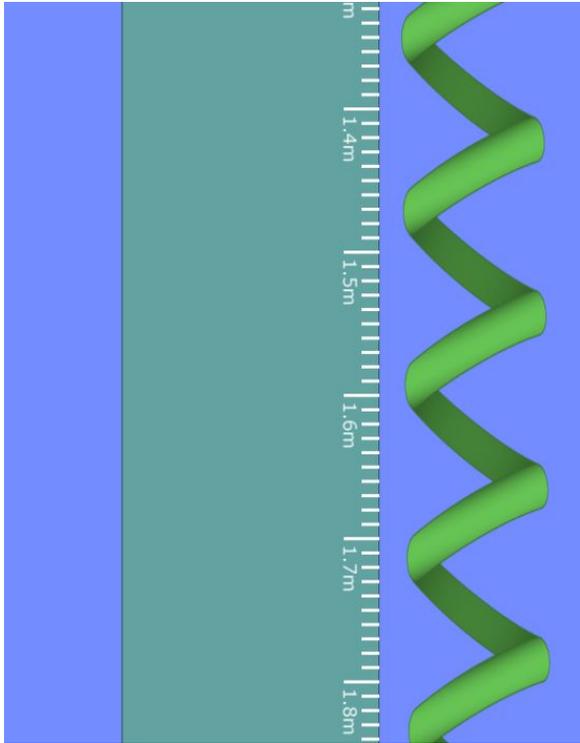
Trial	Mass	Initial pos	Ending pos	Force (Mg)	Stretch
1					
2					

3					
4					
5					
6					
7					

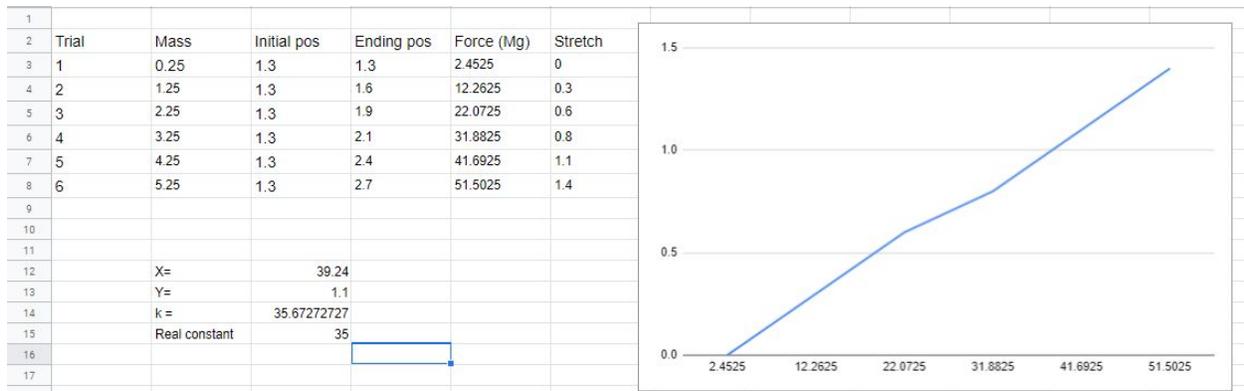
ALGODOO TIPS

You wont need many controls for this, just the move and pan. This should help you get familiar with algodoo. Once you beat this puzzle you can play around with the other tools.

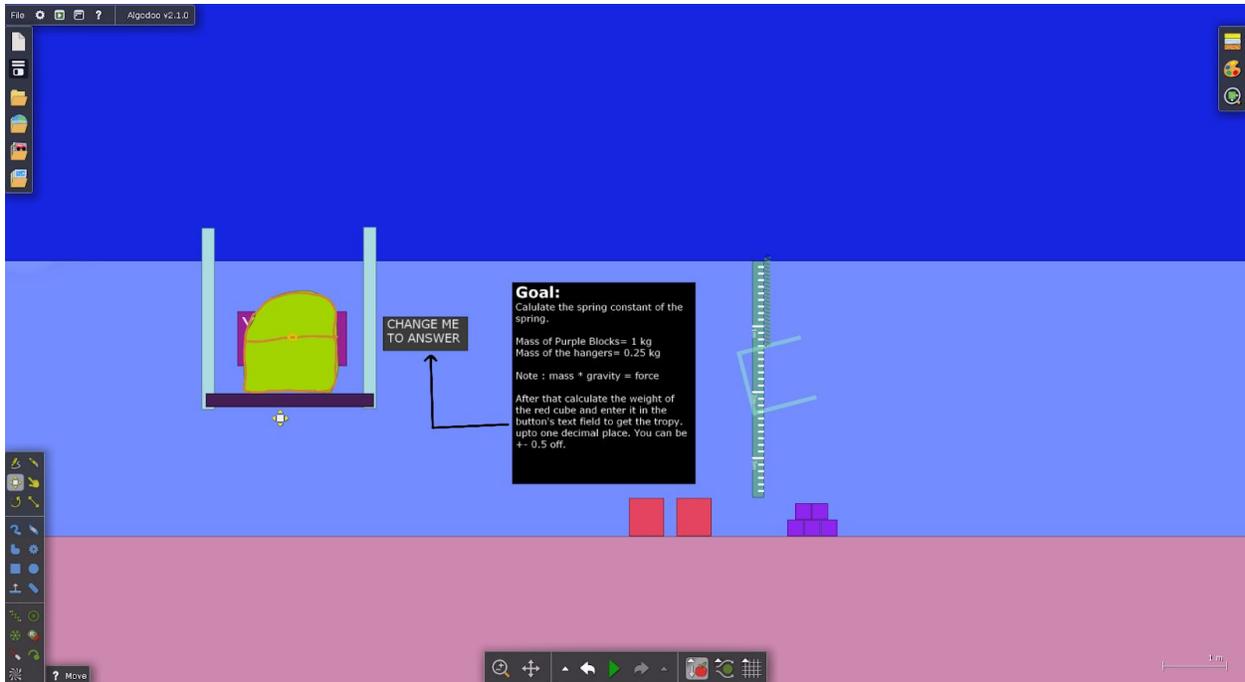




You can zoom into the ruler to get a more detailed readout.



An example in google sheets

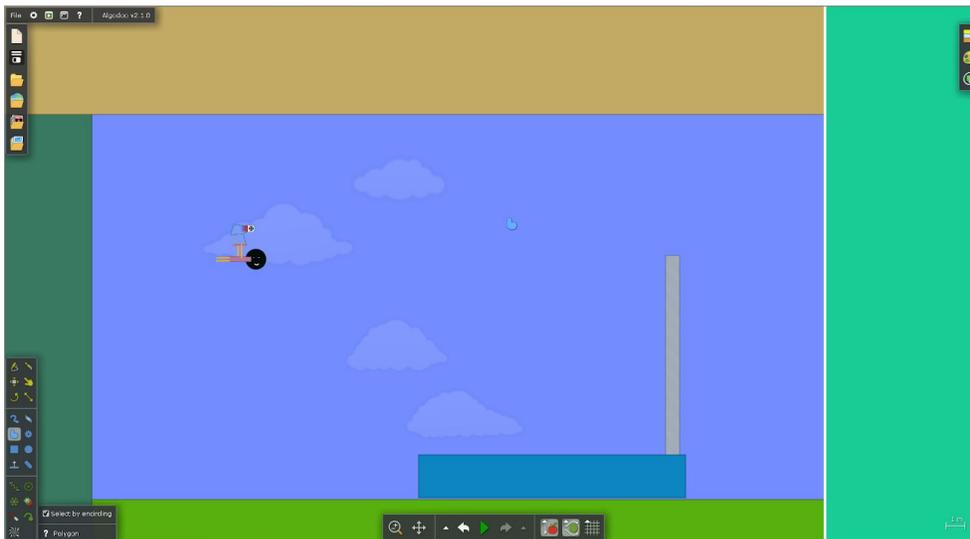


Sample shot of scene.

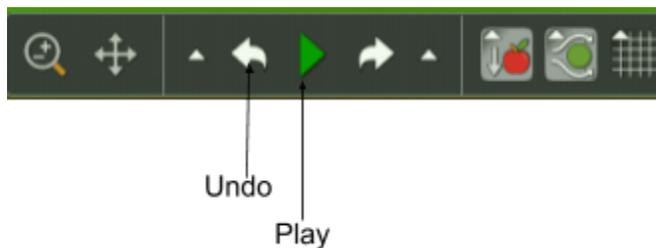
This puzzle can be expanded upon simply by changing the constant's and weights of the different objects. Which is useful for practice.

Reasoning / Hypothesizing (Glider man)

The objective of this simulation is to generate discussion and practice hypothesizing, evaluating and rethinking. Players hit play and watch “glider-man” fly down. They can restart/pause or even slow down the simulation. The simulation can be watched as many times as needed and each learner guesses what the speed/time graph would look like for “glider-man”. These guesses are not to be calculated and are purely based on theoretical (common knowledge) reasoning.



Main screen



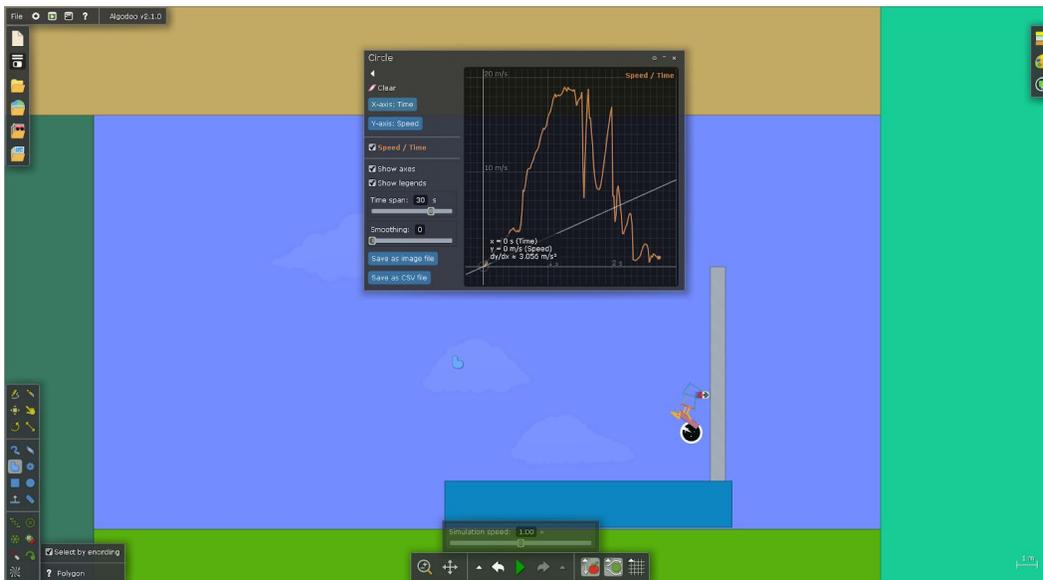
Play controls.

After everyone is comfortable with their guesses activate the show graph function on “glider-man’s” head and replay the simulation (Making sure to pause at the end so the graph doesn’t keep going). Get everyone together to discuss (or the next day in class if it is homework).



Right-click head -> Show graph

- How different are the guesses to the actual speed/time graph?
- What were some of the reasoning for the guessed speed/time graph?
- What are some of the reasons for the actual speed/time graph?



Simulation with speed/time graph



Graph close up

“For example with the graph shown above we can infer that initially while “glider-man” was falling he was gaining speed. Then there is a sharp drop when he smacks into the ground. It never reaches zero because his jetpack is always propelling him. He slams into the ground and keeps squirming until he hits the wall, there we see his speed keep spiking up and down but heading towards a downwards trend.”

Example possible discussion

Now try getting everyone to build their own objects such as cars , planes, ect.. In game and have other students try and guess what their speed/time graphs are.

- What software tools were used to create the “glider-man”?
- How does the speed/time graph of a car slamming into a wall look like? why?
- What new tools exist in the software?
- What are the limitations of game’s/simulations like this?

This conversation should help steer real life physics as it relates to the theory and formula being learnt. At the end of this exercise/homework learners would learn the rationale for arguing the basics of speed/time and the forces that are acting on an object.

Economics Analysis practice (Capitalism labs)

This is a custom scenario of capitalism labs (a sandbox company simulator). The scenario has companies and markets presteup as opposed to the games normal blank start. Players are to look at the market landscape and use different strategic planning techniques and tools to evaluate what kind of business would be best to start.

NOTE: It is highly recommended that you have everyone playing to have spent time playing the 9 tutorial levels, which should take about 1 ½ hours approx.

Ways of play:

In class - Learners form small groups of “CEO’s” and play in teams. The game starts paused for everyone to discuss and use SWOT, Porter's 5 forces and Blue ocean to evaluate how different potential businesses would play out and which would be the most successful. After this every one unpauses the game and continues playing. The game stores company data every 10 years and the game plays out for 50 years. When the time is up players are given a score as well as

various metrics of their company. Here the class can compare how the different teams did and decide a “winner”

Homework - If given as homework it plays similar to in the class but learners play alone. This has the down side of requiring more attention as there is more data and analysis to perform, plus you don't get the benefits of group thinking. This comes with the upsides of learners playing on their own time and not having the less social learners be a backseat to the stronger personalities on the team. When played as homework the class can decide a date by which everyone finishes their 50 years and at the end of it the class can discuss the various strategies taken as well share their analysis.

Play Tutorial:

To start a custom game, click new game -> challenges -> load script.





Example start on a small town

NOTE: make sure the game is paused.

This is an example of a small town script start, As you can see there are companies set up and the world has been pre-simulated. Assuming the tutorial has been played everyone should feel comfortable with the user interface.

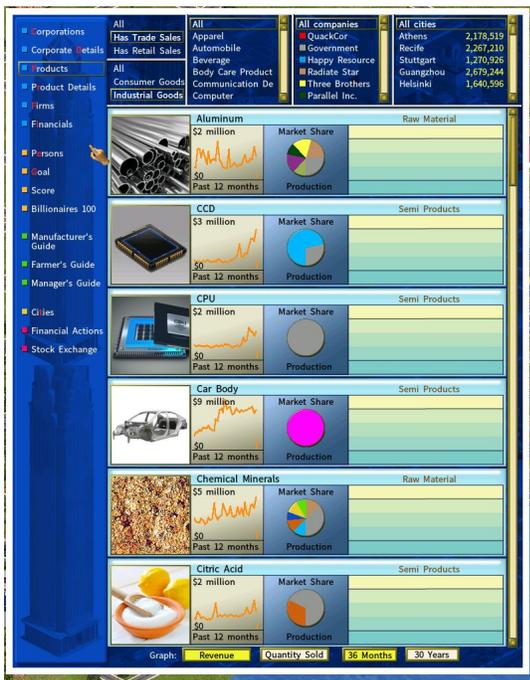
In a normal capitalism game players can choose a wide variety of paths. Players can build almost any kind of business imaginable, from a specialist cake store to an e-commerce only amazon like store. Since this would provide too much freedom I have limited what can be built in the scripted scenario



All buildings (Left) Vs limited building options (Right)



Statistic button



Statistic screen example

Next players can use the statistics button to bring up global stats of all the companies in the game currently (including the “port”) which acts as a govt organization. In this screen players

can look at the other companies and what markets they control, look at products by market share, price , demand ect... This should be the basis for the start of discussion.

Example Discussion

Modding notes:

Capitalism labs supports simple scripting. This can be used to change some in game values, create custom scenarios and pick what the winning goals are. I have scripted a few starting scenarios vaguely modeling a small town, large city and a small town rich with natural resources. If I continue with this I would want to create a program that can randomly create scripts within parameters so that instructors/teachers can easily create scenarios that focus on lessons they want to teach.

Ideally it would also be nice to save out game statistics (like yearly balance sheet data) then doing different analysis on them such as using different test ratios to try and rationalize different business actions.