I want to say a few words about the way we will measure the world around us while building this technology.

for each of these, talk about units used, orders of magnitude, conversions, meaning, and how to measure, typical values of things. Also post apocalyptic metrology, metrology from cars, piggyback metrology on existing nation states and corporations. Each unit gets a ipython notebook. Each unit has a simple measurement.

1. mass
2. position, with or without direction
3. velocity and speed
4. acceleration
5. rotation
6. force
7. mass flow
8. charge
9. charge flow(current)
10. voltage
11. energy
12. impedance
13. volume, density
14. inductance
15. capacitance
16. resistance
17. spring constant

It looks on examinign this that I need a resonator chapter, right after motors, when the motor has been built and testing is happening. Need to get ideas of Q and damping in, real and imaginary Z.

Start with Mass

What is mass? How do we measure it? Why do we care? Mass represents how much of something there is in an object. Everything I deal with in this work will either be some sort of massless field like the field around a magnet, or various objects and substances made up of atoms. In the case of the former it mostly does not make sense to talk about mass. In the case of the latter the total mass can generally be thought of as the number of atoms times how heavy each atom is. We can think of an atom as a sun-like nucleus surrounded by a cloud of probability that describes the location of electrons on the outside. The nucleus is made up of positively charged protons and neutral neutrons

If we ignore the electrons it always make a much smaller than 0.1% difference and they can be ignored.

watt balance and also the silicon ball demonstrate a electric balance of some kind

Water and density, and getting mass from water volume, on other densities. Do experiments with drink bottles of water, post apocalyptic balance, lever theory and use

The American illegal drug trade, American cook books, and mixed units

masses of: 1. earth 2. moon 3. human 4. a blood cell 5. an atom 6. a hemoglobin molecule 7. an electron compared to an atom, mass energy equivalents again

add mass flow here, talk about mass flow controllers, how mass flow is like electricity, set some markers here to return on on electricity

momentum, momentum of water in a pipe, toilet circuit, compute R, L, C of the flush and refill.

little g and big g

figures:

1. scales
2. watt balance
3. silicon sphere image
4. kilogram in france
5. spring scale

atoms and mols

Distance, Position, Displacement, time, speed

Miles, inches, feet, meters, cm, mm, microns, mils/thousanths, yards, km, original meter, circumpherence of Earth, wavelength, frequency, time, speed of light, speed of sound

loop back to volume in relation to mass, hit on resonators

Measure distance with some form of electromagnetic wavelength measurement

how to use vernier calipers, how to make a set from scratch and calibrate it, make a giant vernier caliper out of sticks, post apocalyptic tape measure

pictures of measurement tools pictures of calipers

Force and Acceleration

Gravity as force and acceleration, units, ipython gravity notebook

measure acceleration on a smart phone

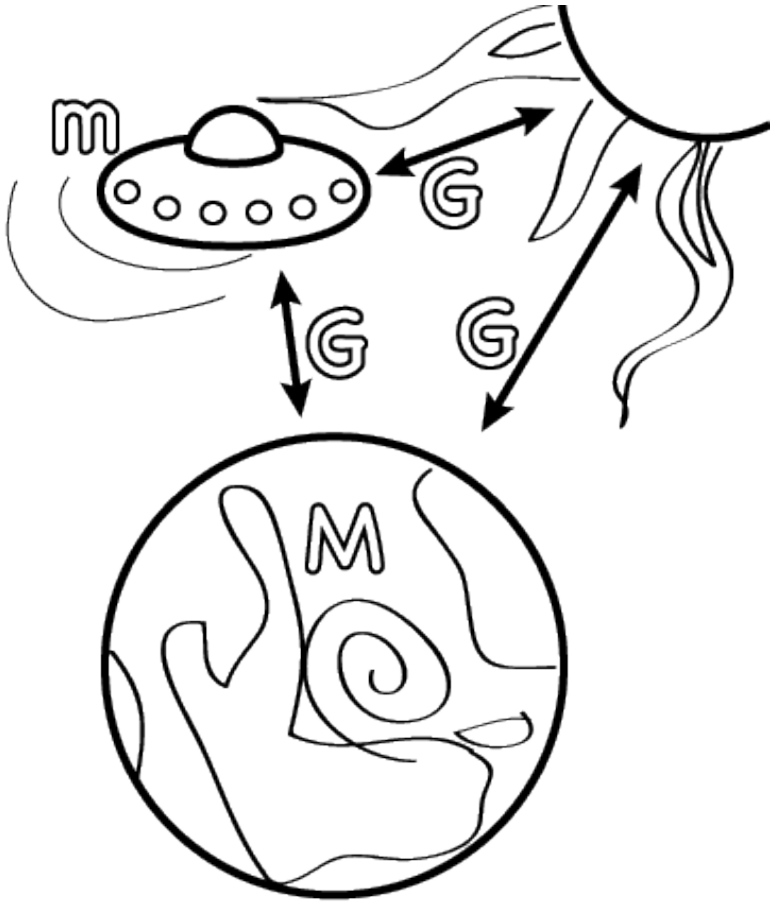

Figure 1: image

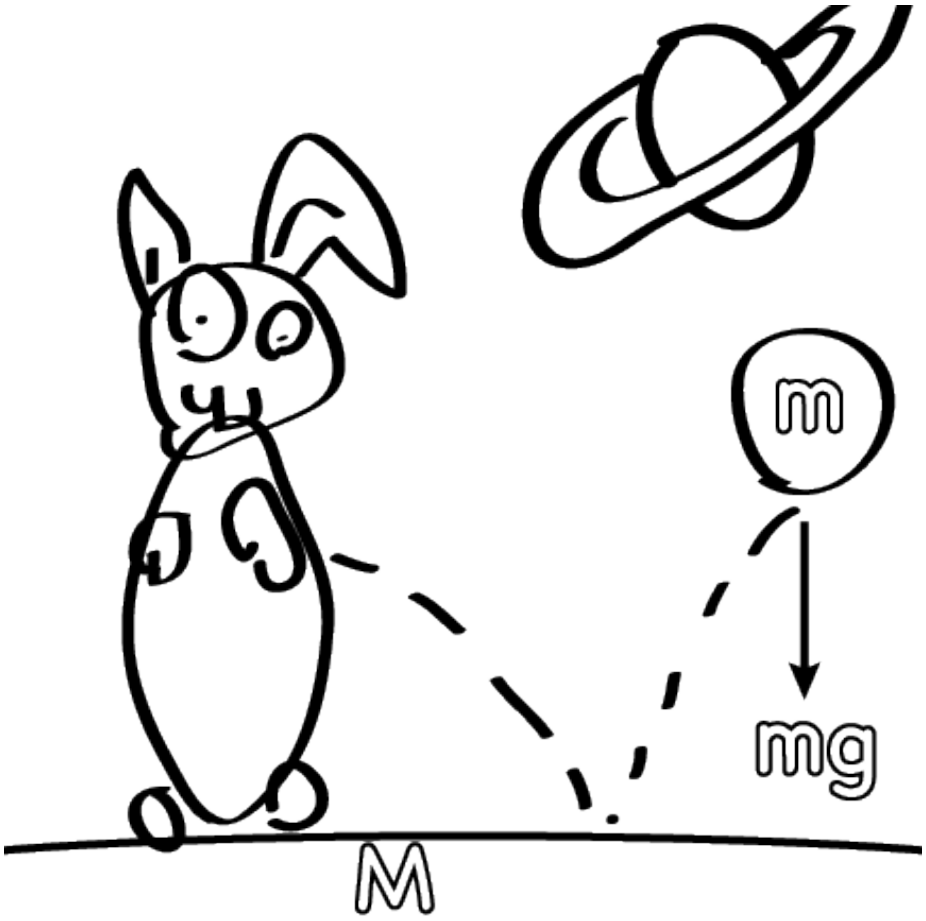

Figure 2: image

use integrals to get from acceleration to speed and from speed to position

ipython notebook to make the phone do all the things listed above and graph them

get a phone to act as fit bit or whatever to track sports bullshit and graph it all using your mass

rotational motion

start with angles, introduce radians, give examples in ipython of radian units, have a table

simple trig cartoon

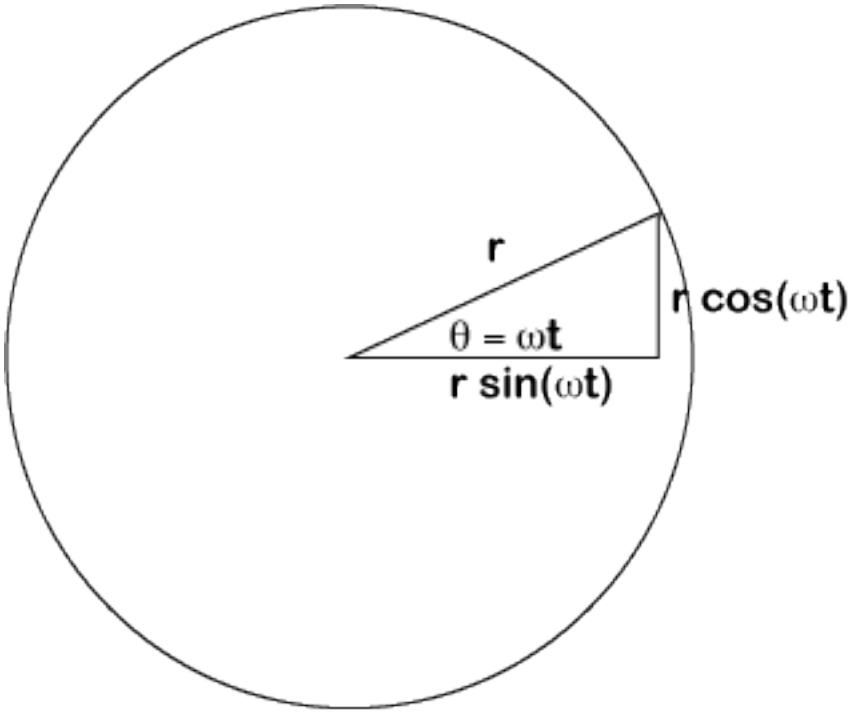

Figure 3: image

F u ma again, but in rotation: torque, angular momentum

sin, cos, period, frequency, angular frequency, generic nature of resonance, forshadowing of things to come in resonance, mini rant about importance of themes like resonance threading throughout your physics education curriculum.

Electrical Units:

charge first, then voltage, then measure EVERYTHING with the arduino, go step by step through the RC demos on the arduino with resistors, not slime. Loop this back to the pipes, toilets, etc.

RC experiment leads into the LR experiment, and inductance, and again back to the pipes and toilets, connect impedance between toilets and these circuits as well

Some trivial electrical and water based resonators

more about charge, real units, ipython notebook for that, also ipython notebooks for: 1. all the electrical units 2. control and graphing RC 3. control and graphing LR 4. control and graphing LRC 5. specific component value units, examples 6. build an LRC meter with the trash wizard stick–this should have a gui that lives in the browser of a smart phone, talking to the pi zero, which talks to the coil drive board, which measures voltages

figures:

1. images of components
2. schematics of experiments
3. graphs from experiments with explanations of units
4. photos of experiments

springs

wood, steel, hooke's law, mechanical impedance, examples, measuring k, units, ipytyhon notebook with unit examples, damping constant

1. cartoons of springs
2. photos of springs

impedance units

energy and power units

Dimensional analysis and Factor Label Method gets whole section

Google calculator with units Ipython with units BIPM, the NMI system, and metrology constants vs. units and the quantum SI