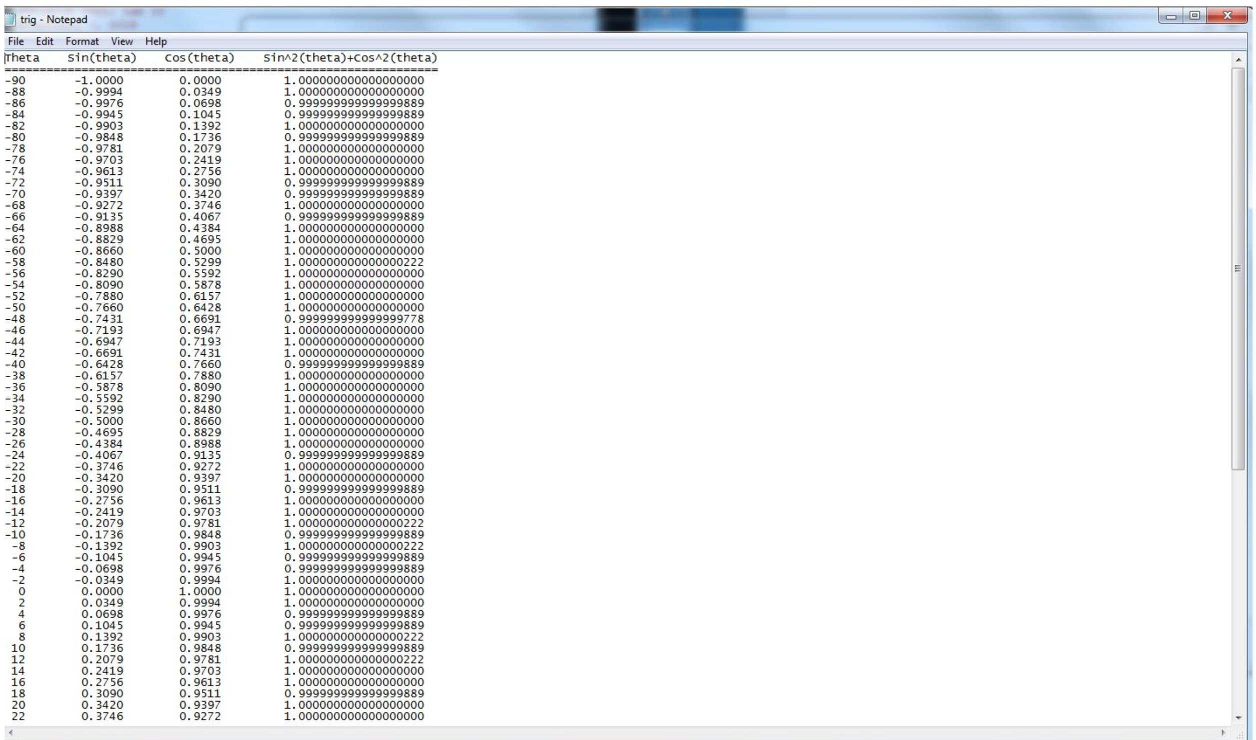
Driver: Cameron Klotz - 50% of the work
Navigateur Extraordinaire: **Cameron Kimber** **-** 100% of the remaining work
14 February 2018
Physics 242L

Problem 1.

In this problem, we are tasked with writing a file called *trig.txt*, made of columns containing various quantities. A screenshot of the file is shown below. A question is posed- why are the sums of sines squared and cosines squared not equal to 1? The answer is actually a constant theme of the physics 240 series: computers are not always perfectly accurate. The amount of memory allocated to hold these numbers in binary puts an upper limit on the size of the numbers that we store and perform operations on. Computers do not analytically solve problems, so taking some Taylor series of these functions, squaring the values, then summing up two of these unwieldy decimal approximations leads to some number that rounds up to one.



Theta	Sin(theta)	Cos(theta)	Sin^2(theta)+Cos^2(theta)
-90	-1.0000	0.0000	1.000000000000000000
-88	-0.9994	0.0349	1.000000000000000000
-86	-0.9976	0.0698	0.999999999999999889
-84	-0.9945	0.1045	0.999999999999999889
-82	-0.9903	0.1392	1.000000000000000000
-80	-0.9848	0.1736	0.999999999999999889
-78	-0.9781	0.2079	1.000000000000000000
-76	-0.9703	0.2419	1.000000000000000000
-74	-0.9613	0.2756	1.000000000000000000
-72	-0.9511	0.3090	0.999999999999999889
-70	-0.9397	0.3420	0.999999999999999889
-68	-0.9272	0.3746	1.000000000000000000
-66	-0.9135	0.4067	0.999999999999999889
-64	-0.8988	0.4384	1.000000000000000000
-62	-0.8829	0.4695	1.000000000000000000
-60	-0.8660	0.5000	1.000000000000000000
-58	-0.8480	0.5299	1.000000000000000222
-56	-0.8290	0.5592	1.000000000000000000
-54	-0.8090	0.5878	1.000000000000000000
-52	-0.7880	0.6157	1.000000000000000000
-50	-0.7660	0.6428	1.000000000000000000
-48	-0.7431	0.6691	0.999999999999999778
-46	-0.7193	0.6947	1.000000000000000000
-44	-0.6947	0.7193	1.000000000000000000
-42	-0.6691	0.7431	1.000000000000000000
-40	-0.6428	0.7660	0.999999999999999889
-38	-0.6157	0.7880	1.000000000000000000
-36	-0.5878	0.8090	1.000000000000000000
-34	-0.5592	0.8290	1.000000000000000000
-32	-0.5299	0.8480	1.000000000000000000
-30	-0.5000	0.8660	1.000000000000000000
-28	-0.4695	0.8829	1.000000000000000000
-26	-0.4384	0.8988	1.000000000000000000
-24	-0.4067	0.9135	0.999999999999999889
-22	-0.3746	0.9272	1.000000000000000000
-20	-0.3420	0.9397	1.000000000000000000
-18	-0.3090	0.9511	0.999999999999999889
-16	-0.2756	0.9613	1.000000000000000000
-14	-0.2419	0.9703	1.000000000000000000
-12	-0.2079	0.9781	1.000000000000000222
-10	-0.1736	0.9848	0.999999999999999889
-8	-0.1392	0.9903	1.000000000000000222
-6	-0.1045	0.9945	0.999999999999999889
-4	-0.0698	0.9976	0.999999999999999889
-2	-0.0349	0.9994	1.000000000000000000
0	0.0000	1.0000	1.000000000000000000
2	0.0349	0.9994	1.000000000000000000
4	0.0698	0.9976	0.999999999999999889
6	0.1045	0.9945	0.999999999999999889
8	0.1392	0.9903	1.000000000000000222
10	0.1736	0.9848	0.999999999999999889
12	0.2079	0.9781	1.000000000000000222
14	0.2419	0.9703	1.000000000000000000
16	0.2756	0.9613	1.000000000000000000
18	0.3090	0.9511	0.999999999999999889
20	0.3420	0.9397	1.000000000000000000
22	0.3746	0.9272	1.000000000000000000

Fig 1. The output of the first problem.

Problem 2.

The next problem asks us to open up the previously created file, and numerically calculate the derivative of our sin values. To compare the precision of our calculations, we plot our values against that of an actual cosine function. The results may shock the uninitiated reader.

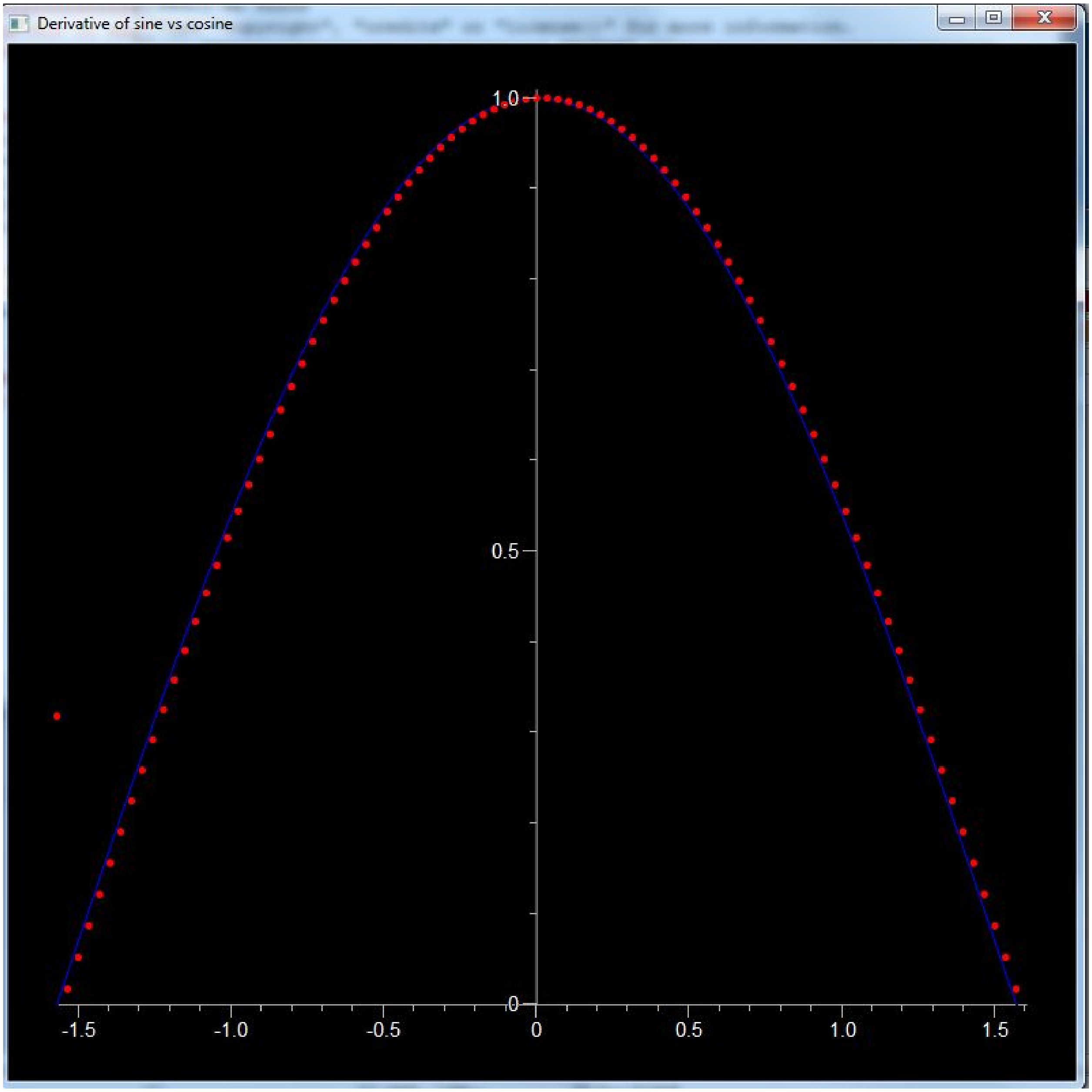


Fig 2. The shocking results. The red dots indicate our calculated derivative, while the blue curve is the analytical solution. Note by using a forward difference technique, our calculated values are slightly 'ahead' of the analytical derivative.

Problem 3.

The follow up to problem 2 is not dissimilar- we are prompted to write a program that will open a file, calculate numerically a derivative, and plot it against something else. The something else in this case is actually a column from the file we are opening, and not some analytical value calculated like in the previous example. For higher precision, we used a center difference technique in this problem, and the results are more 'centered' on the accepted values, as expected. The data is from a physical pendulum, the columns are time, angle, and angular velocity. We calculate the derivative of the angle, and plot them against angular velocity.

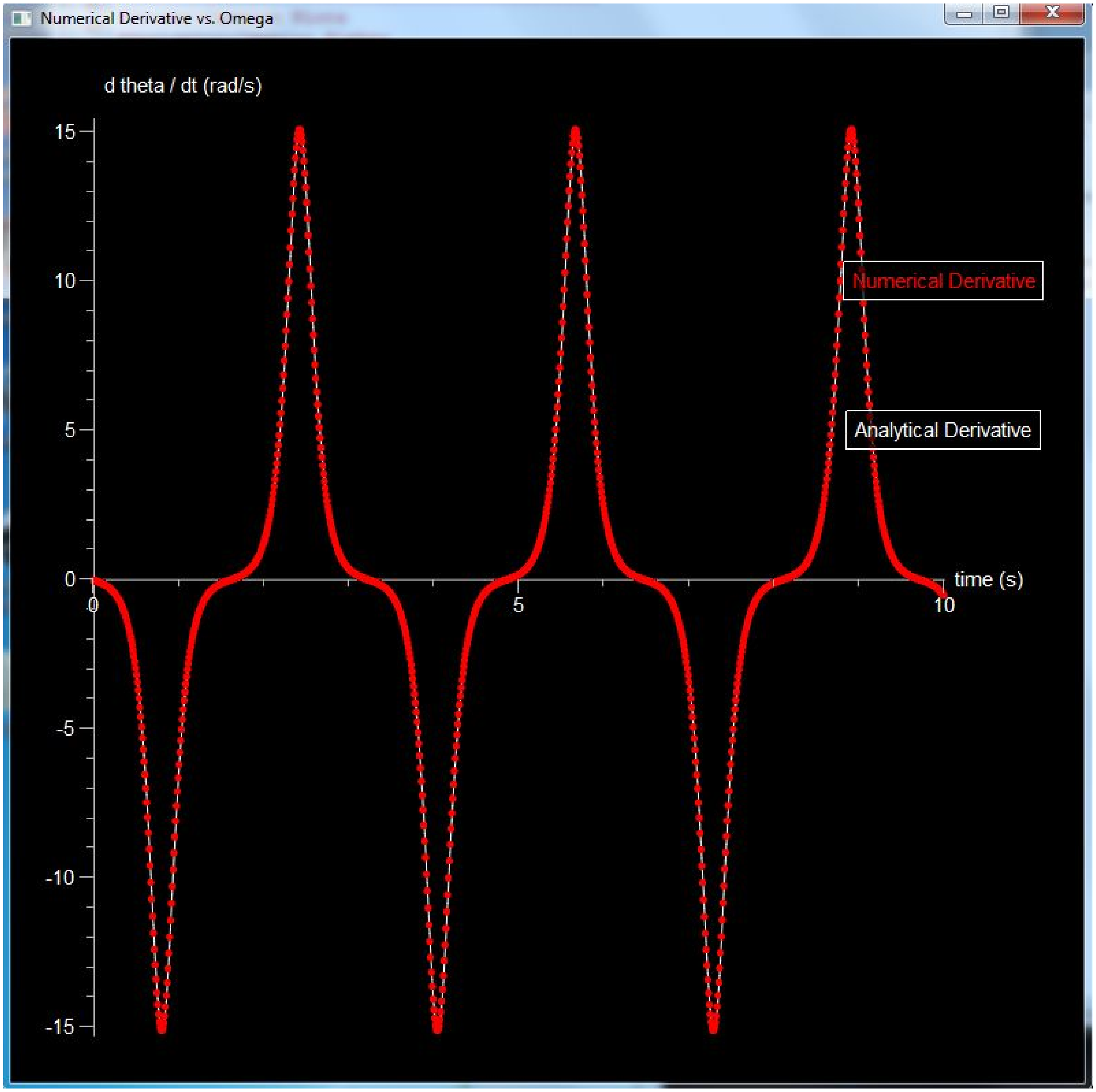


Fig 3. Center differencing makes all the difference.

Problem 4.

Finally, we had to simulate a problem we have seen in the book. A space rock (Are there really rocks in space? -C. Kimber) hits a rod floating in space (There are obviously rods in space) at an angle of 26º. What happens next? For starters, the rock ricochets and the stick begins to rotate. Energy isn't conserved, but angular and linear momenta are. There are values the question tells us to calculate at the end, and they are revealed at the end of the simulation. Our stick velocity was in excellent agreement with the book, while our angular velocity was a little off.

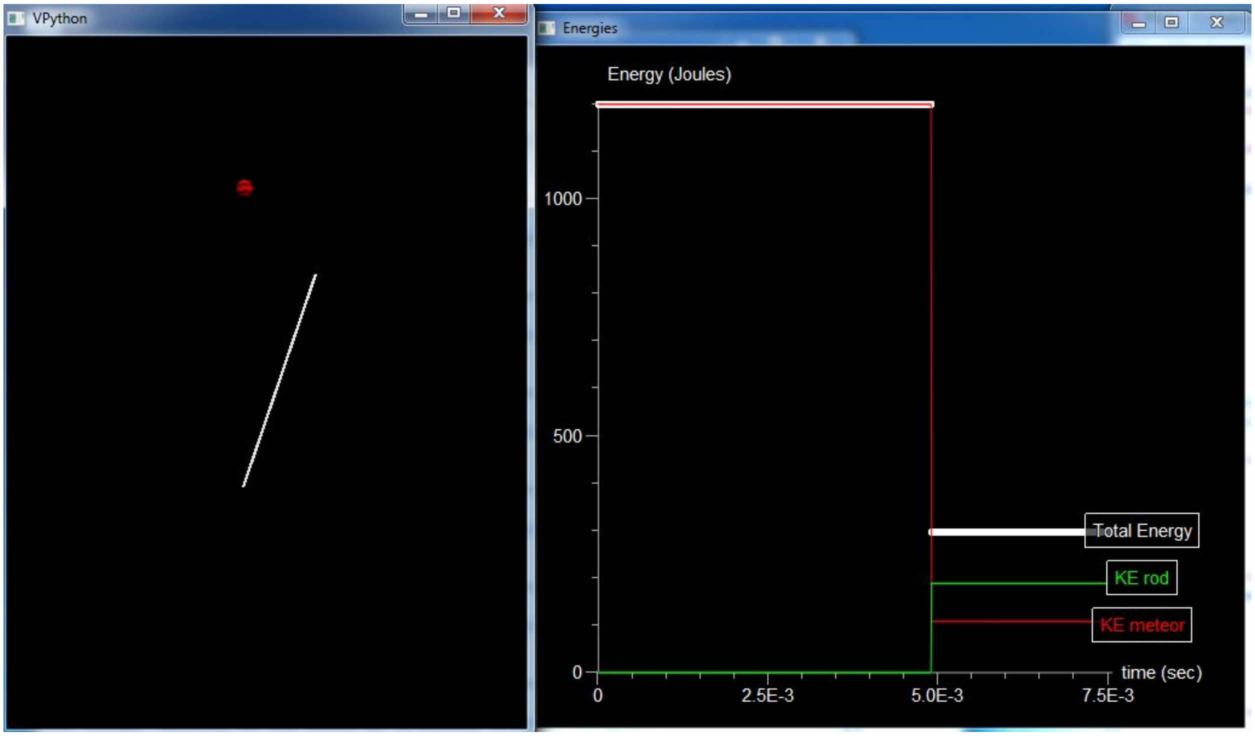


Fig 4. The simulation and energy graphs of problem 4.