Penn Engineering

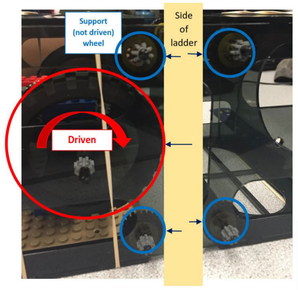
Courtesy of Dr. Bruce Kothmann

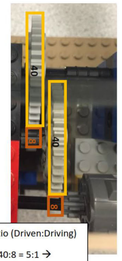
Students in Dr. Kothmann's Mechanical Engineering and Applied Mechanics course are asked to create ePortfolios to document their work from start to finish. As part of the assignment, students reflect and draw conclusions about the process, course content, and their own learning.

SEMESTER'S BEST WORK

Ladder Climbing Vehicle – Deliverable
Erica Higa, MEAM-248-103
Team Members: Anna Estep and Spencer Fox

We created a box that worked essentially like an elevator traveling up and down the sides of the ladder. By measuring the width of the ladder, we were able to determine how far to put holes in the acrylic walls of our box so that the six wheels that were used on each side effectively held the box in place with the use of normal forces. Thus, by obtaining a high enough gear ratio to create enough torque to carry the heavy box, we created a system that traveled by using the concept of rolling without slipping. The free body diagram for one side of our vehicle is shown below.



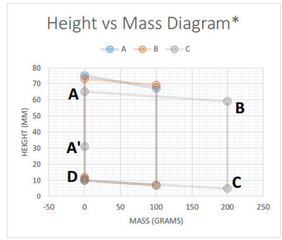


Gear Ratio (Driven:Driving)

(a) 40:8 = 5:1 →
(b) 40:8 = 5:1 →

Total = (a)*(b) = 25:1

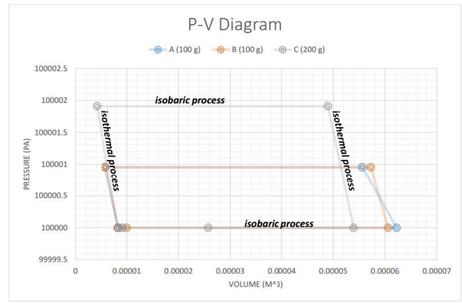
Figure 2



*Our analysis didn't follow the expected real-life Heat Engine 'cycle' because it did not leak air in a model-able fashion. This is because our chamber had water trapped in it. The unusual leakage rates we found are shown in the table to the right.

mass (g)	leakage rate (mm/s)
150	0.00833
392	0.0
392	0.00556

Figure 3

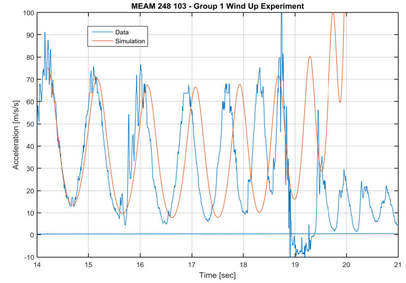


THINGS I'M STILL CONFUSED ABOUT

- Arduino
- Simulink
- How Voltage/Current works

Data and Analysis

From the Simulink model, the equation $\ddot{\theta} = \frac{r\dot{\theta}^2 - gsin\theta - K_{servo}(L_0 - r\theta)^2\dot{\theta}^2}{L_0 - r\theta}$ can be extracted as the acceleration of the accelerometer. In the plot below, the Simulink Model data is compared to the experimental data. This shows that the accelerometer worked in that it effectively translated the motion of the hardware into numerical/graphical data that shows the maximum and minimum acceleration experienced by a rigid body as it travels in circular motion with the effect of gravity. We see that at the bottom of the path, the body experiences the greatest number of g's, while at the top, it experiences the fewest amount.



THINGS I LEARNED

- *You are in charge of what you learn!*
  - As I've looked over the work I did this past semester in order to create this portfolio, I've realized when I did and didn't take advantage of the learning opportunities that this course gave me. For example, page three shows my deliverable from the wind up experiment early in the semester. At this point, I remember being very confused about how to understand Simulink and apply it to understanding a model of the lab experiment; in response, I asked Bruce for help with interpreting the Simulink model and matching it to the excel data we received. Clearly, this was successful, as I managed to find the overarching equation for the system and then create a nice looking graph that showed how it related to the real life data. With time, however, I saw from my deliverables that I was still confused about the labs and how to model various concepts we were looking at, but with the added weight of other classes getting more difficult and training for soccer getting more intense, I lost the motivation to put in the extra time needed to understand concepts that I had not encountered before. When the group design projects came along (ladder climbing vehicle, heat engine), I put in more effort because I didn't want to let my team down. I hope that next semester I will put in more effort to get help with concepts and projects I don't understand in a more timely manner.

THINGS I WANT TO LEARN MORE ABOUT

- I think that Simulink is a really good tool, so I would like to learn how to create my own models for various systems. Furthermore, I'd like to be able to pair this with Dr. Kuchenbecker's matlab models in order to have a fuller picture of how a system works.
- I enjoyed the water rockets and my role as the simulation engineer, despite the challenge it was. It was great because it combined the theories of both Dynamics and Thermodynamics into one fairly understandable system, and required me to translate the theories from these disciplines into a model that a layman could understand. I think that this is a very valuable skill for engineers to have