Summary

This week, we simulated two weights hanging from a pulley, one hanging from each side of the pulley. We measured the different times it took to hit the ground under a change in mass, delta m. We then used 2 different formulas to calculate acceleration and compared them with a percent difference calculation.

Data Sheet

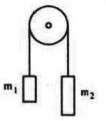
Experiment M-7 **Data Sheet**

$g = 980\ cm/s^2$

Δm = mass transferred from m_1 to m_2 after the a = 0 trial.

m_1 and m_2 each include the mass of the weight hanger.

$a_{meas} = \frac{2s}{t^2}$ $a_{pred} = \frac{2\Delta m g}{m_1 + m_2}$



Trial	m_1	m_2	$m_1 + m_2$	Δm	s	t	a_{meas}	a_{pred}	% Dif.
	g	g	g	g	cm	s	cm/s^2	cm/s^2	%
0	1070	1073	2143	0	NA	NA	0	0	NA
1	1065	1078	2143	5	84	5.59	5.376	4.57613	16.080
2	1060	1083	2143	10	84	4.34	8.919	9.152	2.5784
3	1055	1088	2143	15	84	3.46	14.033	13.728	2.19596
4	1050	1093	2143	20	84	2.94	19.436	18.30	5.9978

$$\frac{a\,meas - a\,pred}{a\,meas + a\,pred} \times 200$$

Calculations

```
[Quinns-iMac:homework qd$ python3
Python 3.8.5 (default, Jul 21 2020, 10:41:41)
[Clang 10.0.0 (clang-1000.11.45.5)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
[>>> s = 84
[>>> 2 * s / 5.59**2
5.376326880674346
[>>> 2 * s / 4.34**2
8.919280511372083
[>>> 2 * s / 3.46**2
14.033211934912625
[>>> 2 * s / 2.94**2
19.436345966958214
[>>> g = 9.80665
[>>> m1_p_m2 = 2143
[>>> w * 5 * g / m1_p_m2
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'w' is not defined
[>>> 2 * 5 * g / m1_p_m2
0.04576131591227251
[>>> 2 * 10 * g / m1_p_m2
0.09152263182454502
[>>> 2 * 15 * g / m1_p_m2
0.13728394773681754
[>>> 2 * 20 * g / m1_p_m2
0.18304526364909005
[>>> def percent_error(meas, pred):
[...     return 200 * abs((meas - pred) / (meas + pred))
[...
[>>> percent_error(5.376326880674346, 0.04576131591227251)
196.62408177417097
[>>> 2 * 5 * (100 * g) / m1_p_m2
4.576131591227251
[>>> percent_error(5.376326880674346, 0.04576131591227251*100)
16.080354250284103
[>>> percent_error(8.919280511372083,0.09152263182454502 * 100)
2.578447918226364
[>>> percent_error(14.033211934912625 ,0.13728394773681754 * 100)
2.1959619587615995
[>>> percent_error(19.436345966958214 ,0.18304526364909005 * 100)
5.997845476897128
>>>
```

Analysis & Conclusion

I think it's curious that two very different equations can get results that are in a few percent error of eachother. However, on some observations the percent error was quite high, like 16%. Possible sources of error might be the delta m is imperfect, m1 and m2 are imperfect, the timing mechanism is imperfect, or the string tension force is not uniform throughout the string.

Questions

1.

- $a = (g(m2 - m1) - F_f) / (m1 - m2)$
- $T = m2\ g - (m2(m2 - m1) - F_f) / (m1 + m2)$

2. Newton's first law, on wikipedia, says "an object either remains at rest or continues to move at a constant velocity, unless acted upon by a force" (given an inertial frame of reference). The third law says that every action has an equal and opposite reaction. I think we're implicitly using law number 3, because the acceleration upward of the one weight is complemented by the acceleration downward of the other.

3a. Newton's third law.
3b. Newton's third law.
3c. Newton's third law.
3d. Newton's third law.