Lab 3 Newton's Laws

Student Name: Harshan Atwal
Access Code (located on the underside of the lid of your lab kit): AC-8C7GM34

Pre-Lab Questions

Use the free body diagram of the pulley (Figure 4) to answer the Pre-Lab Questions.

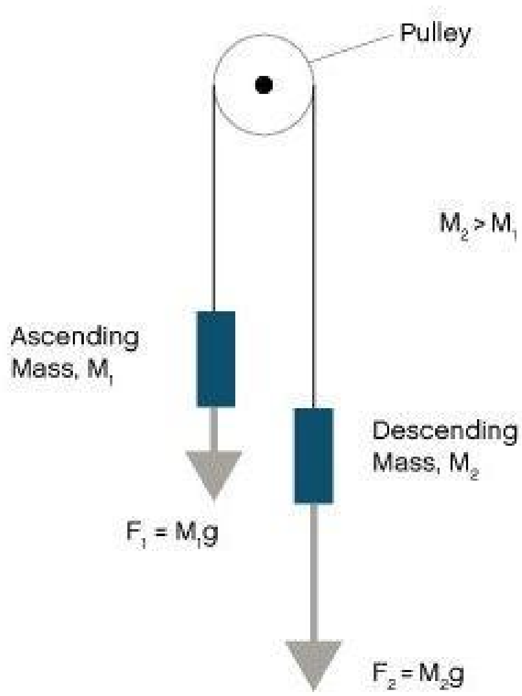
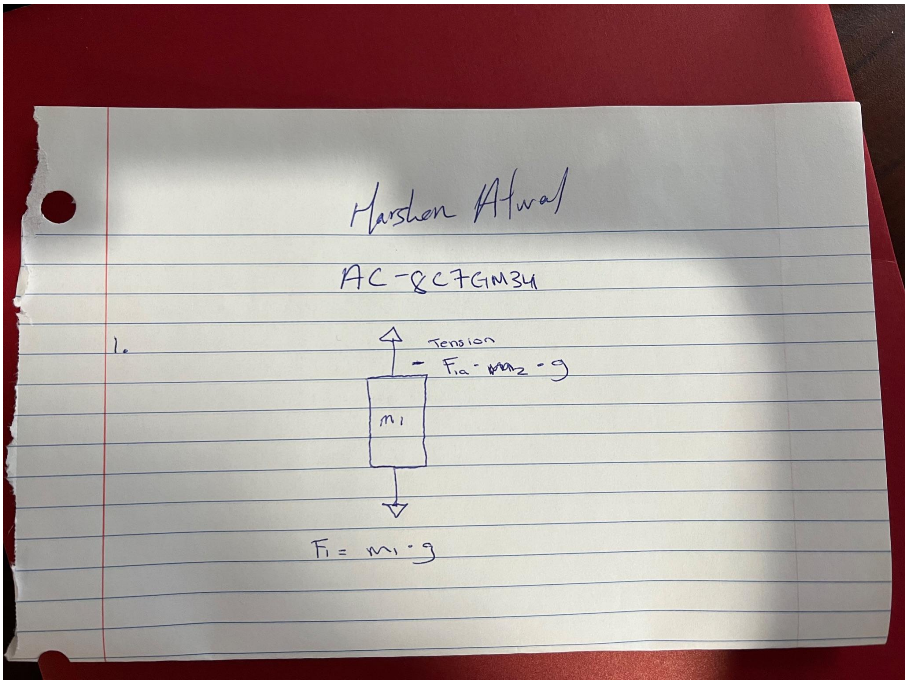
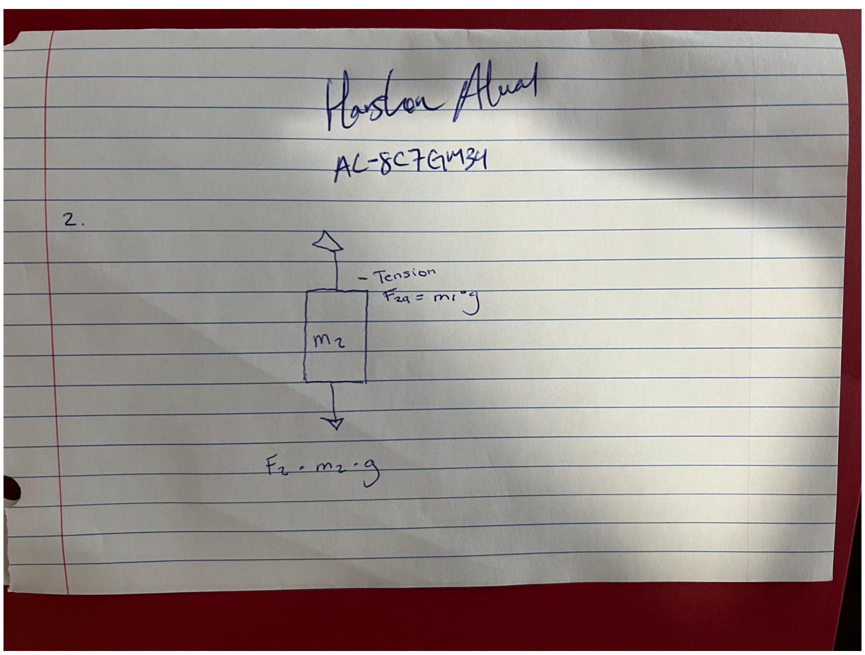


***Figure 4:* Free Body Diagram: 2 objects with mass hanging on a pulley by string.**

1. Draw a free body diagram for M_1. Handwrite your name next to your diagram.



2. Draw a free body diagram for M_2. Handwrite your name next to your diagram.



3. Apply Newton's 2nd Law to write the equations for M_1 and M_2. You should get two equations with Tension in the string, weight for each mass and accelerations for each mass (a_1 and a_2).
For M1: Tension - M1*g* = *M1*a1 For M2: M2*g* - *Tension* = *M2*a2

4. This results in two equations with three unknowns! A third equation is required to solve the system. What is the third equation? (Hint: What is the relationship between a_1 and a_2?)
The third equation is M2*g* - *Tension* = -*M1*a1

EXPERIMENT 1: NEWTON'S FIRST LAW OF MOTION

Data Table

Table 1. Motion of Water Observations

Motion	Observations
a	water splashed out
b	water moved but did not spill
c	water spilled left when turning right and spilled right when turning left
d	water first spilled forward then back at me

Table 2. Observations after Flicking Notecard Off of Cup

Trial	Observations
1	card and coin both fell away
2	coin fell into cup and card fell away
3	coin and card both fell away

4	coin fell into cup and card fell away
5	coin fell into cup and card shifted to side of cup

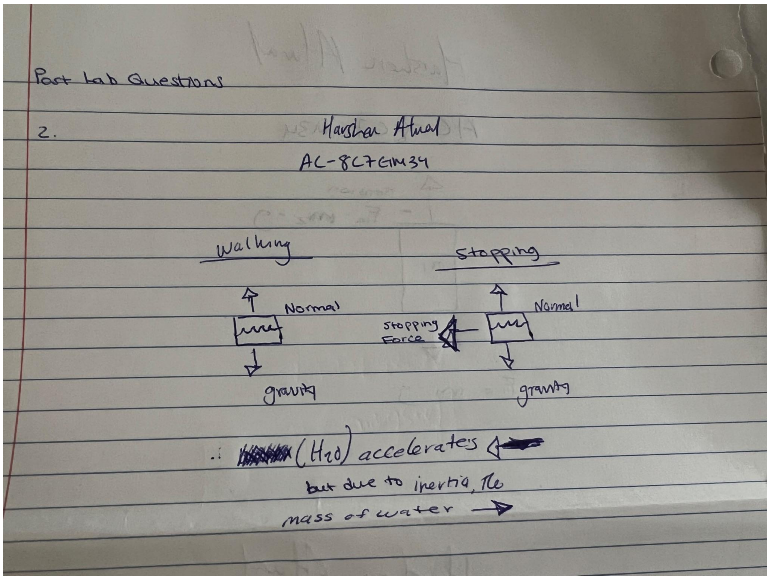
Post-Lab Questions

1. Explain how your observations of the water and washer demonstrate Newton's law of inertia.
   In the case of the water and washer, when an external force was applied, due to inertia, the water stayed at rest and spilled side to side and front and back.

2. Draw a free body diagram of your containers of water from the situation in Part 1 Step 4d. Draw arrows for the force of gravity, the normal force (your hand pushing up on the container), and the stopping force (your hand accelerating the container as you stop.) What is the direction of the water's acceleration?

   The direction of water was towards me

   Handwrite your name next to your diagram.



3. Can you think of any instances when you are driving or riding a car that are similar to this experiment? Describe two instances where you feel forces in a car in terms of inertia.

   Two situations where you feels forces in a car regarding inertia are during sudden braking, which causes one to thrust forward, and during sudden acceleration, where one is thrust back into the seat.

EXPERIMENT 2: NEWTON'S THIRD LAW AND FORCE PAIRS

Data Table

Table 3. Forces on a Stationary Spring

Force on Stationary 10 N Spring Scale (N)
5.5N
Force on Stationary 5N Spring Scale (N)
5N

Table 4. Spring Scale Force Data

Suspension Set Up	Force (N) on 10 N Spring Scale	Force (N) on 5 N Spring Scale
0.5 kg Mass on 10 N Spring Scale	5N	
0.5 kg Mass with String on 10 N Spring Scale	5.3N	
0.5 kg mass, string and 5 N Spring Scale on 10 N spring scale	5.5N	5N
0.5 kg mass, string and 5 N Spring Scale on 10 N spring scale on Pulley	6.2N	5N

Post-Lab Questions

1. How did the magnitude of the forces on both spring scales compare after you moved the 10

N spring scale?

magnitude forces of both scales are equal

2. How did the magnitude of the forces on both spring scales compare after you move the 5 N spring scale?

   Both will read at 5N

3. Use Newton's 3rd Law to explain your observations in Questions 1 and 2.

   Newton's Third Law states that for every action, there is an equal and opposite reaction; therefore, when we pull one scale by 5N, the other scale will exert the same amount in the opposite direction.

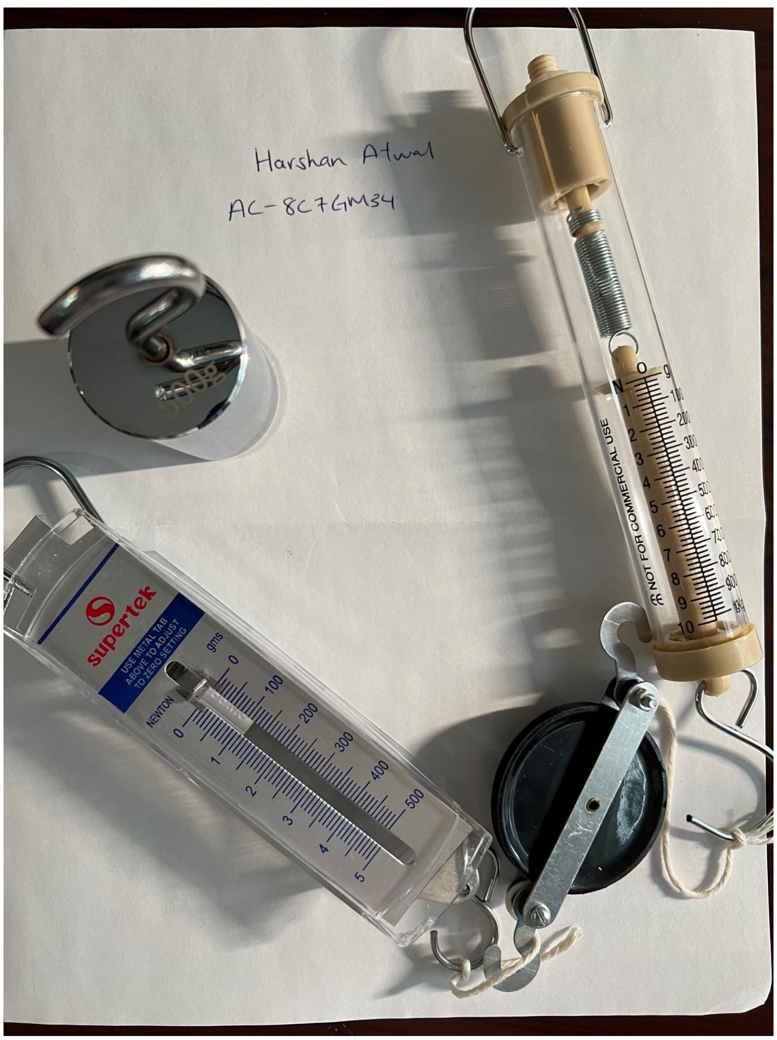
4. Compare the force on the 10 N spring scale when it was directly attached to the 0.5 kg mass and when there was a string between them.

   it was slightly greater with the string than when it was directly attached

5. Compare the force on the two spring scales in Steps 5 and 6. What can you conclude about the tension in a string?

   In Step 5, the force applied to each spring scale was equal to the 5 N string tension. Then due to the increased string tension in Step 6, the force on the 10 N spring scale increased while the force on the 5 N spring scale dropped. This shows that if the string has no mass and doesn't stretch out, the tension is constant throughout the entire string.

Take a photo of your pulley, spring scales, and 0.5kg mass setup (should look like Figure 6) . Be sure to have your name handwritten in the background of the photo.



EXPERIMENT 3: Newton's second law and the Atwood

Data Table

Table 5. Motion Data

Mass of 15 Washers (kg)	0.06kg	Average Mass of Washer (kg)	0.004kg
Procedure 1			
Height (m): 1.25m			
Trial	**Time (s)**		
1	3.62s		
2	3.70s		
3	3.55s		
4	3.82s		
5	3.65s		
Average	3.67s		
Average Acceleration (m/s^2)	**0.34m/s^2**		
Procedure 2			
Height (m): 1.45m			
Trial	**Time (s)**		
1	1.30s		
2	1.15s		

3	1.10s
4	1.20s
5	1.20s
Average	1.19s
Average Acceleration (m/s^2)	**0.82m/s^2**

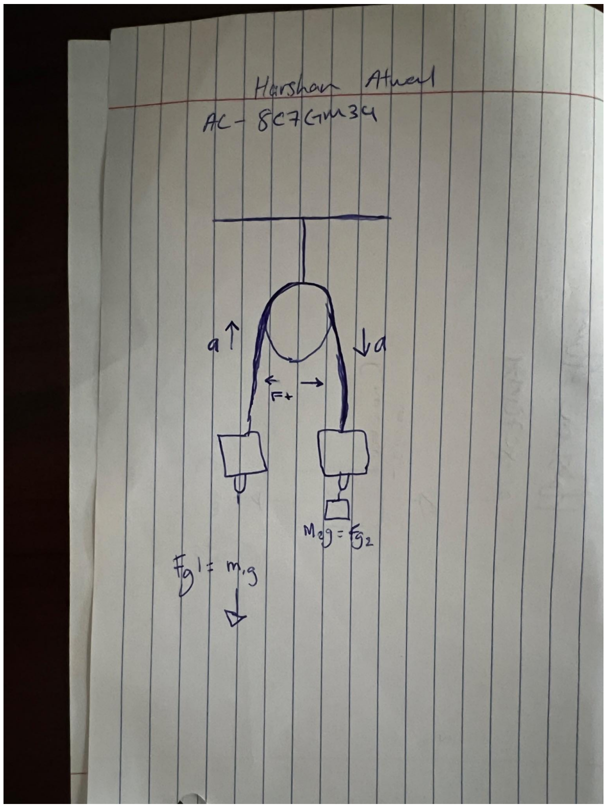
Post-Lab Questions

1. When you give one set of washers a downward push, does it move as easily as the other set? Does it stop before it reaches the floor? How do you explain this behavior?

The washers push back on the hand with an equal and opposite force, this makes it harder to move the set that is pushed downward. It stops before it reaches the floor because of gravity and friction.

2. Draw a free body diagram for M_1 and M_2 in each procedure (Procedure 1 and Procedure 2). Draw force arrows for the force due to gravity acting on both masses (F_{g1} and F_{g2}) and the force of tension (F_T). Also draw arrows indicating the direction of acceleration, *a*.

Handwrite your name next to your diagram.



3. Use Newton's Second Law to write an equation for each of the free body diagrams you drew in Question 2. (Note: Be sure to use the correct signs to agree with your drawings). Solve these four equations for the force of tension (F_T). You answer should be in variable form.

FT2= m2g - m2a FT1= m1g + m1a

4. Set the two resulting expressions for the force of tension equal to one another (as long as the string does not stretch, the magnitude of the acceleration in each equation is the same). Replace F_{g1} and F_{g2} with M_1 and M_2, respectively. Solve the resulting equation for *a*. Then, go back to Question 3 and solve for the F_T.

m2g - m2a = m1g + m1a (m2 -m1)g = (m1+m2)a

a= (m2-m1)g / m1 + m2

5. Calculate the acceleration for the two sets of data you recorded and compare these values to those obtained by measuring distance and time using percent error. What factors may cause discrepancies between the two values?

Set 1 Percent error: |(0.38 - 0.34) / 0.34| x 100% = 11.76%

Set 2 Percent error: |(0.79 - 0.82) / 0.82| x 100% = 3.66%

The discrepancies are caused by measurement and timing errors.

6. Calculate the tension in the string for the falling washers. From these two values, and the one where the masses were equal, what trend do you observe in the tension in the string as the acceleration increases?

The tension in the string will grow as the system's acceleration increases. This is due to the string's tension having to be strong enough to accelerate both masses in the same direction.