ATWOOD MACHINE

Mass difference, total mass, tension, and acceleration

Name: _____	Period: _____	Date: _____

INVESTIGATION QUESTION **How do mass difference and total mass determine the acceleration of an Atwood machine?**

TIME 30 minutes	SIMULATION BuildPhysics > Atwood machine	UNIT 2 Force & Translational Dynamics

Learning targets

- Apply Newton's second law to a two-mass system.
- Test acceleration while total mass or mass difference is controlled.
- Compare rope tension with the weights of the two masses.

Model before you measure

The pulley is massless in this preset. Label the heavier side m_1 and choose its downward direction as positive.	$a = (m_1 - m_2)g/(m_1 + m_2)$

Important: Use $g = 9.8\ m/s^2$. Keep both masses clear of the pulley and floor, and reset before each run.

Pre-lab prediction | 4 minutes

1. What happens when the two masses are equal?

2. If total mass stays constant, how should acceleration change as the mass difference grows?

3. If mass difference stays constant but total mass increases, how should acceleration change?

PART A Keep total mass constant

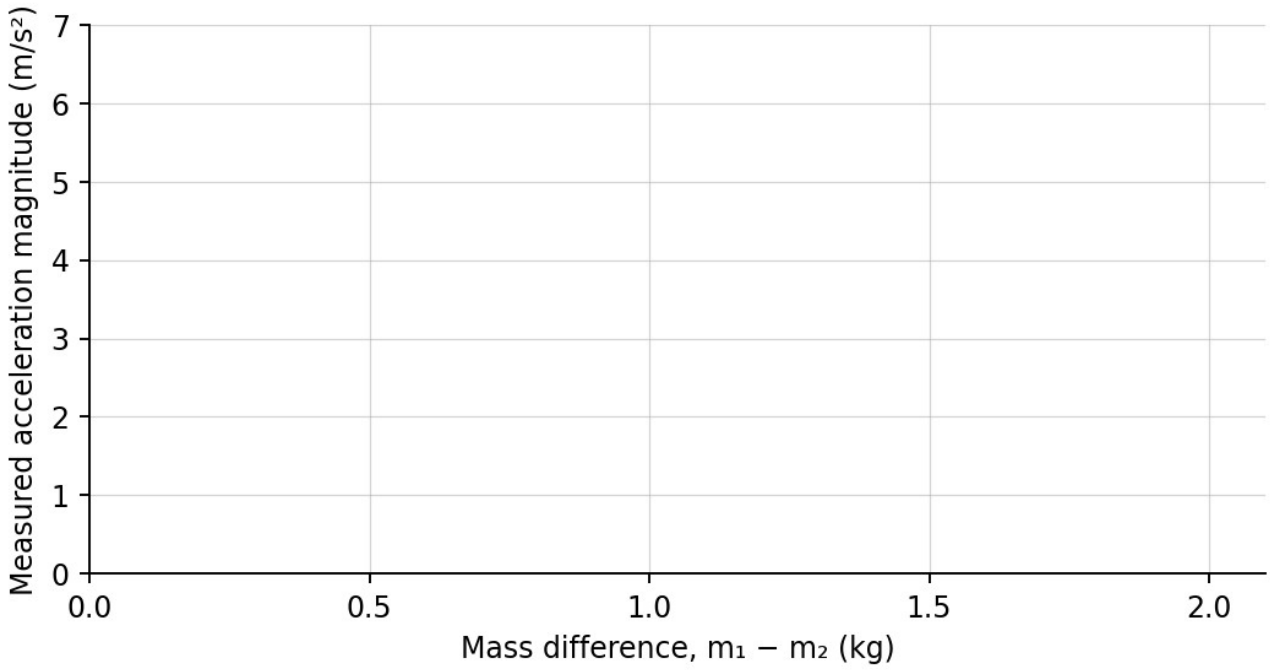
Setup | 3 minutes

- ☐ Load Atwood machine. Confirm the pulley is massless and the rope is connected to both masses.
- ☐ Set m_1 and m_2 so their total is 3.0 kg for every Part A trial.
- ☐ Select a mass to read acceleration and select the rope or mass to read tension.
- ☐ Reset, run briefly, pause before either mass reaches an obstacle, and record.

Control: Keep $m_1 + m_2 = 3.0$ kg. The independent variable is the mass difference $m_1 - m_2$.

Data table | 10 minutes

m_1 (kg)	m_2 (kg)	$m_1 - m_2$ (kg)	Predicted a (m/s²)	Measured a (m/s²)
1.50	1.50			
1.75	1.25			
2.00	1.00			
2.25	0.75			
2.50	0.50			



4. Plot measured acceleration versus mass difference. Draw a best-fit line.

PART B Keep mass difference constant

Total-mass test | 6 minutes

Control: Keep $m_1 - m_2 = 1.0$ kg while increasing both masses.

m_1 (kg)	m_2 (kg)	Predicted a (m/s^2)	Measured a (m/s^2)
2.0	1.0		
3.0	2.0		
4.0	3.0		

Analysis | 8 minutes

5. What did the slope in Part A represent when total mass was 3.0 kg?

6. Why did equal masses produce zero acceleration even though both weights were nonzero?

7. Why did acceleration decrease in Part B while the mass difference stayed 1.0 kg?

8. For the 2.0 kg and 1.0 kg trial, calculate the predicted rope tension using either mass.

Claim-Evidence-Reasoning conclusion

Evaluate this statement: “Only the difference between the two masses determines an Atwood machine's acceleration.”

CLAIM	Accept, reject, or revise the statement.
EVIDENCE	Cite at least two measurements or graph features.
REASONING	Connect your evidence to the force model and Newton's laws.

Exit ticket

Predict the acceleration of an ideal Atwood machine with masses 3.0 kg and 1.0 kg. Use $g = 9.8$ m/s².