BUILD PHYSICS | GUIDED INVESTIGATION

ELEVATOR FORCES

Apparent weight, acceleration, and Newton's second law

Name: _____	Period: _____	Date: _____

INVESTIGATION QUESTION **When is apparent weight greater than, equal to, or less than actual weight?**

TIME 30 minutes	SIMULATION Build Physics > Elevator forces	PHYSICS 1 Force & Translational Dynamics

Learning targets

- Use force and acceleration data to test Newton's second law.
- Explain why the normal force--not weight--is the rider's apparent weight.
- Interpret the slope and intercept of a graph of normal force versus acceleration.

Model before you measure

Choose +y upward. Forces on rider: F_N upward; $F_g = mg$ downward.	**Sum $F_y = F_N - mg = ma_y$** **Therefore: $F_N = mg + ma_y$**

Important: velocity tells how the elevator is moving; acceleration determines the net force and the scale reading.

Pre-lab prediction | 4 minutes

Without calculating, complete each row. Use up, down, or 0 for acceleration and >, =, or < for F_N compared with F_g.

Elevator motion	Direction of a_y	F_N ___ F_g	Rider feels...
Moving upward and speeding up			heavier / same / lighter
Moving upward and slowing down			heavier / same / lighter
Moving downward and speeding up			heavier / same / lighter
Moving downward and slowing down			heavier / same / lighter

PART A

How acceleration changes apparent weight

Setup | 3 minutes

1. Open Build Physics. Choose Elevator forces, then load/reload the experiment.
2. Confirm that force vectors and vector values are visible. The rider begins at m = 1.00 kg.
3. Select Elevator floor. In the Object Inspector under Prescribed motion, edit y acceleration.
4. Select Elevator rider to read F_N, F_g, and a_y. Keep mass and gravity constant in Part A.

FAST, CONSISTENT TRIALS Reset, then set a_y > Run briefly > Pause > record. Do not reload between trials; Reload experiment restores the original settings.

Data table | 10 minutes

Before each run, calculate the predicted normal force. After pausing, record the displayed values. Use g = 9.8 m/s^2.

Trial	Floor a_y (m/s^2)	Calculated F_N (N)	Measured F_g (N)	Measured F_N (N)	Rider a_y (m/s^2)	Feels...
1	+5.0					heavy / same / light
2	+2.0					heavy / same / light
3	0.0					heavy / same / light
4	-2.0					heavy / same / light
5	-5.0					heavy / same / light

Prediction: $F_N = mg + ma_y$

Free-body diagrams | 3 minutes

Draw and label only the forces acting on the rider. Make arrow lengths show relative force magnitudes.

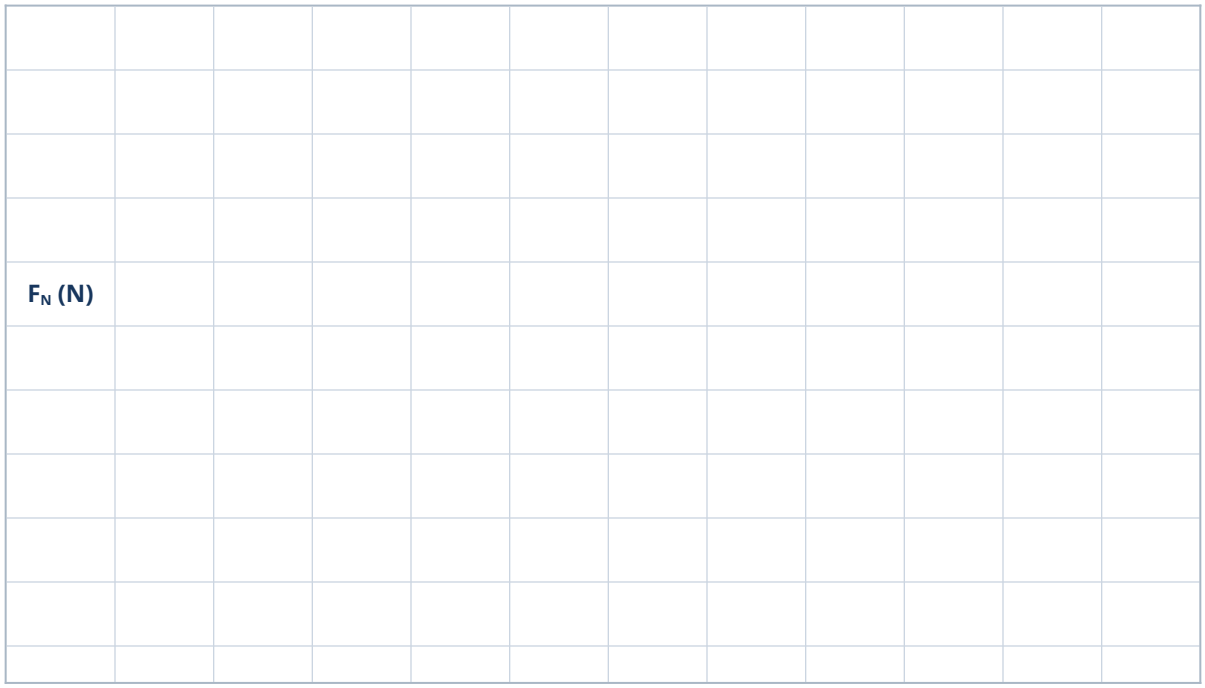
Trial 1: a_y = +5.0 m/s^2	Trial 5: a_y = -5.0 m/s^2

PART A ANALYSIS

Turn the data into a model

Graph | 5 minutes

Plot measured F_N on the vertical axis and floor a_y on the horizontal axis. Draw one best-fit line; do not connect point-to-point.



Best-fit slope: _____ kg	**y-intercept: _____ N**	**Equation: F_N = _____**

Analyze | 7 minutes

1. As a_y increased, what happened to F_N? Describe the pattern using evidence from two trials.

_____

_____

2. What physical quantity should the graph's slope represent? Compare your slope with the rider's mass.

_____

_____

3. What should the y-intercept represent physically? Explain why.

_____

_____

4. Why did F_g remain constant even though the rider's apparent weight changed?

_____

_____

5. Use Sum $F_y = ma_y$ to explain why the two force arrows in your diagrams have different lengths.

_____

_____

PART B

Change the mass, test the relationship

Keep floor a_y = +2.0 m/s^2 and g = 9.8 m/s^2. Change only the rider's mass. Reset, run briefly, pause, and record each trial.

m (kg)	Calculated F_g (N)	Measured F_g (N)	Calculated F_N (N)	Measured F_N (N)	Measured F_N / m (N/kg)
0.50					
1.00					
1.50					

6. At constant acceleration, how did changing mass affect F_N? Use one ratio or comparison from your table.

7. Did changing mass change the rider's acceleration? Explain using Newton's second law.

Reasoning challenge

A 70.0 kg passenger is moving downward while the elevator slows at 2.0 m/s^2. Determine the passenger's acceleration direction and the normal force. Then state whether the passenger feels heavier or lighter than usual.

Claim-Evidence-Reasoning conclusion

Evaluate this claim: "The direction an elevator is moving determines whether a passenger feels heavier or lighter."

CLAIM	Accept, reject, or revise the statement.
EVIDENCE	Cite at least two measured trials or graph features.
REASONING	Connect your evidence to Sum $F_y = F_N - mg = ma_y$.

Exit ticket

In true free fall, what value would a scale read? Does that mean gravity has disappeared? Explain in one sentence.