NET FORCE AND ACCELERATION

Vector addition, acceleration, and the direction of ΣF

Name: ____________________________	Period: ____________	Date: ______________

INVESTIGATION QUESTION **How do multiple forces combine to determine an object's acceleration?**

TIME	SIMULATION	UNIT 2
30 minutes	BuildPhysics > Net force and acceleration	Force & Translational Dynamics

Learning targets

- Add force components vectorially and compare the result with the displayed net force.
- Test whether acceleration is parallel to the net-force vector.
- Explain how mass changes acceleration without changing the applied-force sum.

Model before you measure

The preset is gravity-free. Choose +x right and +y up. Use the Object Inspector to set exact x- and y-components for each applied force.	$\Sigma F = ma$

Important: The acceleration vector follows the net force, not necessarily any single applied force. Use $g = 9.8\ m/s^2$ only if you later turn gravity on.

Pre-lab prediction | 4 minutes

1. Two forces are 6 N east and 8 N north. Predict the magnitude and direction of their vector sum.

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2. What should happen to acceleration when the applied forces add to zero?

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3. If the same net force acts on twice the mass, how should acceleration change?

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PART A Add forces and test vector addition

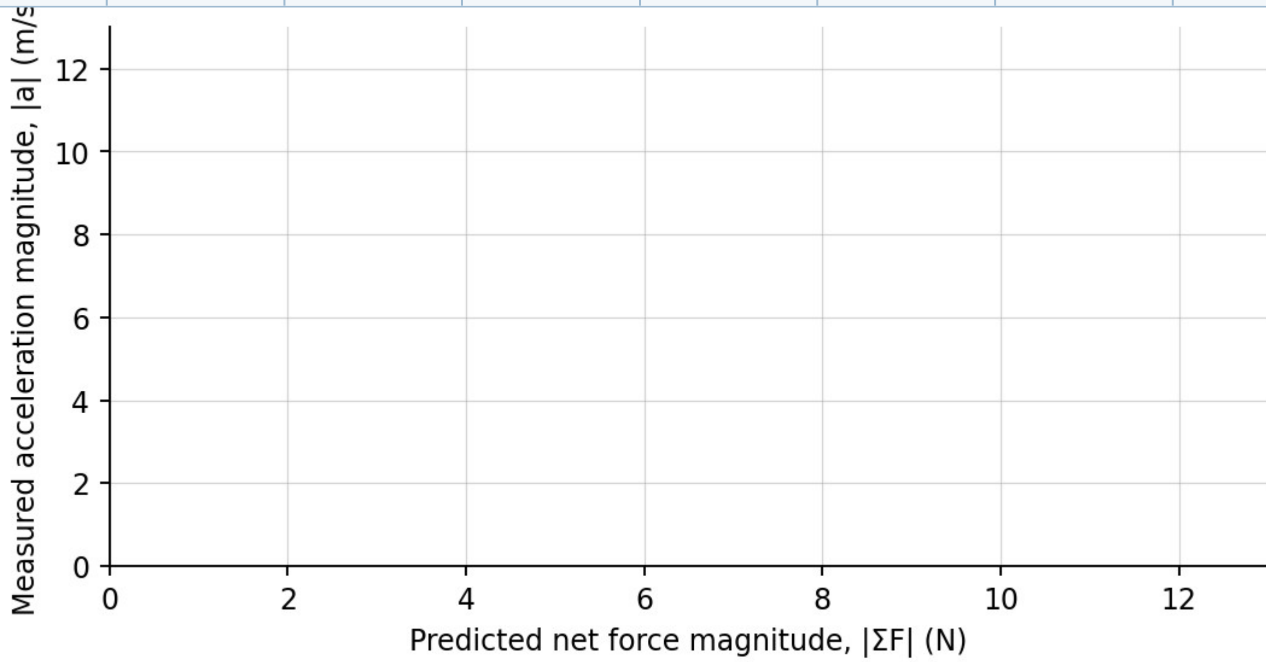
Setup | 3 minutes

- ☐ Load Net force and acceleration. Confirm gravity is off and the Force disk is selected.
- ☐ Use Draw force to add two forces. In the Object Inspector, edit each force component to match the table.
- ☐ Keep mass at 1.00 kg. Turn on ΣF, acceleration, vector values, and x- and y-components.
- ☐ Reset after every change, run briefly, pause, and record the displayed acceleration.

Consistent trials: Change only the listed force components. The disk may move off-screen during a long run, so pause after about 0.5 s.

Data table | 10 minutes

Trial	$F_{1}x$ (N)	$F_{1}y$ (N)	$F_{2}x$ (N)	$F_{2}y$ (N)	Predicted |ΣF| (N)	Measured |a| (m/s²)	Direction of a
1	+6	0	0	+8			
2	+10	0	−4	0			
3	+6	+8	−6	0			
4	+5	+5	−2	−9			
5	+8	0	−8	0			



4. Plot measured |a| versus predicted |ΣF|. Draw a best-fit line.

PART B Keep the force sum constant and change mass

Mass test | 7 minutes

Force pair: Use F_1 = 6 N east and F_2 = 8 N north for every trial. The net-force magnitude is 10 N.

Mass m (kg)	Predicted $|a| = |\Sigma F|/m$ (m/s^2)	Measured $|a|$ (m/s^2)
0.50		
1.00		
2.00		
4.00		

Analysis | 7 minutes

5. For which trial in Part A was the acceleration zero? Explain using vector addition.

6. Compare the direction of a with the direction of ΣF in at least two trials.

7. How did changing mass affect acceleration when the force sum stayed constant?

8. Why is it incorrect to predict acceleration from only the largest individual force?

Claim-Evidence-Reasoning conclusion

Evaluate this statement: “The largest individual force always determines the direction of 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

A 2.0 kg object experiences 3.0 N east and 4.0 N north. Determine the magnitude and direction of its acceleration.