UNIFORM CIRCULAR MOTION

Centripetal acceleration, string tension, speed, and mass

Name: _____	Period: _____	Date: _____

INVESTIGATION QUESTION **How does the required centripetal force depend on tangential speed?**

TIME 30 minutes	SIMULATION BuildPhysics > Uniform circular motion	UNIT 2 Force & Translational Dynamics

Learning targets

- Measure tension and inward acceleration during uniform circular motion.
- Test the v^2 dependence of centripetal force.
- Test how mass changes force while speed and radius remain fixed.

Model before you measure

Gravity is off. The string tension is the inward net force. The baseline radius is 3.0 m and the baseline mass is 1.0 kg.	$a_c = v^2/r$ $F_c = mv^2/r$
Important: The velocity is tangent to the circle while acceleration and tension point toward the center. No value of g is needed because gravity is off.	

Pre-lab prediction | 4 minutes

1. If speed doubles, by what factor should tension change?

_____

2. If mass doubles at the same speed and radius, what should happen to tension?

_____

3. Are velocity and acceleration parallel in uniform circular motion? Explain.

_____

PART A Change speed at fixed mass and radius

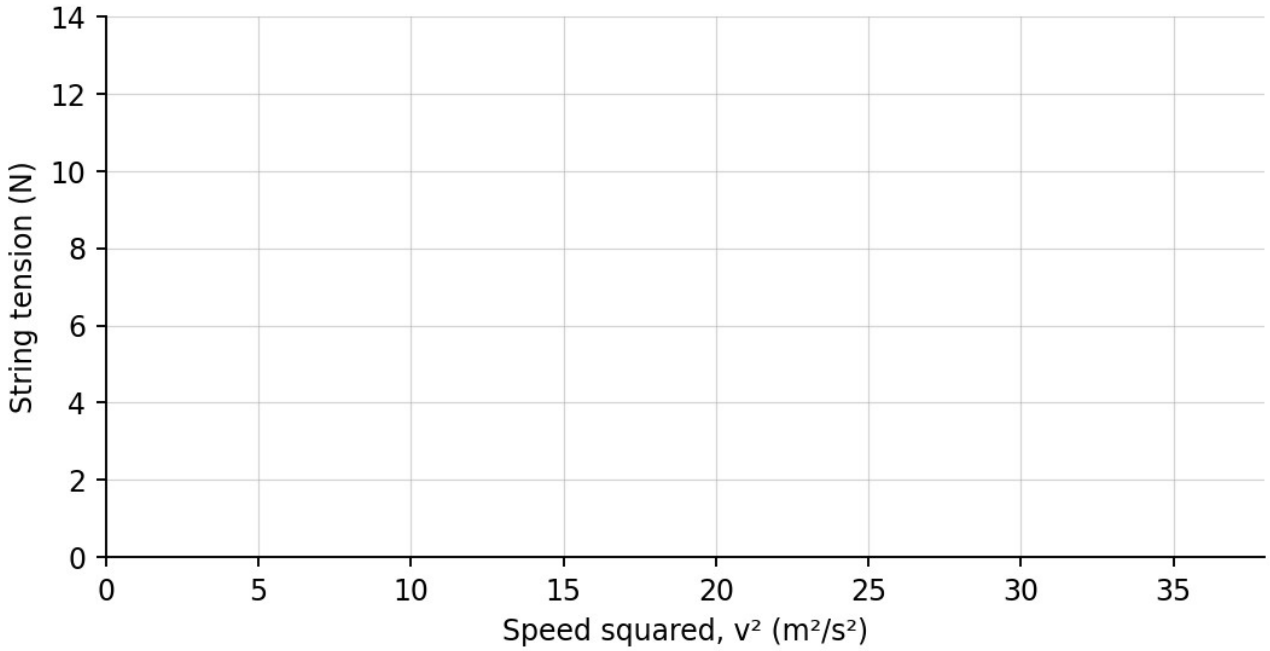
Setup | 3 minutes

- ☐ Load Uniform circular motion. Keep m = 1.0 kg and r = 3.0 m.
- ☐ Select the moving mass and set its tangential velocity to the listed speed.
- ☐ Graph tension, acceleration magnitude, and speed. Reset before each trial.
- ☐ Run for at least one revolution and record the steady values.

Tangential direction: At the starting point to the right of the pivot, set $v_x = 0$ and v_y equal to the listed positive speed.

Data table | 10 minutes

v (m/s)	v^2 (m^2/s^2)	Predicted $T = mv^2/r$ (N)	Measured T (N)	Measured $\lvert a \rvert$ (m/s^2)
2	4			
3	9			
4	16			
5	25			
6	36			



4. Plot measured tension versus v^2. Draw a best-fit line.

PART B Change mass and radius

Mass test | 5 minutes

Fixed motion: Use v = 4.0 m/s and r = 3.0 m.

Mass (kg)	Predicted T (N)	Measured T (N)
0.50		
1.00		
1.50		
2.00		

Radius challenge | 3 minutes

Use m = 1.0 kg and v = 4.0 m/s. Compare r = 2.0 m and r = 4.0 m. Record T_2m = _____ N and T_4m = _____ N.

Analysis | 7 minutes

5. What did the slope of the T-versus-v^2 graph represent?

6. How did tension change with mass? How did it change with radius?

7. Why can speed remain constant while velocity changes continuously?

8. Compare the direction of tension, acceleration, and velocity at one point on the path.

Claim-Evidence-Reasoning conclusion

Evaluate this statement: “Doubling an object's speed in a circle doubles the required centripetal force.”

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 moves at 6.0 m/s in a circle of radius 3.0 m. Determine its centripetal acceleration and net force.