ELLIPTICAL ORBIT

Radius, speed, gravitational force, energy, and angular momentum

Name: _____	Period: _____	Date: _____

INVESTIGATION QUESTION **How do orbital speed and gravitational force change between apoapsis and periapsis?**

TIME 30 minutes	SIMULATION BuildPhysics > Elliptical orbit	UNIT 6 Energy & Momentum of Rotating Systems

Learning targets

- Compare orbital quantities at apoapsis and periapsis.
- Test conservation of angular momentum in a central-force orbit.
- Track kinetic, gravitational potential, and total mechanical energy.

Model before you measure

Gravity is a central force, so its torque about the planet center is zero. The satellite moves fastest at periapsis and slowest at apoapsis.	$L = mrv_t = \text{constant}$ $E = \frac{1}{2}mv^2 - GMm/r$ $F_g = GMm/r^2$

Important: Use the planet center as the angular-momentum axis. Record radius from the planet center to the satellite center.

Pre-lab prediction | 4 minutes

1. At which point should speed be greatest: apoapsis or periapsis?

_____

2. At which point should gravitational-force magnitude be greatest?

_____

3. Predict how total mechanical energy changes during one complete orbit.

_____

PART A Analyze one complete elliptical orbit

Setup | 3 minutes

- ☐ Load Elliptical orbit. Turn on the trail and graph radius, speed, gravitational force, kinetic energy, and gravitational potential energy.
- ☐ Run at least one complete orbit and identify apoapsis and periapsis from the radius graph.
- ☐ Pause at apoapsis and periapsis and record all requested quantities.
- ☐ Calculate mrv at each point using the tangential speed.

Apoapsis-periapsis data | 10 minutes

Location	Radius r (m)	Speed v (m/s)	|Fg| (N)	K (J)	Ug (J)	Angular momentum mrv (kg·m²/s)
Apoapsis						
Periapsis						

Energy comparison | 3 minutes

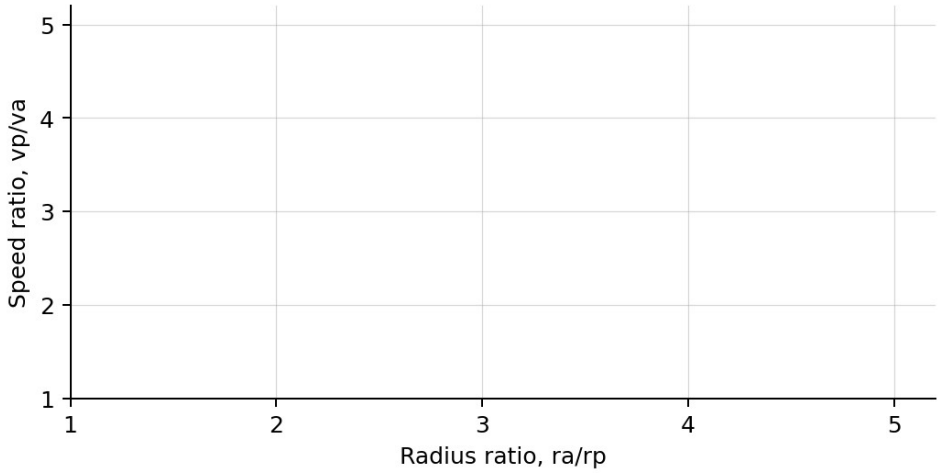
Total mechanical energy at apoapsis (J)	Total mechanical energy at periapsis (J)	Orbital period (s)

PART B Change the initial tangential speed

Orbit-shape test | 8 minutes

Procedure: Reset to the same starting radius. Change only the initial tangential speed, run one orbit, and record the new apoapsis and periapsis values.

Trial	Initial speed (m/s)	ra / rp	vp / va	Total mechanical energy (J)	Orbit classification
Trial 1					
Trial 2					
Trial 3					
Trial 4					



4. Plot speed ratio vp/va versus radius ratio ra/rp. Draw a best-fit line.

Analysis | 6 minutes

5. Compare angular momentum at apoapsis and periapsis.

6. How did kinetic and gravitational potential energy trade off during the orbit?

7. Why should vp/va equal ra/rp at the two apsides?

8. How did changing initial speed affect orbit shape and total mechanical energy?

Claim-Evidence-Reasoning conclusion

Evaluate this claim: The satellite moves faster at periapsis because gravity does more positive work there than at other parts of the orbit.

CLAIM	Accept, reject, or revise the statement.
EVIDENCE	Cite at least two measured trials or graph features.
REASONING	Use central-force torque, angular momentum conservation, and energy changes over the full path.

Exit ticket

At apoapsis the orbital radius is three times the periapsis radius. Use angular momentum conservation to predict vp/va.