

Classical mechanics

GRE · GRE Subject Test · GRE Physics

A planet accelerates even when its speed is constant: velocity includes direction.

Prerequisites: 47.

- Apply Newtonian, Lagrangian and Hamiltonian descriptions
- Analyse rotation, central forces and oscillations
- Use conservation laws with their conditions

Choose the system and model

Newton's second law is a vector statement. Choose coordinates and identify constraints before components.

Use the governing relation

Energy conservation applies when work from nonconservative forces is accounted for; momentum conservation needs zero net external impulse.

Apply the conditions

For small oscillations, linearise around a stable equilibrium. A restoring term proportional to displacement gives harmonic motion.

Check the conclusion

Lagrange's equations use $L=T-V$ and generalised coordinates. This undergraduate formalism is distinct from school-level force substitution.

Worked method

Choose an inertial frame and a coordinate x measured from spring equilibrium. For a conservative spring, the Lagrangian avoids solving constraint forces.

$$L = \frac{1}{2}m\dot{x}^2 - \frac{1}{2}kx^2.$$

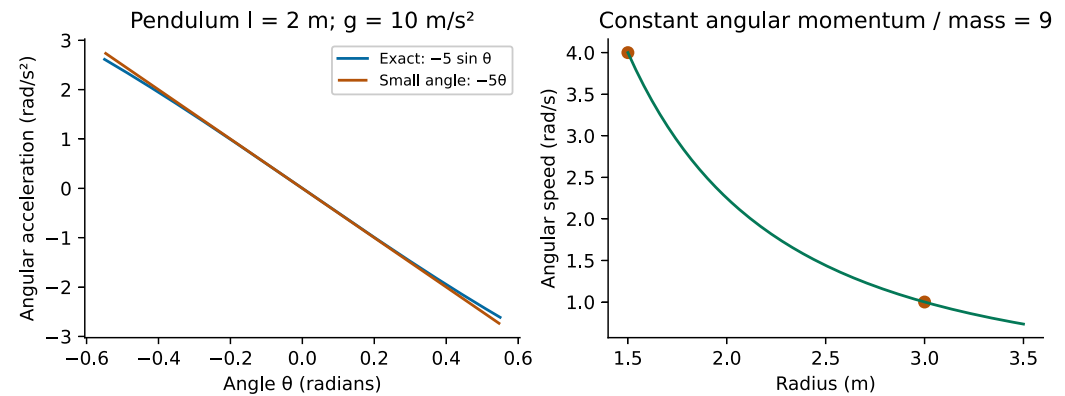
$$\frac{d}{dt}\frac{\partial L}{\partial \dot{x}} - \frac{\partial L}{\partial x} = 0, \quad m\ddot{x} + kx = 0.$$

With $m = 2.0 \text{ kg}$ and $k = 18 \text{ N/m}$,

$$\omega = \sqrt{k/m} = \sqrt{(18 \text{ N/m})/(2.0 \text{ kg})} = 3.0 \text{ rad/s}.$$

$$T = 2\pi/\omega = 2\pi/(3.0 \text{ rad/s}) = 2.09 \text{ s}.$$

Positive stiffness gives stable motion. The units of k/m are inverse seconds squared.



Classical mechanics: original GRE teaching diagram.

Check conditions and vocabulary

Conservation of kinetic energy does not hold in every collision, even when momentum is conserved.

Lagrangian: Kinetic energy minus potential energy for the standard mechanical system.

angular momentum : The moment of linear momentum about a reference point.