

Section 2: Mechanics II

1. Gravitational Dependence

A simple pendulum has a period of 4 seconds on Earth. What would its period be on the Moon, where the gravitational acceleration is about 1/6th of Earth's?

2. Inelastic Collision

A 70 kg runner moving at 3 m/s jumps onto a 140 kg stationary cart. What is the final speed of the cart with the runner? Is kinetic energy conserved in this collision? Explain.

3. Harmonic Motion

A 10 kg mass is attached to a spring and oscillates according to the equation $x(t) = 0.2 \cos(10\pi t)$ (in meters). What is the spring constant k ? What is the total mechanical energy of the system?

4. Conservation of Energy

A pendulum with a length of 1.0 meter is released from an initial angle of 15° . What is the speed of the pendulum bob at the bottom of its swing?

5. Energy & Momentum

A 0.5 kg block slides down a frictionless track from a height of 3.0 m. At the bottom, it collides and sticks to a 1.5 kg block which is initially at rest. What is the speed of the combined mass just after the collision?

6. Horizontal Projectile

A stone is thrown horizontally with a speed of 20 m/s from the top of a cliff that is 50 m high. How far from the base of the cliff does the stone land?

7. Dynamics with Friction

A 5 kg block is placed on a 10 kg block. A horizontal force of 45 N is applied to the 10 kg block, and the 5 kg block is tied to the wall. The coefficient of kinetic friction between all moving surfaces is 0.2. Find the acceleration of the 10 kg block.

8. Pendulum Design

What is the required length of a simple pendulum to have a period of exactly 1 second on Earth?

9. Kinematics Integration

The velocity of an object is given by $v(t) = 4t + 5$. Find the displacement $x(t)$ and acceleration $a(t)$, assuming $x(0) = 0$.

10. Energy Dissipation

A tennis ball is dropped from a height of 2.0 m. After each bounce, it loses 30% of its mechanical energy. To what height does it rise after the second bounce?