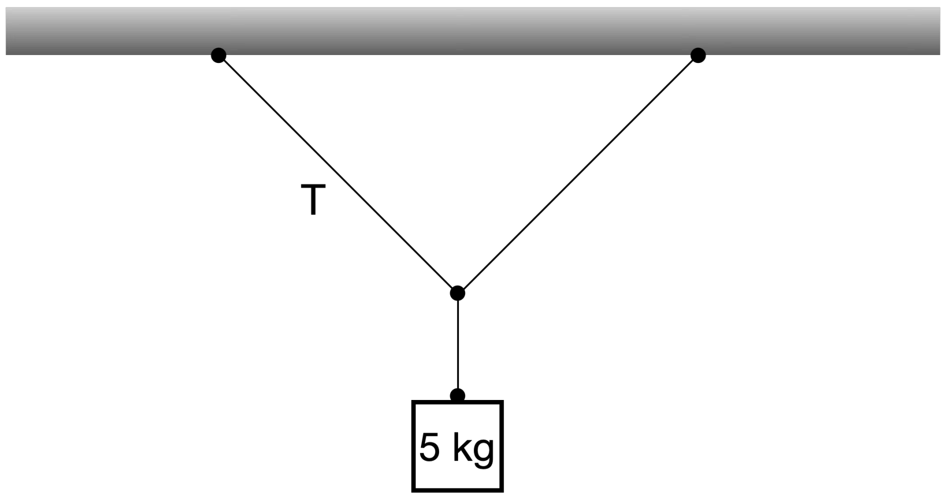
PHYS 1022 Worksheet 28 Aug 2025

Solve each of the following three problems.

You can assume that the acceleration due to gravity at the Earth's surface is $g = 10$ m/s^2.

(1) Two massless wires are fixed to the ceiling and meet at a 90° angle. A 5 kg mass hangs from a massless wire, which is attached to the junction of the upper two wires:



Find the tension T in each of the wires attached to the celing.

(2) An object with mass $m = 1$ kg starts from rest and falls 20 m to the ground. Use Newton's Second Law to calculate how fast the object is moving when it hits the ground.

(3) Repeat **(2)** using conservation of mechanical energy instead of Newton's Second Law.

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Solutions

(1) The tension in the vertical wire is just $mg = 50$ N. This must equal the vertical component of tension supplied by the two wires attached to the ceiling, so

$$50 \text{ N} = 2 \times \frac{T}{\sqrt{2}} \qquad \text{and} \qquad T = 25\sqrt{2} \text{ N}$$

(2) Motion under constant acceleration $a = -g$ from a height h is

$$y = h - v_0 t - \frac{1}{2} g t^2$$

Solving for t when $y = 0$ and $v_0 = 0$ gives $t = \sqrt{2h/g} = \sqrt{40/10} = 2$ seconds. The (downward) velocity as a function of time is given by

$$v = -v_0 - gt$$

The speed when it hits the ground is therefore $gt = 20$ m/s.

(3) The mechanical energy $E = mv^2/2 + U = mv^2/2 + mgh$ is conserved. Before the object starts to fall, $E = mgh$, and when it hits the ground, $E = mv^2/2$. Therefore

$$mgh = \frac{1}{2} m v^2 \qquad \text{so} \qquad v = \sqrt{2gh} = \sqrt{2 \times 10 \times 20} = 20 \text{ m/s}$$