Mechanics: Projectiles, Friction and Moments

Mechanics · 6 questions · step-by-step answers at the end

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USEFUL EQUATIONS

$x = (u\cos\theta)t$, $y = (u\sin\theta)t - (1/2)gt^2$ $F_{max} = \mu R$ moment $= Fd$ range $= u^2 \sin 2\theta / g$

Questions

Show your working in the space under each question.

1. EASY Resolve a 10 N force acting at 60° to the horizontal into horizontal and vertical components.

2. EASY A 4 kg block rests on a rough horizontal surface with $\mu = 0.5$. Find the maximum friction force.

3. MEDIUM A stone is thrown horizontally at 12 m/s from the top of a 20 m cliff. Find the time to reach the ground and the horizontal distance travelled.

4. MEDIUM A uniform beam AB of length 4 m and weight 100 N rests on supports at A and B. A 200 N load is placed 1 m from A. Find the two reactions.

5. HARD A block is on the point of sliding on a plane inclined at 25°. Find the coefficient of friction.

6. HARD A ball projected at 45° lands 40 m away on level ground. Find its speed of projection.

Step-by-step answers

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1. Horizontal: 10 cos 60° = **5 N**. Vertical: 10 sin 60° = **8.66 N**.
2. R = 4g = 39.2 N. F = 0.5 × 39.2 = **19.6 N**.
3. $20 = 4.9t^2$ gives **t = 2.02 s**. Distance = 12 × 2.02 = **24.2 m**.
4. Moments about A: $4R_B = 100 \times 2 + 200 \times 1 = 400$, so $\mathbf{R_B = 100\ N}$. Vertically: $R_A = 300 - 100 =$ **200 N**.
5. mg sin 25° = μ mg cos 25°, so μ = tan 25° = **0.466**.
6. Range = $u^2 \sin 90°/g$, so $u^2 = 40 \times 9.8 = 392$ and **u = 19.8 m/s**.