This print-out should have 15 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering. The due time is Central time.

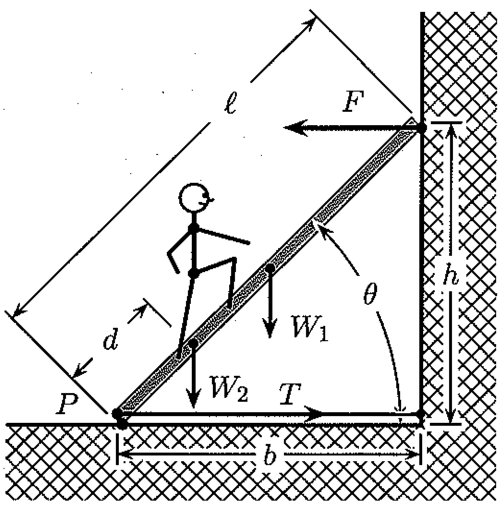
Ladder 02

12:08, trigonometry, multiple choice, > 1 min, fixed.

001

Consider a uniform ladder leaning against a smooth wall and resting on a smooth floor at point P. There is a rope stretched horizontally, with one end tied to the bottom of the ladder essentially at P and the other end to the wall. The top of the ladder is at a height is h up the wall and the base of the ladder is at a distance b from the wall.

The weight of the ladder is W_1. Jill, with a weight W_2, is one-fourth the way $\left(d = \frac{\ell}{4}\right)$ up the ladder. The force which the wall exerts on the ladder is F.



Note: Figure is not to scale.

The torque equation about P is given by

1. $(W_1 + W_2)\,\frac{h}{2} = F\,b$
2. $\frac{h}{4}\,W_2 + \frac{h}{2}\,W_1 = F\,b$
3. $\frac{b}{2}\,W_2 + b\,W_1 = F\,h$
4. $\frac{h}{2}\,W_2 + h\,W_1 = F\,b$
5. $(W_1 + W_2)\,\frac{b}{2} = F\,h$
6. $\frac{b}{4}\,W_2 + \frac{b}{2}\,W_1 = F\,h$

002

Given: $W_2 = 3\,W_1 = W$, $h = b$.

Determine the force F the wall exerts on the ladder.

1. $F = \frac{1}{12}\,W$
2. $F = \frac{1}{6}\,W$
3. $F = \frac{1}{4}\,W$
4. $F = \frac{1}{3}\,W$
5. $F = \frac{1}{2}\,W$
6. $F = \frac{5}{12}\,W$
7. $F = \frac{7}{12}\,W$
8. $F = \frac{2}{3}\,W$
9. $F = \frac{3}{4}\,W$
10. $F = \frac{5}{6}\,W$

003

Given: $W_2 = 3\,W_1 = W$, $h = b$.

When Jill has climbed up the ladder such that the rope tension reaches $T = \frac{W}{2}$ determine Jill's height y from the floor.

1. $y = \frac{1}{3}\,b$
2. $y = \frac{1}{6}\,b$
3. $y = \frac{1}{4}\,b$
4. $y = \frac{1}{12}\,b$

5. $y = \frac{5}{12}\, b$

6. $y = \frac{1}{2}\, b$

7. $y = \frac{7}{12}\, b$

8. $y = \frac{2}{3}\, b$

9. $y = \frac{3}{4}\, b$

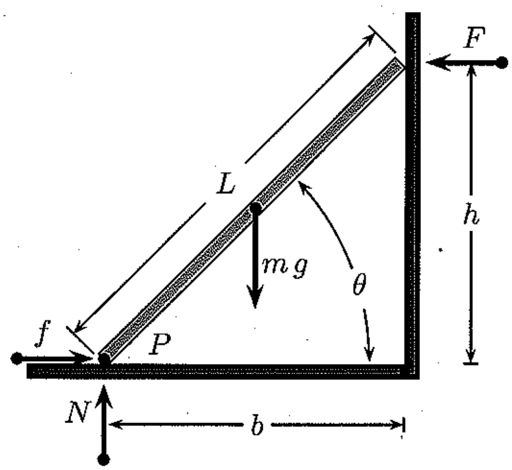
10. $y = \frac{5}{6}\, b$

Ladder 13

12:08, trigonometry, numeric, > 1 min, normal.

004

A uniform ladder is leaning against a smooth wall and is resting on a rough floor with a coefficient of the static friction μ.



The equilibrium condition of the sum of the torques about the point P is given by

1. $F\,L \sin\theta - \frac{m\,g\,L}{2} \cos\theta = 0$

2. $F\,L \cos\theta - \frac{m\,g\,L}{2} \sin\theta = 0$

3. $F\,L \cos\theta - \frac{m\,g\,L}{2} \cos\theta = 0$

4. $F\,L \cos\theta - m\,g\,L \sin\theta = 0$

5. $F\,L \sin\theta - m\,g\,L \cos\theta = 0$

6. $F\,L \sin\theta - m\,g\,L \sin\theta = 0$

005

Let the "critical force" be the force F, which the wall exerts on the ladder, above which the ladder will slip. This critical force is given by

1. $F_{critical} = m\,g \sin\theta$

2. $F_{critical} = \frac{1}{2}\, m\,g$

3. $F_{critical} = m\,g$

4. $F_{critical} = 2\,m\,g$

5. $F_{critical} = m\,g \tan\theta$

6. $F_{critical} = \mu\,m\,g$

7. $F_{critical} = m\,g \cos\theta$

8. $F_{critical} = \frac{1}{2}\,\mu\,m\,g$

9. $F_{critical} = 2\,\mu\,m\,g$

10. $F_{critical} = 0$

006

The coefficient of static friction is 0.8, the length of the ladder is 10 m, and its mass is 30 kg.

Find the minimum height h below which the ladder will slip. Answer in units of m.

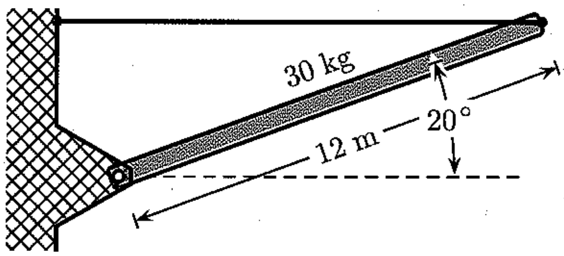
Hinged Beam and Cable

12:04, trigonometry, numeric, > 1 min, normal.

007

A uniform 30 kg beam at an angle of 20° with respect to the horizontal has length of 12 m. It is supported by a pin and horizontal cable, as shown in the figure.

The acceleration of gravity is 9.8 m/s^2.



What is the magnitude of the total force $F^{\text{pin}} = \sqrt{(F_x^{\text{pin}})^2 + (F_y^{\text{pin}})^2}$ exerted by the pin on the beam? Answer in units of N.

Old MacDonald Had a Farm

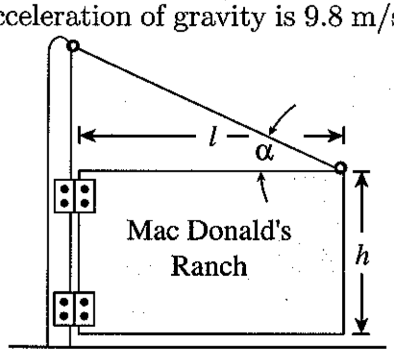
12:08, trigonometry, numeric, > 1 min, normal.

008

Old MacDonald had a farm, ei, ei, oh! And on that farm he had a gate, ei, ei, oh! And a squeak, squeak, here. A squeak, squeak, there. And a squeak, squeak, everywhere...

The gate is $\ell = 3$ m wide and $h = 1.8$ m tall with hinges attached to the top and bottom. The guide wire makes an angle of $\alpha = 30°$ with the top of the gate and has a tension of 200 N. The mass of the gate is 40 kg.

The acceleration of gravity is 9.8 m/s^2.



Determine the magnitude of the horizontal force exerted on the gate by the bottom hinge. Answer in units of N.

009

Determine the magnitude of the horizontal force exerted on the gate by the upper hinge. Answer in units of N.

010

Determine magnitude of the total horizontal force exerted on the gate by the two hinges. Answer in units of N.

011

Determine the magnitude of the total vertical force exerted on the gate by the two hinges. Answer in units of N.

012

What must be the tension in the guy wire so that the horizontal force exerted by the upper hinge is zero? Answer in units of N.

Forces on the Golden Gate

12:02, trigonometry, numeric, > 1 min, normal.

013

Consider a simplified model of the Golden Gate bridge, where the bridge is represented by four equal weights, each weighing 5 N, hanging from a wire. The angle between the hanging wire and the vertical supporting beam is $\theta = 45°$ (refer to the figure). The bridge is symmetric.

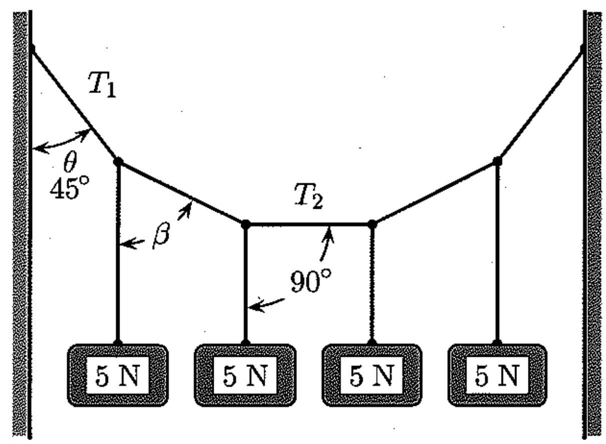


Figure: Not drawn to scale.

Calculate T_1, the tension in the left segment of the wire. Answer in units of N.

014

Calculate T_2, the tension in the middle segment of the wire. Answer in units of N.

015

Calculate the angle β in the figure. Answer in units of °.