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 $h$ 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 ($d = \frac{\ell}{4}$) 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. $(W_1 + W_2) \frac{h}{2} = Fb$
2. $\frac{h}{4} W_2 + \frac{h}{2} W_1 = Fb$
3. $\frac{b}{2} W_2 + b W_1 = Fh$
4. $\frac{h}{2} W_2 + h W_1 = Fb$
5. $(W_1 + W_2) \frac{b}{2} = Fh$
6. $\frac{b}{4} W_2 + \frac{b}{2} W_1 = Fh$

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.

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

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

1. \( F \cdot L \cdot \sin \theta - \frac{m \cdot g \cdot L}{2} \cdot \cos \theta = 0 \)
2. \( F \cdot L \cos \theta - \frac{m \cdot g \cdot L}{2} \cdot \sin \theta = 0 \)
3. \( F \cdot L \cos \theta - \frac{m \cdot g \cdot L}{2} \cdot \cos \theta = 0 \)
4. \( F \cdot L \cos \theta - m \cdot g \cdot L \cdot \sin \theta = 0 \)
5. \( F \cdot L \sin \theta - m \cdot g \cdot L \cdot \cos \theta = 0 \)

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. \( F_{\text{critical}} = m \cdot g \sin \theta \)
2. \( F_{\text{critical}} = \frac{1}{2} m \cdot g \)
3. \( F_{\text{critical}} = m \cdot g \)
4. \( F_{\text{critical}} = 2 m \cdot g \)
5. \( F_{\text{critical}} = m \cdot g \tan \theta \)
6. \( F_{\text{critical}} = \mu \cdot m \cdot g \)
7. \( F_{\text{critical}} = m \cdot g \cdot \cos \theta \)
8. \( F_{\text{critical}} = \frac{1}{2} \mu \cdot m \cdot g \)
9. \( F_{\text{critical}} = 2 \mu \cdot m \cdot g \)
10. \( F_{\text{critical}} = 0 \)

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/s².
What is the magnitude of the total force 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, e i, e i, oh! And on that farm he had a gate, e i, e i, oh! And a squeak, squeak, here. A squeak, squeak, there. And a squeak, squeak, everywhere...
The gate is \( l = 3 \text{ m} \) wide and \( h = 1.8 \text{ m} \) tall with hinges attached to the top and bottom. The guide wire makes an angle of \( \alpha = 30^\circ \) with the top of the gate and has a tension of \( 200 \text{ N} \). The mass of the gate is 40 kg.
The acceleration of gravity is \( 9.8 \text{ m/s}^2 \).

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.

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**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.

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**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 \( \theta = 45^\circ \) (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 \( \beta \) in the figure. Answer in units of \(^\circ\).