Problem 21 Solution:

A violation should be reported to the organization that has promulgated the rule.

(Answer D)
Static Equilibrium

Problem 30 Solution:

The equilibrium system means all the forces acting to the system are balanced. Therefore, we will use two equilibrium equations (vertical and horizontal forces) to solve this problem.

Equilibrium in vertical forces (Y direction):

\[ \sum F_y = 0 \]
\[ T_1 \sin \theta - 2500 = 0 \]
\[ T_1 = 3125 \text{ lb} \]

Equilibrium in horizontal forces (X direction):

\[ \sum F_x = 0 \]
\[ T_1 \cos \theta - T_2 = 0 \]
\[ T_2 = 1875 \text{ lb} \]

(Answer A)
Truss Analysis

Problem 31 Solution:

To solve the support reaction, equilibrium should be satisfied.

\[ \sum M_A = 0 \]
\[ 1200 \text{ lb} \times 8 \text{ ft} - R_B \times 32 \text{ ft} = 0 \]
\[ R_B = 300 \text{ lb} \uparrow \]

\[ \sum F_y = 0 \]
\[ R_A + R_B - 1200 \text{ lb} = 0 \]
\[ R_A + 300 \text{ lb} - 1200 \text{ lb} = 0 \]
\[ R_A = 900 \text{ lb} \uparrow \]

(Answer D)
Truss Member Forces

Problem 32 Solution:

Member CD is zero-force member. Check the equilibrium of vertical forces at joint D:

\[ \sum F_y = 0 \]
\[ T_{CD} = 0 \]

Member EG can be solved by ‘cutting’ the truss as shown below.

Check the equilibrium of system to get the support reaction at B:

\[ \sum M_A = 0 \]
\[ -R_B \times 32 \text{ ft} + 1200 \text{ lb} \times 8 \text{ ft} = 0 \]
\[ R_B = 300 \text{ lb} (\uparrow) \]

Check the equilibrium of moment at joint F by looking at ‘right side’ part:

\[ \sum M_F = 0 \]
\[ -R_B \times 16 \text{ ft} - T_{EG} \times \frac{8}{\sqrt{8^2 + \left(\frac{8}{3}\right)^2}} \times \frac{8}{3} \text{ ft} - T_{EG} \times \frac{8}{\sqrt{8^2 + \left(\frac{8}{3}\right)^2}} \times 8 \text{ ft} = 0 \]

\[ T_{EG} = -948.68 \text{ lb} = 948.68 \text{ lb} \text{(compression)} \] >> Answer : C
**Kinetic Energy**

**Problem 40 Solution:**

The velocity at 2-m height:

\[ V_t^2 = V_0^2 - 2gh = 8^2 - 2 \times 9.8 \times 2 = 24.8 \]

\[ V_t = \sqrt{24.8} = 4.98 \text{ m/s} \]

The kinetic energy at 2-m height:

\[ E_k = \frac{1}{2} mV_t^2 = \frac{1}{2} \times 0.5 \times 24.8 = 6.2 \text{ Joule} \]

*(Answer B)*
Friction Force

Problem 41 Solution:

Define the forces working to the moving box in the inclined plane, then apply the equation.

\[ f_k = \mu N = \mu mg \cos \theta \]

\[ \sum F = ma \]
\[ F - mg \sin \theta - \mu mg \cos \theta = ma \]
\[ F - 12 \times 9.8 \times \sin 10^\circ - 0.15 \times 12 \times 9.8 \times \cos 10^\circ = 12 \times 0.5 \]
\[ F = 43.8 \approx 45 \text{ N} \]

(Answer C)
Strain (Elastic Deformation)

Problem 49 Solution:

\[
\Delta = \frac{PL}{EA} = \frac{80 \text{ lb} \times \left(25 \text{ ft} \times 12 \text{ in} \over \text{ft}\right)}{(10900 \times 10^3 \text{ psi}) \times \left(\frac{1}{4} \pi \times (0.25 \text{ in})^2\right)} = 0.045 \text{ in}
\]

\[
\varepsilon = \frac{\Delta}{L} = \frac{0.045 \text{ in}}{25 \text{ ft} \times 12 \text{ in} \over \text{ft}} = 1.5 \times 10^{-4}
\]

(Answer C)
Torsion

Problem 50 Solution:

There are two limitations to find the maximum allowable torque:

1. Check the maximum allowable shear stress

\[ \tau_{\text{max}} = \frac{Tr_0}{J} \]

\[ 40 = \frac{T \times 25}{2500000} \]

\[ T = 4 \times 10^6 \text{ N-mm} = 4 \text{ kN-m} \]

2. Check the maximum allowable twist

\[ \phi_{\text{max}} = \frac{TL}{GJ} \]

\[ 0.025 = \frac{T \times 2000}{70000 \times 2500000} \]

\[ T = 2187500 \text{ N-mm} = 2.1875 \text{ kN-m} \]

The maximum allowable torque is the minimum between those two values, taken as 2 kN-m.

(Answer A)