1) Calculate the moment of the force $F$ about the point $O$.

$$F = \begin{bmatrix} 3z^2 + 2x^4 + 4y^6 \end{bmatrix} \cdot 50 + 10k \cdot B$$

$$M_o = F_{ab} = F$$

$$M_o = \begin{bmatrix} 3z^2 + 2x^4 + 4y^6 \end{bmatrix} \cdot (-20 + 50z - 10k) \cdot lb$$

$$\vec{M}_o = \begin{bmatrix} -2.80 & 9.0 & 110 \end{bmatrix} \cdot lb$$

2) The suspended load weighs 2 kN. Use the method of joints to find the force in member $DE$.

$$\sum F_x = F_{\text{eq}} + 20 \cdot 25 = \Sigma F_y = 5.558 \text{ kN}$$

$$F_{\text{eq}} = 5.558 \text{ kN}$$

3) Replace the given force-couple system with an equivalent force-couple system located at point $O$. Draw the equivalent force-couple system on the diagram below. Label the resultant force in magnitude-angle format.

$$\sum \mathbf{M}_o = 0$$

$$178 \text{ kN}$$

4) The 200 lb force is located halfway between points $A$ and $B$ and it is perpendicular to the bar $AB$. What is the magnitude of the reaction force at pin $A$? Note: the slot is smooth.

$$|\mathbf{A}| = 100 \text{ lb}$$

5) Write the 60 lb force in Cartesian vector format.

$$\mathbf{F}_{\text{AB}} = \begin{bmatrix} 6z^2 + (7 - 4.33) \cdot k \end{bmatrix} + (0 - 2.5) \cdot \mathbf{k}$$

$$\mathbf{F}_{\text{AB}} = \begin{bmatrix} 6z^2 + 2.47 - 2.5 \end{bmatrix} \cdot \mathbf{k}$$

$$\mathbf{F}_{\text{AB}} = \begin{bmatrix} 0.854 \cdot \mathbf{k} + 0.380 \cdot \mathbf{j} - 0.356 \cdot \mathbf{k} \end{bmatrix} \cdot \mathbf{k}$$

$$\sum \mathbf{F}_{\text{AB}} = \begin{bmatrix} 51.2 \cdot \mathbf{j} + 22.8 \cdot \mathbf{k} \end{bmatrix} \cdot \mathbf{k}$$

6) Use the method of sections to find the force in member $GH$. In the figure, $L = 2$ m.

$$F_{\text{GH}} = 600 \text{ N}$$

$$\sum \mathbf{M}_o = -600 \cdot (4w) + F_{\text{GH}} \cdot (3w) = 0$$

$$F_{\text{GH}} = 600 \text{ N}$$
7) A motorcyclist exits the ramp 1 m above the ground and at a 30° angle from the horizontal. The motorcyclist remains in the air for 1.5 seconds before landing at point B. Calculate the speed when he leaves the ramp:

\[ v = v_0 + \frac{1}{2} a t^2 \]

\[ v = \sqrt{v_y^2 + v_x^2} \]

\[ v_y = v_0 \sin 30° \]

\[ v_x = 13.38 \text{ m/s} \]

8) The 15 Mg boxcar A is coasting at 1.5 m/s on a horizontal track when it encounters a 12 Mg tank car B coasting at 0.75 m/s as shown. When the cars hit they couple together. Calculate the velocity of both cars after the collision:

\[ m_v v_1 + m_v v_2 = (m_v + m_v) v_f \]

\[ 1.5 \times 1.5 + 1.2 \times 0.75 = 1.5 \times 1.5 + 0.75 \]

\[ v_f = \frac{1.5 \times 1.5 + 0.75}{1.5 + 0.75} \]

\[ \frac{v_f}{v_1} = 0.55 \text{ m/s} \]

9) Two cyclists, A and B, are traveling counterclockwise around a circular track as shown. At this instant, both cyclists have a speed of 8 ft/s. The speed of A is increasing at a rate of 1.5 ft/s² while the speed of B is constant. Calculate the magnitude of the acceleration of both cyclists:

\[ a_n = \frac{v^2}{r} = \frac{8^2}{5} = 1.28 \text{ ft/s}^2 \]

\[ \frac{v^2}{r} = \frac{(1.5)^2}{1.28} = 1.97 \text{ ft/s}^2 \]

10) At this instant, the winding drum \( D \) is drawing in the cable with a speed of 12 m/s, however, the speed is decreasing at a rate of 2 m/s². Calculate the acceleration of the crate:

\[ \frac{Z_a}{a_a} = 0 \]

\[ \frac{Z_a}{a_a} = 0 \]

\[ a_n = 1 \text{ m/s}^2 \]

\[ a_B = \frac{1}{4} \text{ m/s}^2 \]

11) Assuming that the force acting on the 2 g bullet, as it passes horizontally through the barrel of a rifle, varies with time in the manner shown, determine the maximum net force \( F_0 \) applied to the bullet when fired. The muzzle velocity is 500 m/s when \( t = 0.75 \) ms. Neglect friction and note that the time axis is in ms (i.e., 10^{-3} s):

\[ \frac{m_v + \frac{1}{2} m_v \left( \frac{1}{2} \cdot 0.75 \right) v_2^2}{0 + \frac{1}{2} m_v \left( 0.02 \cdot 0.75 \right) v_2^2} = 0.002 \text{ kg (500 m/s)} \]

\[ F_0 = 267 N = 2.67 \text{ kN} \]

12) The mass of ball \( A \) is 3 kg and the mass of block \( B \) is 4 kg. The coefficient of restitution \( e = 0.5 \). Block \( B \) is initially at rest. Calculate the velocity of block \( B \) immediately after the collision:

\[ v = \text{directly opposite} \]

\[ m \text{V}_A + m \text{V}_B = m \text{V}_A + m \text{V}_B \]

\[ 3 \times 0 + 4 \times 0 = 3 \times 0 + 4 \times 0 \]

\[ e = \frac{v_2 - v_1}{v_2 - v_1} \Rightarrow v_2 = 0.5 (1.20 m/s) + v_1 = 4.698 + v_1 \]

\[ 2.19 = 3 \times 0 + 4 (4.698) \]

\[ 9.208 = 7 \text{V}_2 \]

\[ \text{V}_B = 1.31 \text{ m/s} \]

\[ \text{V}_B = 4.698 + 1.31 = 6.01 \text{ m/s} \]
13) The mass of A is 12 kg and the mass of B is 6 kg. Determine the acceleration of A. Neglect friction and the mass of the pulleys and the rope.

\[ \sum F_y = 0 \to T = \frac{200 \text{ lb}}{2} = 100 \text{ lb} \]

\[ a_y = \frac{0 - 0}{0.8947} = 0 \text{ m/s}^2 \]

\[ a_x = \frac{0 - 0}{0.8947} = 0 \text{ m/s}^2 \]

14) If the crate weighs 600 lb and its acceleration is 3 ft/s² to the right, what is the magnitude of the force, F?

\[ \sum F_x = 0 \to T = \frac{600 \text{ lb}}{3} = 200 \text{ lb} \]

15) The 0.5 kg ball of negligible size is fired up the smooth vertical circular track using a spring plunger. The spring is uncompressed when \( s = 0 \). Determine the minimum distance \( s \) the plunger must be pulled back and released so that the ball will make it around the loop and land on the platform at B.

\[ \frac{1}{2} k s^2 = m g (3.5 m) \]

\[ s = \sqrt{\frac{2 m g (3.5 m)}{k}} \]

\[ v = \sqrt{\frac{2 m g (3.5 m)}{k}} = 3.8 \text{ m/s} \]

16) The 20 lb crate is initial rolling down the smooth plane at a speed of 6 ft/s. A constant force of \( F = 9 \text{ lb} \) is applied to the crate as shown. Determine the time it will take to bring the crate to rest.

\[ m v_f + F t = m v_i \]

\[ 20 \text{ lb} (-6 \text{ ft/s}) + 9 \text{ lb} t = 0 \]

\[ t = \frac{1.725 \text{ sec}}{} \]