1. (30%) The weights of collars $A$ and $B$ are $W_A = 75 \text{ lb}$ and $W_B = 90 \text{ lb}$, respectively. If the effect of friction is negligible and equilibrium of the system as shown exists, determine (a) the tension $T_{AB}$ in the connecting cable $AB$, (b) the reaction $A$ exerted on collar $A$ by the rod, (c) the reaction $B$ exerted on collar $B$ by the rod, (d) the magnitude of the applied force $P$.

![Fig. P1](image1) ![Fig. P2](image2) ![Fig. P3 A, B, C](image3)

2. (30%) A 48-N force $F$ acts at the end $D$ of a pipeline as shown. Determine (a) the moment $M_A$ of the force $F$ about the joint at $A$, (b) the moment $M_{AB}$ of $F$ about the axis of the pipe $AB$, (c) whether the action of $F$ tends to tighten or loosen the joint at $A$ where the threads are right-handed, (d) the shortest distance $d_{s1}$ between point $A$ and the line of action of $F$, (e) the shortest distance $d_{s2}$ between the $x$ axis and the line of action of $F$.

3. The system shown is in equilibrium, and the tension in the cable $CD$ is known to be 288 lb. **Circle on this test sheet** the nearest item for each of the following:

   **A.** (5%) The tension in the cable $CE$ is
   - (a) 75 lb.  
   - (b) 150 lb.  
   - (c) 225 lb.  
   - (d) 300 lb.  
   - (e) 375 lb.  
   - (f) 450 lb.  
   - (g) 525 lb.

   **B.** (5%) The weight of cart $B$ is
   - (a) 875 lb.  
   - (b) 750 lb.  
   - (c) 625 lb.  
   - (d) 500 lb.  
   - (e) 375 lb.  
   - (f) 250 lb.  
   - (g) 125 lb.

   **C.** (5%) The weight of block $A$ is
   - (a) 702 lb.  
   - (b) 1053 lb.  
   - (c) 1228 lb.  
   - (d) 1404 lb  
   - (e) 1580 lb.  
   - (f) 1755 lb.  
   - (g) 2106 lb.

   **D.** (5%) The critical load for a cantilevered column is $P_{cr} = (\pi^2 EI)/(4L^2)$. For $E = 20 \times 10^6 \text{ lb/in}^2$, $I = 1.5 \times 10^3 \text{ mm}^4$, $L = 3.5 \text{ ft}$, and $1 \text{ lbm} = 0.4536 \text{ kg}$, the largest mass $m$ (in kg) of a block which may be placed on the top of the column without causing the column to buckle is
   - (a) 45.7 kg.  
   - (b) 43.2 kg.  
   - (c) 40.9 kg.  
   - (d) 38.8 kg.  
   - (e) 36.8 kg.  
   - (f) 35.0 kg.  
   - (g) 33.3 kg.


   **A.** (5%) Describe the **rigid-body principle**.

   **B.** (5%) Define the vectors $\mathbf{\lambda}_{BC}$ and $\mathbf{r}$ in the formula $M_{BC} = \mathbf{\lambda}_{BC} \cdot (\mathbf{r} \times \mathbf{F})$ for computing the moment of a force $\mathbf{F}$ about the axis $BC$.

   **C.** (5%) Describe **Varignon’s theorem**.

   **D.** (5%) The moment of a force $\mathbf{F}$ about a point $P$ is actually the same as the moment of this force $\mathbf{F}$ about a specific axis. Describe the **location** and the **orientation** of this **specific axis**.