PROBLEM 1.4 A 250-kg DRUM WITH A 750mm DIAMETER IS SUPPORTED BY BAR AB AND CABLE BC AS SHOWN. DETERMINE THE FORCES ON EACH ELEMENT.

GIVEN:

CONSTRAINTS
1. 750mm DIAMETER DRUM WEIGHTING 250 kg.
2. DRUM REST ON A WALL AND BEAM
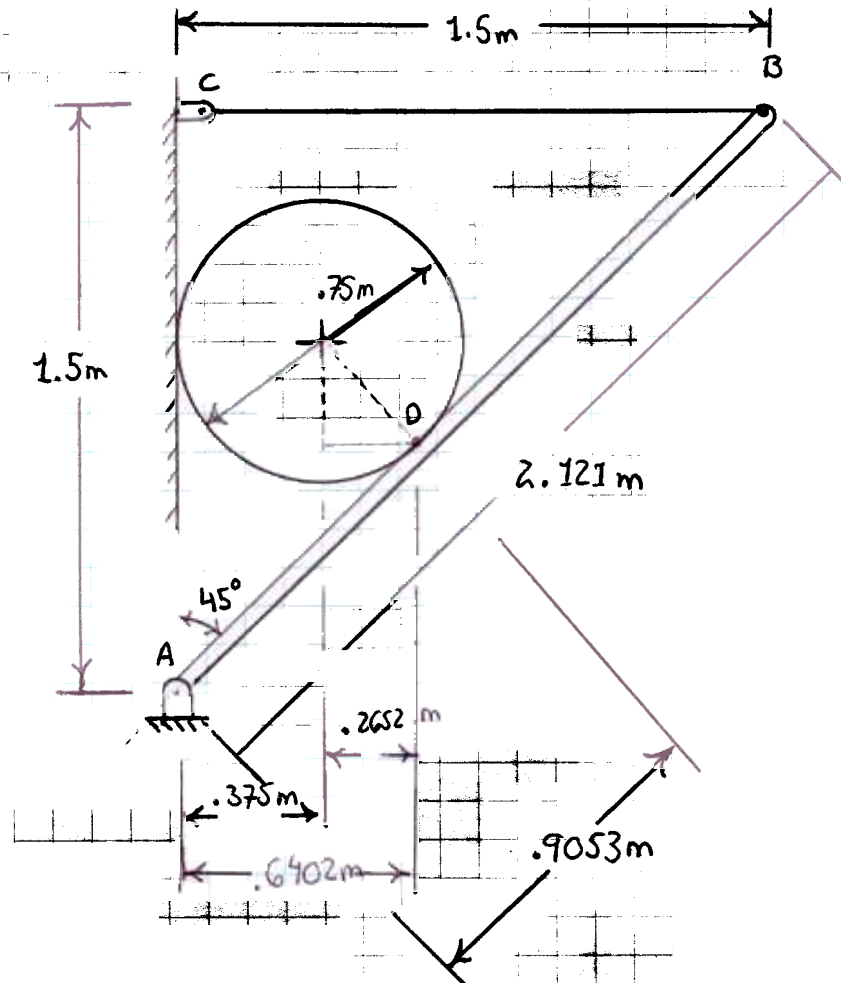3. THE BEAM IS PINNED AT ONE END AND ATTACHED TO THE WALL BY A HORIZONTAL CABLE

ASSUMPTIONS
1. THE CONTACT BETWEEN THE DRUM, WALL, AND BEAM ARE ALL FRICTIONLESS.
2. THE BEAM AND WALL ARE RIGID.
3. THE CABLE IS INEXTENSIBLE.
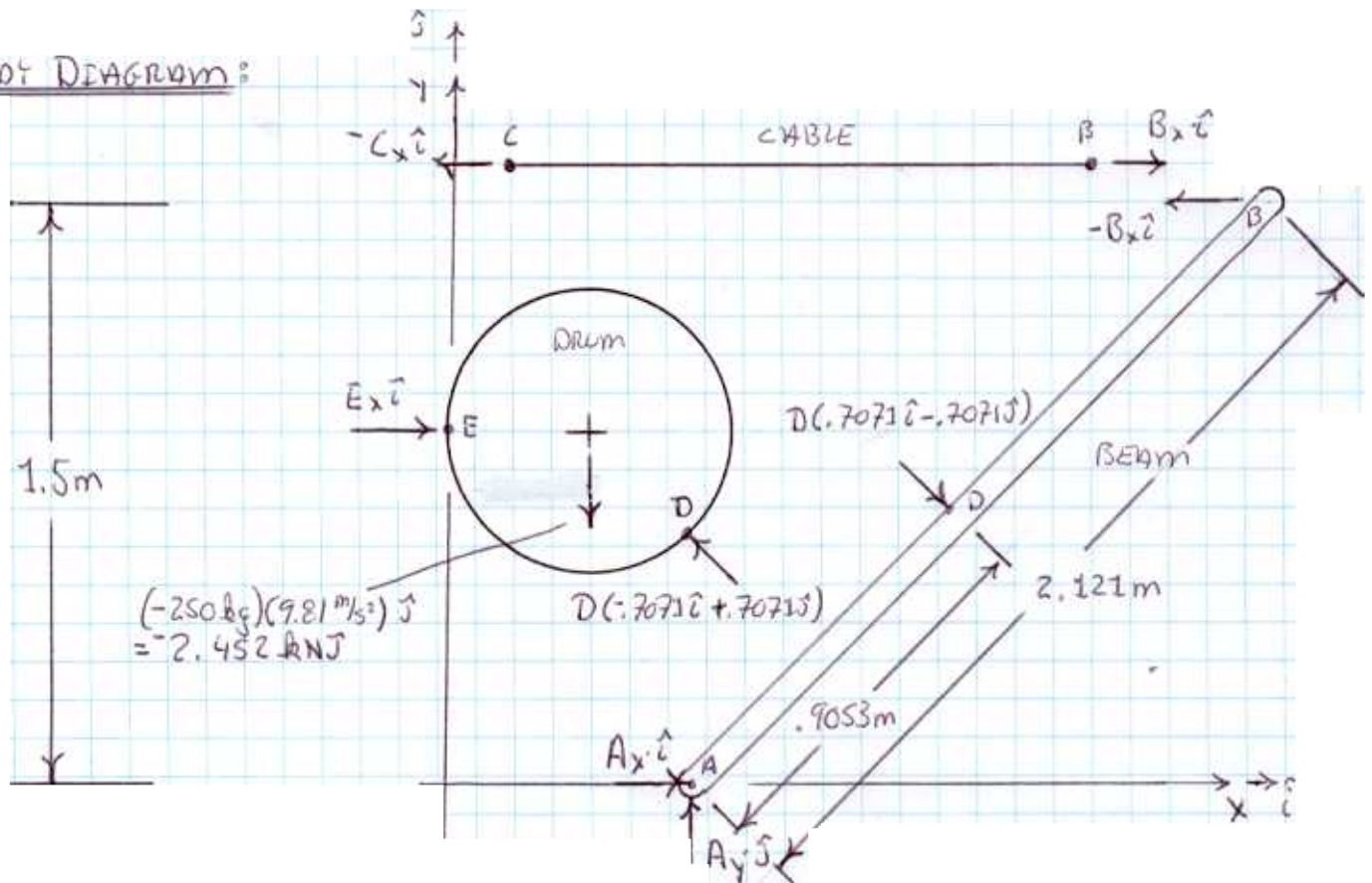4. THE BEAM IS FREE TO ROTATE AT POINT A.

FIND:

1. DETERMINE THE FORCE ON EACH ELEMENT.

DIAGRAM:

FREE BODY DIAGRAM:

SOLUTION:

STARTING THE SOLUTION BY SOLVING FOR THE REACTIONS ON THE DRUM

$$\Sigma F_x = 0 = E_x \quad .7071 \, D \implies \underline{E_x = .7071 \cdot D} \qquad \textcircled{1}$$

$$\Sigma F_y = 0 = -2.452 \, kN + 7071 \cdot D \implies D = (2.452 \, kN)/.7071$$

$$= \boxed{3.468 \, kN} \qquad \textcircled{2}$$

$$\textcircled{2} \to \textcircled{1} \implies E_x = .7071 \, (3.468 \, kN)$$

$$\boxed{2.452 \, kN} \qquad \textcircled{3}$$

NOW THE UNKNOWN LOADS ON BEAM ADB CAN BE CALCULATED

$$\Sigma F_x = 0 = A_x + (.7071) \cdot (3.468 \, kN) - B_x \implies \underline{A_x - B_x = -2.452 \, kN} \qquad \textcircled{4}$$

$$\Sigma F_y = 0 = A_y \quad .7071 \, (3.468 \, kN) \implies \underline{A_y = 2.452 \, kN} \qquad \textcircled{5}$$

$$\Sigma M_{z/@A} = 0 = -3.468 \, kN \cdot .9053m + 1.5m \cdot B_x$$

$$\implies B_x = \frac{3.468 \, kN \cdot .9053m}{1.5m} = \boxed{2.093 \, kN} \qquad \textcircled{6}$$

⑥ → ④ ⟹ $A_x - 2.093 kN = -2.452 kN$ ⟹ $\boxed{A_x = -.3589 kN}$ ⑦

NOW THE REACTION AT POINT "C" IN THE CABLE CAN BE CALCULATED

$\Sigma F_x = 0 = -C_x + B_x$ ⟹ $C_x = B_x = \boxed{2.093 kN}$ ⑧

SUMMARY:

THE SOLUTION TO THIS PROBLEM IS A REVIEW OF RIGID BODY MECHANICS.
THE KEY TO THE SOLUTION IS ESTABLISHING THE ORIENTATION OF THE
UNKNOWN FORCES. BY ASSUMING NO FRICTION ON THE SURFACE OF THE
DRUM, FORCES CAN ONLY ACT PERPENDICULAR TO THE SURFACE. ALL
THESE FORCES ARE DIRECTED TOWARD THE CENTER OF THE DRUM. "B$_x$", AND
"C$_x$" WERE ESTABLISHED AS THE ONLY LOADS ON THE CABLE SINCE CABLES
CAN ONLY SUPPORT TENSILE LOADS.