**NAME:**_____   **GROUP NO:** _____

QUESTION 1: A barge B was being towed into a dock D (located along the –y-axis) by two trucks A and C under a current force of 250 N. Truck A was pulling with a force of F_{BA} = -450 i -600 j (N). Determine the force F_{BC} that truck C must pull the barge to bring it to dock at D and the resultant R of the all the forces. Use,

  a) A graphical solution;
  b) The triangle rule;
  c) Rectangular components.

$F_{current}$

B

x

40°

A

Dock

C
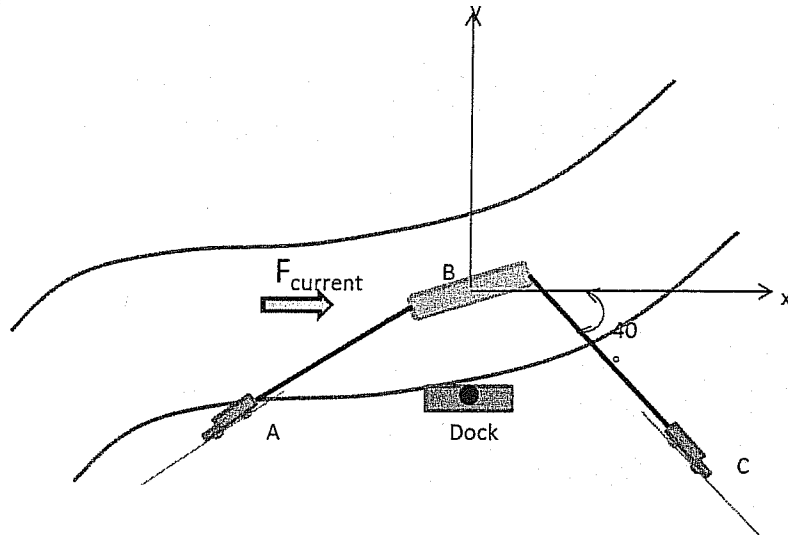
QUESTION 2: Replace the set of forces applied to the bracket shown below with a single force and find where this force crosses the x- and y- axes.

y

20 N

6 m   6 m

A

500 N m
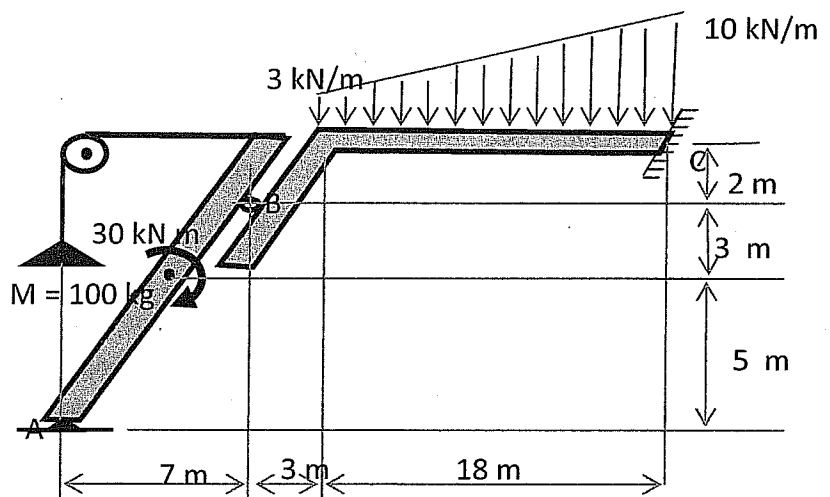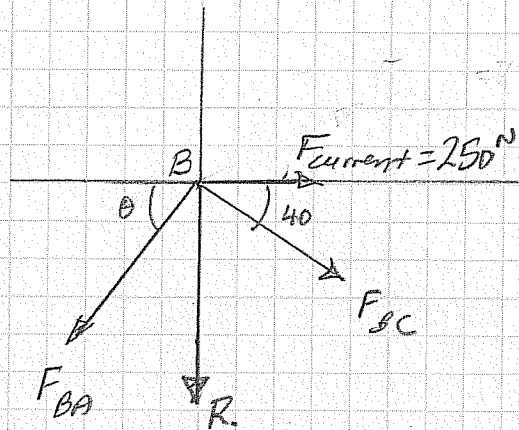
141.4 N

1
1

6 m

50 N

X
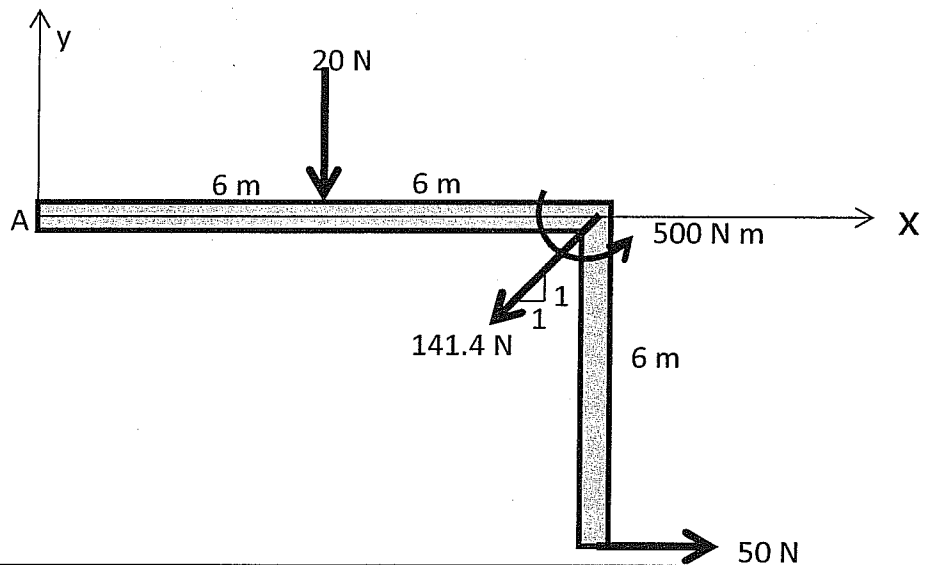
QUESTION 3. Compute the reactions at the supports A and C in the structure shown below.

A is a hinge support and C is affixed support.

Note that the two parts of the structure (AB and BC) are supported at B by a roller. (Summarize your results at the end).
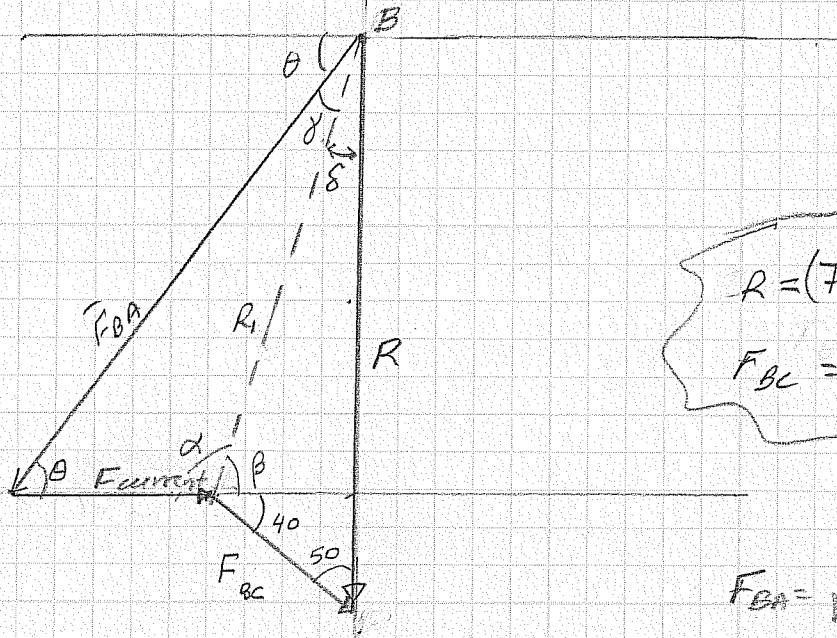
$g = 9.8$ m/sec^2

3 kN/m

10 kN/m

C

2 m

30 kN m

B

M = 100 kg

3 m

5 m

A

7 m   3 m   18 m

$F_{BA} = -450\bar{\imath} - 600\bar{\jmath}$

$\theta = \tan^{-1}\left(\dfrac{600}{450}\right)$

$= 53.1°$

$1cm = 100\ N$

a)

$R = (7.5)100 = 750^{N}$

$F_{BC} = (2.5)100 = 250^{N}$

$F_{BA} = \sqrt{450^2 + 600^2}$

$= 750\ N$

b) $R_1^2 = F_{BA}^2 + F_{current}^2 - 2\,F_{BA}\,F_{current}\cos\theta$

$= 750^2 + 250^2 - 2(750)(250)\cos 53.1$

$= 399842.4$

$R_1 = 632.33\ N$

$\dfrac{F_{BA}}{\sin\alpha} = \dfrac{R_1}{\sin\theta} \qquad \dfrac{750}{\sin\alpha} = \dfrac{632.33}{\sin 53.1} \qquad \alpha = 71.53° \text{ or } 108.47°$

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$$\theta + \alpha + \gamma = 180$$

$$53.1 + 108.47 + \gamma = 180 \qquad \gamma = 18.43° \qquad \& \quad \delta = 90 - \theta - \gamma$$
$$= 18.47°$$

Also $\qquad \beta = 180 - \alpha = 71.53°$

$$\frac{R}{\sin(\beta + 40)} = \frac{F_{BC}}{\sin \delta} = \frac{R_1}{\sin 50}$$

$$\frac{R}{\sin 111.53°} = \frac{F_{BC}}{\sin 18.47} = \frac{632.33}{\sin 50}$$

$$R = 767.8 \, N \quad \downarrow \quad \blacktriangleleft$$

$$F_{BC} = 261.5 \, N \quad \underset{40°}{\not\searrow} \quad \blacktriangleleft$$

c)

FORCE	F (N)	Fx (N)	Fy (N)
$F_{current}$	250	250	0
F_{BA}	750	-450	-600
F_{BC}	F_{BC}	$F_{BC} \cos 40$	$-F_{B} \cos 50$
R	R	0	-R

$$R_x = \Sigma F_x = 250 - 450 + F_{BC} \cos 40 = 0 \qquad F_{BC} = 261.1^N \blacktriangleleft$$

$$R_y = \Sigma F_y = 0 - 600 - F_{BC} \cos 50 = -R \qquad R = 767.8^N \blacktriangleleft$$

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20^N

A

500^{N-m}

141.4^{kN}

50^N
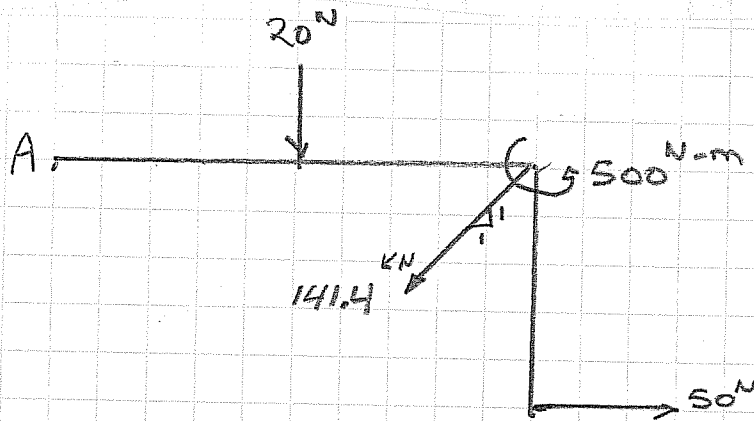
$$\sum F_x = -141.4 \cos 45° + 50 = -50^N \qquad (1)$$

$$\sum F_y = -141.4 \cos 45° - 20 = -120^N \qquad (1)$$

$$\sum M_A = -6(20) + 500 - 12(100) + 50(6) = -520 \; N \cdot m \qquad (2)$$

50^N

520^{N-m}

θ

120^N

R

$$\boxed{R = 130^N} \qquad (1)$$

$$\theta = \tan^{-1}\left(\frac{120}{50}\right) \qquad (1)$$

$$\boxed{\theta = 67.38°}$$

y

dx

θ

$(x, 0)$

$P_1 (x_p, 0)$

dy

x

P_2

R

$(0, y_p)$
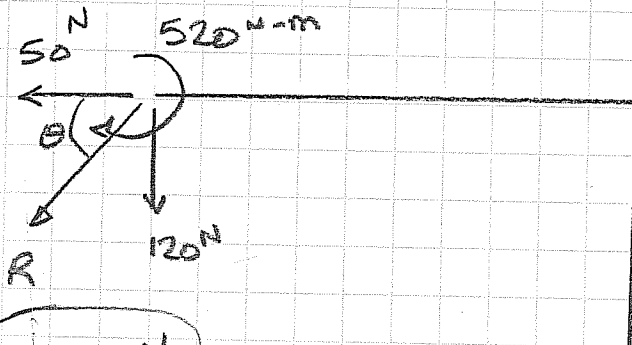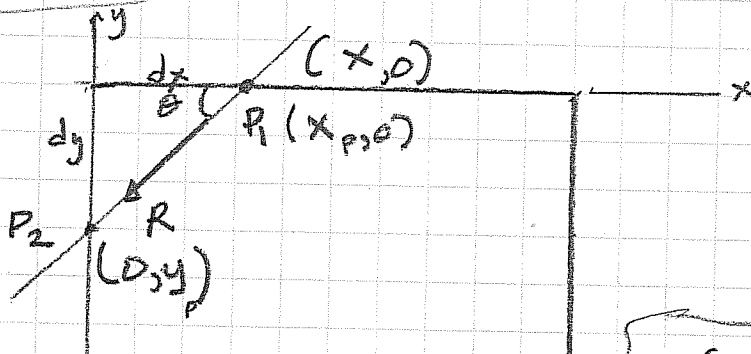
$$dx = \frac{520}{120} = 4.33$$

$$dy = \frac{520}{50} = 10.4$$

$$P_1 (4.33, 0) \qquad (2)$$

$$P_2 (0, -10.4) \qquad (2)$$

FBD ①

$\tan\theta = \frac{8}{7}$

$\theta = 48.8°$

$R_1 = 3(kN/m) \times 18m = 54\ kN$
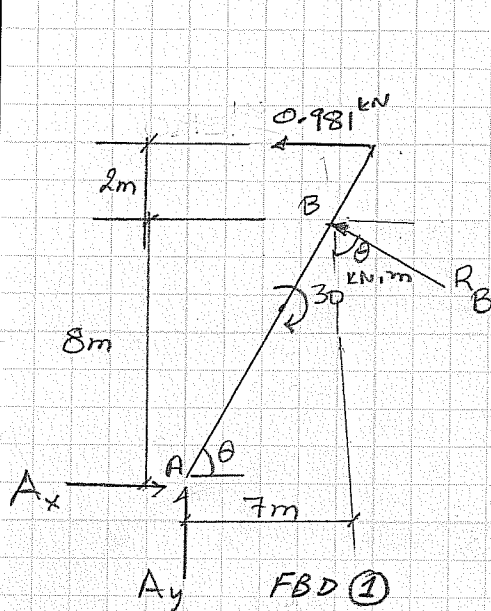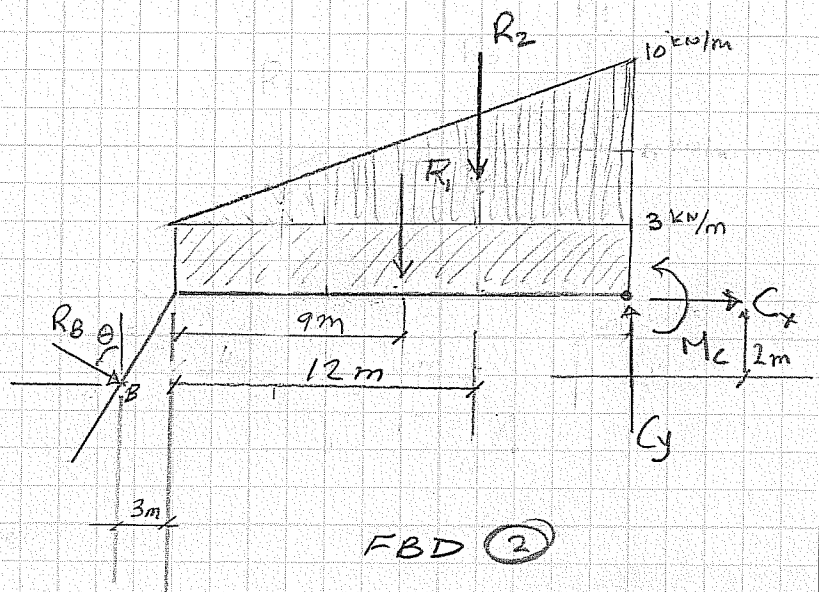
$R_2 = \frac{1}{2}(18m)(7\ kN/m) = 63\ kN$

$\Sigma R = 117\ kN$

FBD ①

$(\Sigma f_x = 0)\quad A_x - R_B \sin\theta - 0.981 = 0 \qquad\qquad (1)$

$(\Sigma F_y = 0)\quad A_y + R_B \cos\theta = 0 \qquad\qquad (2)$

$\curvearrowright (\Sigma M_A = 0)\quad (R_B \sin\theta)(8) + (R_B \cos\theta)(7) + 0.981(10) - 30 = 0 \quad (3)$

$R_B (6.02) + R_B (4.61) + 9.81 - 30 = 0$

$R_B = 1.90\ kN$ ◁

From (1) $A_x = 2.41\quad kN \rightarrow$ ◁

From (2) $A_y = -1.25\ kN$ $A_y = 1.25\ kN \downarrow$ ◁

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FBD ② $[\Sigma F_x = 0]$ $R_B \sin\theta + C_x = 0$ $C_x = -1.43^{kN}$ $C_x = 1.43^{kN}$ ←

$[\Sigma F_y = 0]$ $-R_B \cos\theta + R_1 + R_2 + C_y = 0$

$-(1.90)\cos 48.8° - 117 + C_y = 0$

$$C_y = 118.25 \text{ kN} \uparrow$$

$[\Sigma M_B = 0]$ $-12 R_1 - 15 R_2 + 21 C_y - 2 C_x + M_C = 0$

$-12(54) - 15(63) + 21(118.25) - 2(-1.43) + M_C = 0$

$M_C = -893.11 \text{ kN.m}$

$$M_C = 893.11 \text{ kN.m} \circlearrowleft$$

$A_x = 2.41 \text{ kN} \rightarrow$

$A_y = 1.25 \text{ kN} \downarrow$

$C_x = 1.43^{kN} \leftarrow$

$C_y = 118.25^{kN} \uparrow$

$M_C = 893.11 \text{ kN.m} \circlearrowleft$

$R_B = 1.90^{kN}$

0.981^{kN}

54^{kN} 63^{kN}

$893.11^{kN \cdot m}$

B

$9m$ $3m$ C

1.43^{kN}

1.90^{kN}

$30^{kN \cdot m}$

118.25^{kN}

2.41^{kN}

A

1.25^{kN}