THE UNIVERSITY OF MANITOBA
Faculty of Engineering

ENG 1440 Introduction to Statics
October 12, 2011 Term Test # 1
Time: 6:00 pm – 7:30 pm

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There are three (3) questions.
All questions are of equal value (10 marks each).
CLOSED BOOK: textbooks, notes, problems, etc., are not permitted.
Calculators are permitted.

Wherever necessary a FBD must be drawn.

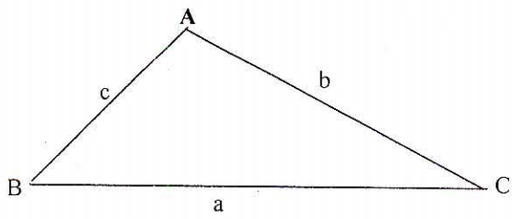
STRAIGHT EDGE IS REQUIRED.
UNDERLINE YOUR ANSWERS.
(Answer directly on the question sheet. You may use the back of the page as well.)

Name : _____

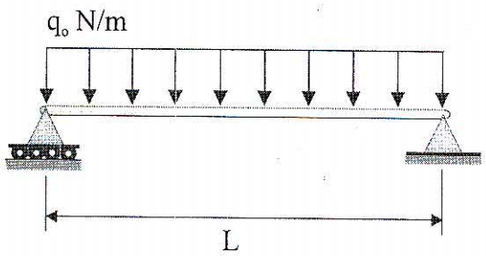
Student Number : _____

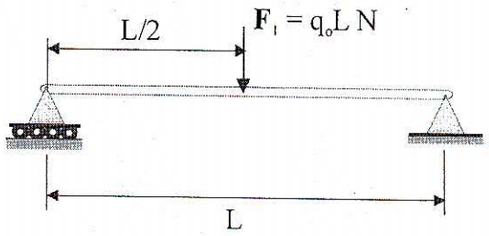
Distance Education Students: Indicate that you are in the Distance Ed. Class and fill out an assignment Return Sheet to attach.

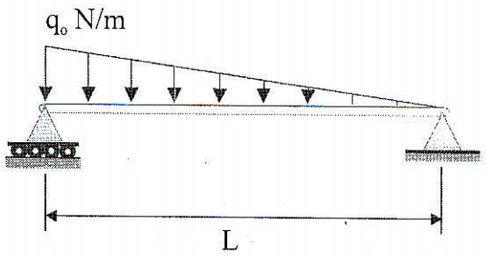
$g = 9.8\ m/sec^2$

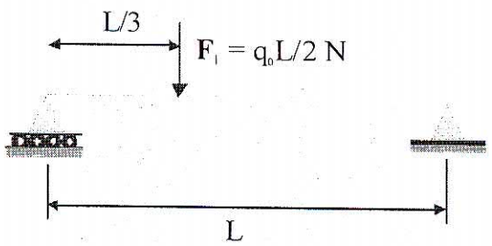


$$a^2 = b^2 + c^2 - 2bc\cos A$$
$$b^2 = a^2 + c^2 - 2ac\cos B$$
$$c^2 = a^2 + b^2 - 2ab\cos C$$
$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$









Term Test #1

Solutions

QUESTION 1

Homer Simpson is stuck on a barge that has broken loose from its mooring at *O* and is floating down the river. In desperation, he sends a text message to his daughter Lisa standing on one bank of the river:
"Lisa Help me. I need you to pull with a force of *500 N* at an angle of *40°*."
Homer also sends a message to Mr. Burns.
"Please Mr. Burns, I need you to pull with a force of *(250**i** - 380**j**)N*.
(Mr. Burns replies – "What else is new.")
If both Lisa and Mr. Burns pull as directed by Homer, will Homer on the barge reach his original position *O*. If not, in what direction will he move.

What is the resultant force on the barge?

Answer this question by:

a) Using a graphical solution, (state the scale you are using), and
b) Using a trig solution, (sine and/or cosine rule.)

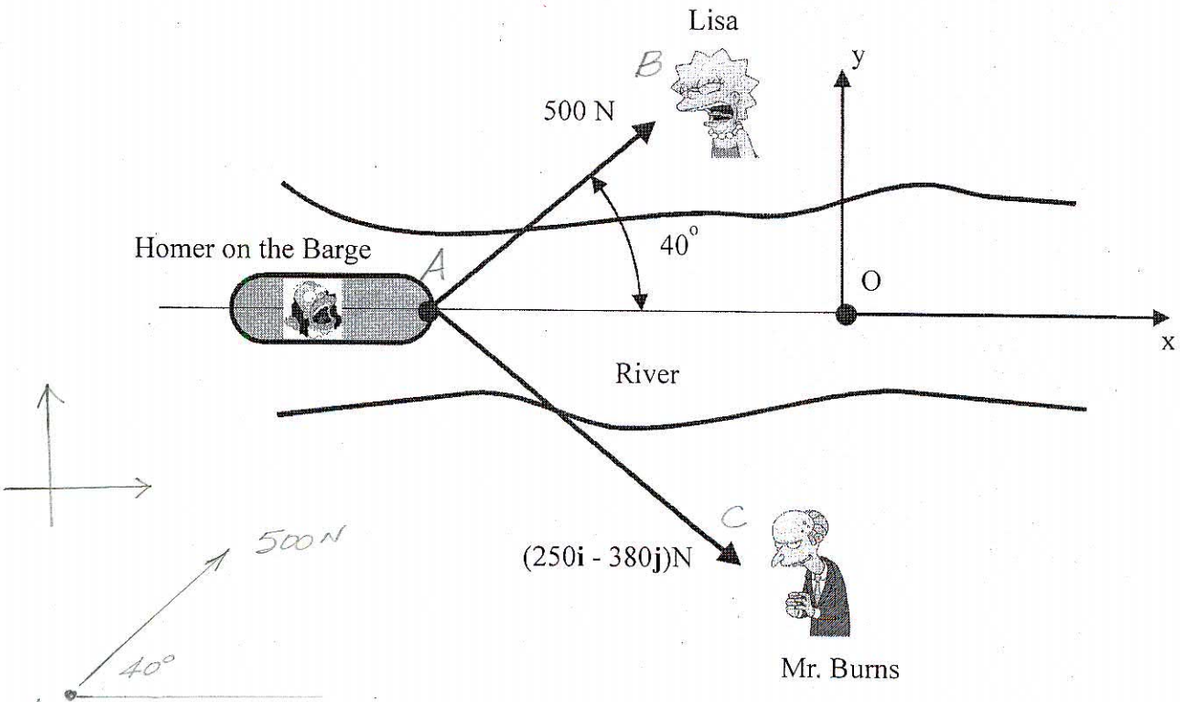


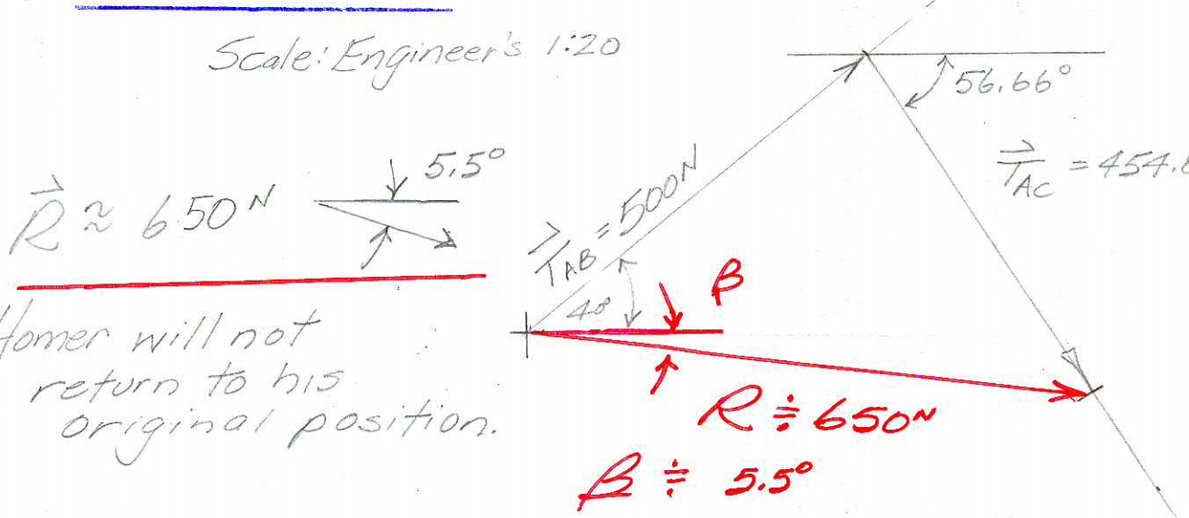
Figure 1

$\tan\alpha = \frac{380}{250} \Rightarrow \alpha = 56.66°$

$T_{AC} = \sqrt{(250)^2 + (-380)^2} = 454.86\ N$

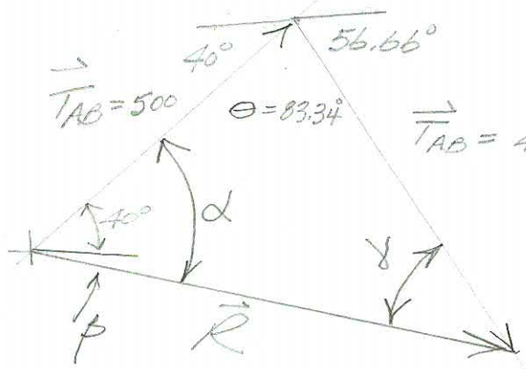
a) Graphical Solution:

Scale: Engineer's 1:20



Homer will not return to his original position.

b) Trig Solution – using triangle from graphical solution



$\theta = 180° - 40° - 56.66° = 83.34°$

Cosine Rule:

$R^2 = 500^2 + 454.86^2 - 2(500)(454.86)\cos 83.34°$

$R = 635.72\ N$

Sine Rule:

$$\frac{632.72}{\sin 83.34°} = \frac{454.86}{\sin\alpha}$$

$$\sin\alpha = \frac{454.86 \sin 83.34°}{632.72} \Rightarrow \alpha = 45.56°$$

$\beta = \alpha - 40° = 45.56° - 40° = 5.56°$

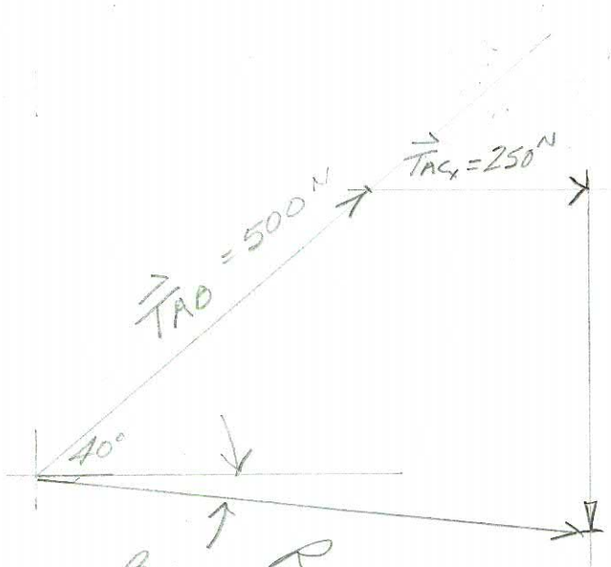
$\vec{R} = 635.72\ N$ at $5.56°$

∴ TRIG Soln

Alternate Graphical Soln.

Scale Engineer's 1:20

Leave T_{AC} in components for placing vectors "tip" to "tail"



$R \approx 635$

$\beta \approx 5.5°$

QUESTION 2

A weight, *W* is held in the position shown in the Figure by a system of cables. The weight is attached to a ring at *B* which in turn is attached to another ring at *D*. A cable is attached to the ring at *D* and passes over *two (2)* pulleys at *F* and *G* to which a force of *3 kN* is applied. Cables *ED* and *CB* are horizontal.

Determine the magnitude of the weight and the tension in cables *BC*, *BD*, *DE* and *DF*.
Om completion of this problem, place your final results in the Table provided.

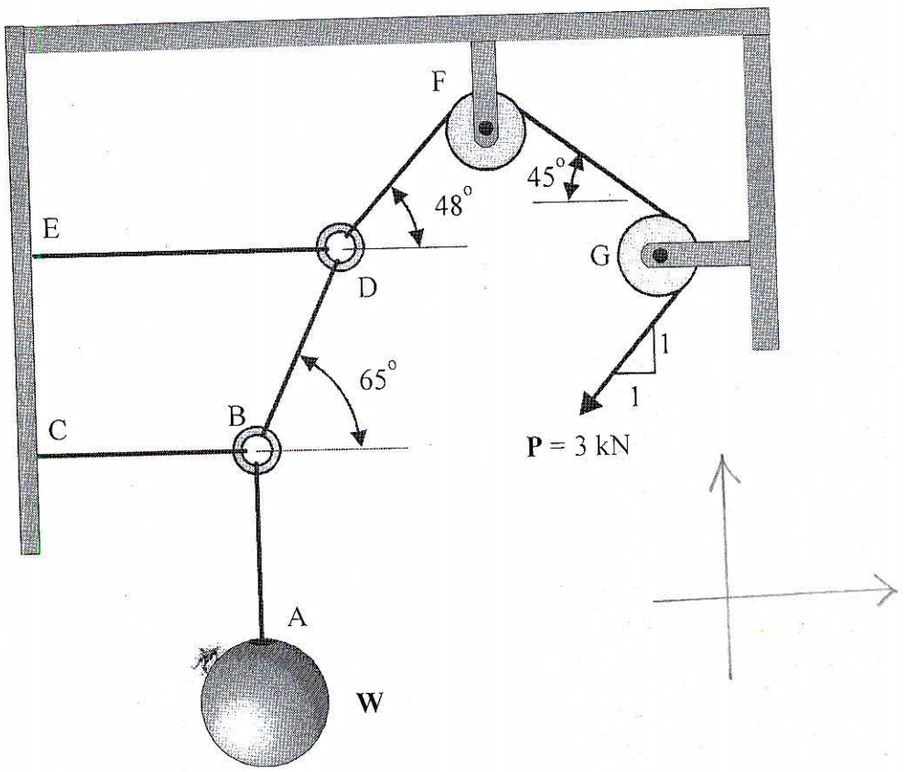
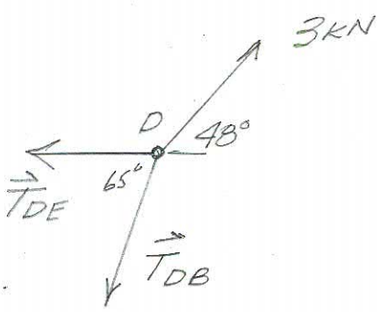
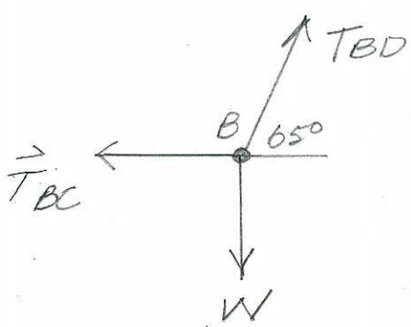


Figure 2

* tension in cable DFG is constant 3 kN



FBD at D.



FBD at B

FROM FBD at D: $\Sigma F_x = 0$ $-T_{DE} - T_{DB}\cos 65 + 3\cos 48^\circ = 0$ (1)

$\Sigma F_y = 0$ $3\sin 48^\circ - T_{DB}\sin 65^\circ = 0$ (2)

TABLE for Final Results:				
W = 2.23kN	F_{BC} = 1.04kN	F_{BD} = 2.46kN	F_{DE} = 0.97kN	F_{DF} = 3 kN

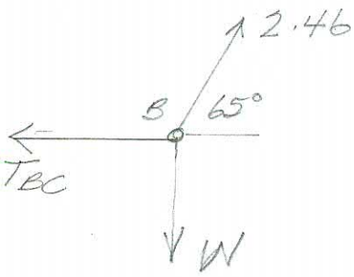
FROM (2) $T_{DB} = \frac{3\sin 48°}{\sin 65°} = +2.46\ kN$

From (1)

$-T_{DE} - 2.46\cos 65° + 3\cos 48° = 0$

$T_{DE} = +0.97 kN$

FROM FBD AT B $T_{DB} = T_{BD}$



$\Sigma F_x = 0 \quad -T_{BC} + 2.46\cos 65° = 0 \quad (1)$

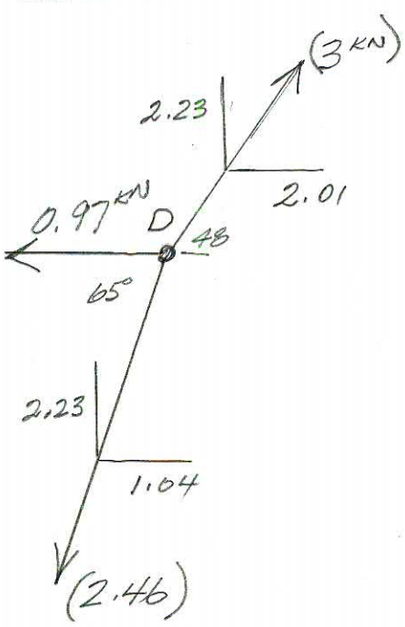
$T_{BC} = +1.04 kN$

$\Sigma F_y = 0 \quad 2.46\sin 65° - W = 0 \quad (2)$

$W = 2.23 kN$

$m = \frac{2.23(1000)}{9.8} = 227.55 kg$

Check

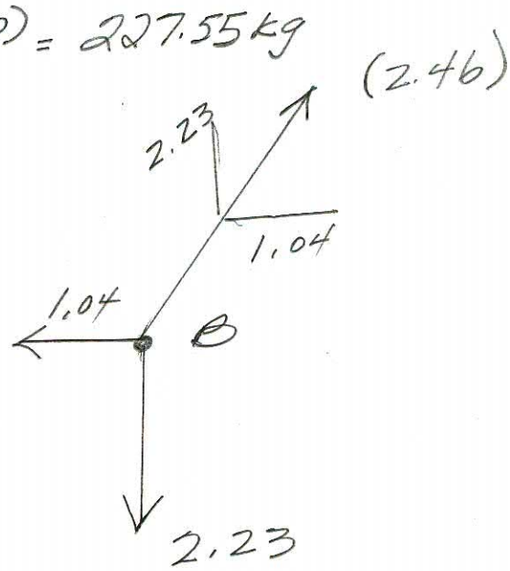


$\Sigma F_x = -0.97 - 1.04 + 2.01 = 0$

$0 = 0$ ✓

$\Sigma F_y = 2.23 - 2.23 = 0$

$0 = 0$ ✓



$\Sigma F_x = 0$

$-1.04 + 1.04 = 0$

$0 = 0$ ✓

$\Sigma F_y = 0$

$2.23 - 2.23 = 0$

$0 = 0$ ✓

QUESTION 3

Three tugboats are pushing on the hull of a large ocean liner each with a force of *10 kN* with lines of action as shown in Figure 3(a). The ocean tides and currents are applying a distributed load on the left side of the hull.

Determine the equivalent force-couple at point *O*. Draw the equivalent force-couple at point *O* on the separate diagram provided, Figure 3(b).

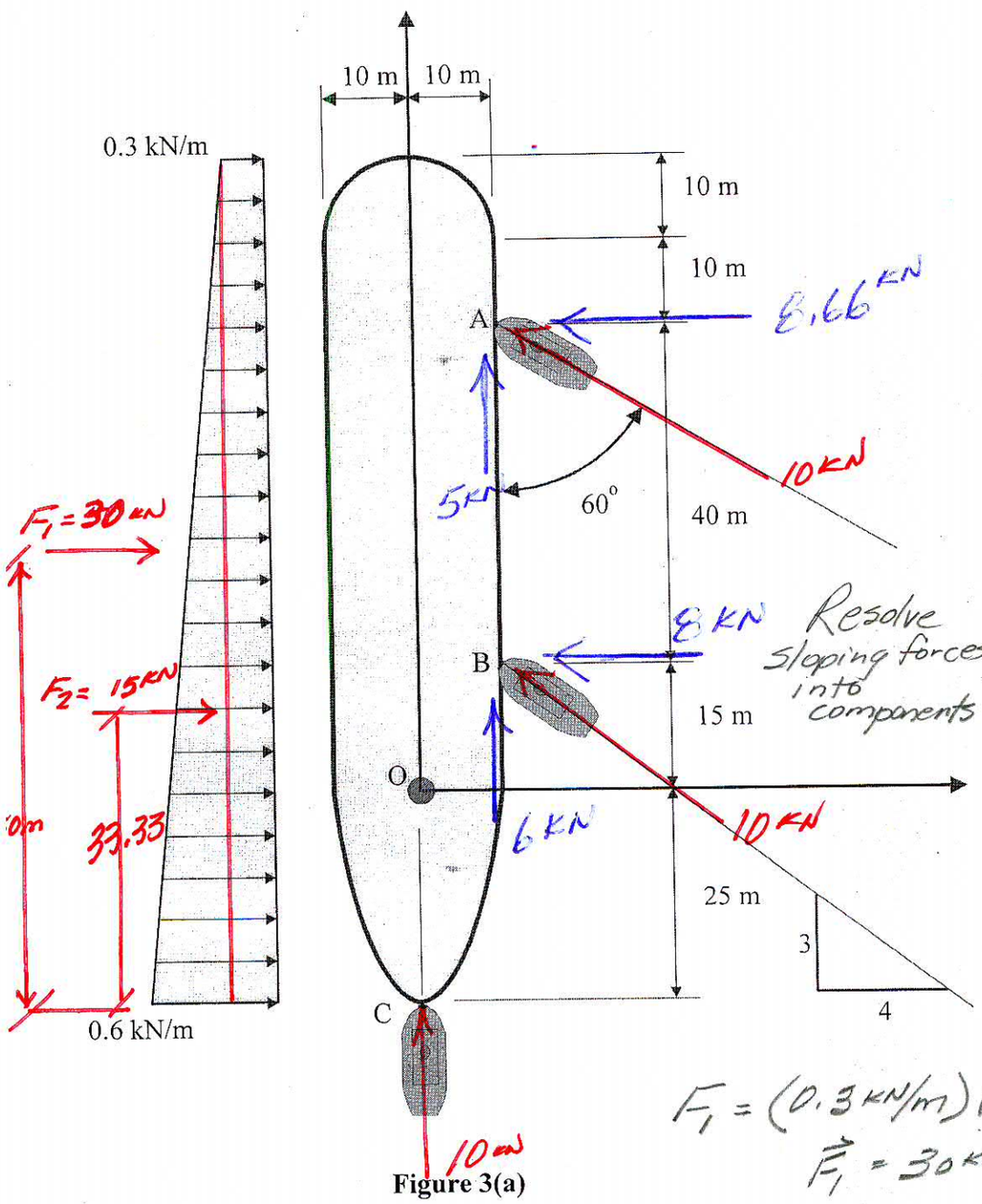


Figure 3(a)

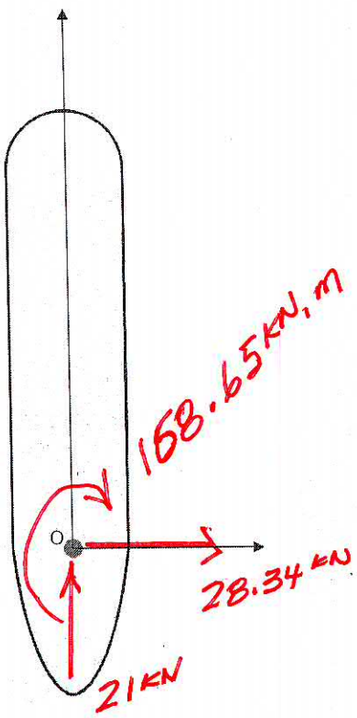
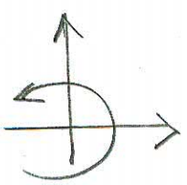


Figure 3(b)

Resolve sloping forces into components



$F_1 = (0.3\ kN/m)(100m) = +30\ kN$

$\vec{F}_1 = 30\ kN \rightarrow$ @ 50m

$F_2 = \frac{(0.6-0.3)(100)}{2} = +15\ kN$

$\vec{F}_2 = 15\ kN \rightarrow$ @ $\frac{100m}{3} = 33.33m$

$R_x = \Sigma F_x$

$R_x = +30 + 15 - 8.66 - 8 = +28.34\ kN$

$\therefore \vec{R}_x = 28.34\ kN \rightarrow$

$R_y = \Sigma F_y$

$R_y = 10 + 5 + 6 = +21\ kN$

$\therefore \vec{R}_y = 21\ kN \uparrow$

$$M_{R_O} = \Sigma M_O$$

$$M_{R_O} = -30(25) - 15(8.33) + 8.66(55) + 5(10) + 8(15) + 6(10) = -168.65\ kN.m$$

$$\therefore \overrightarrow{M_{R_O}} = 168.65\ kN.m \circlearrowright$$

Equivalent Force-Couple at O