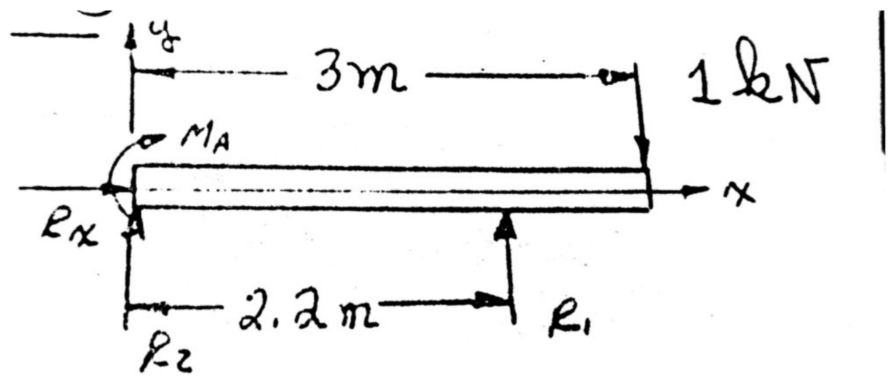
SOLUTIONS TO ASSIGNMENT 1

1.



Σ Fx = 0.

Rx = 0.

Σ Fy = 0.

$-1000 + R_1 + R_2 = 0.$

Σ Mo = 0

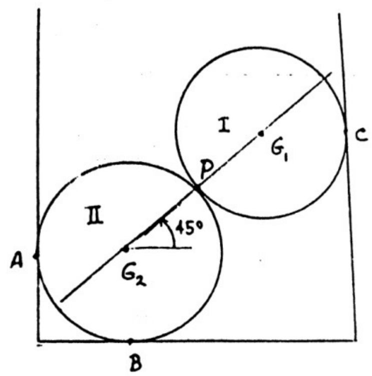
$-M_A + 2.2\ R_1 - 3 \times 1000 = 0.$

The structure is statically indeterminate. There are two independent equilibrium equations for the three unknowns (M_A, R_1, R_2).

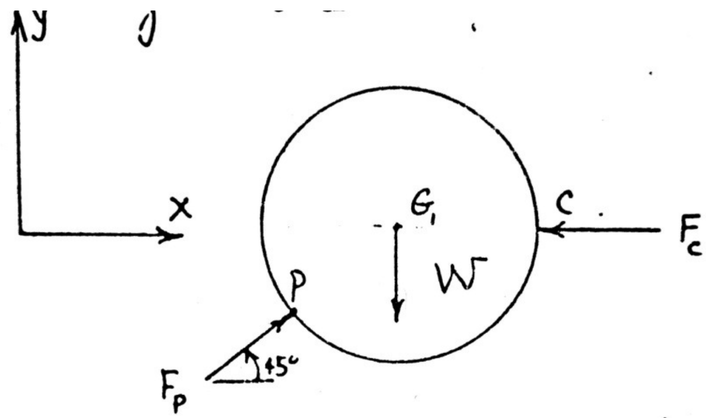
Options – (d)

(a) M_A = 100 Nm, R_1 = 200 kN, R_2 = 200 kN.
(b) M_A = 150 Nm, R_1 = 250 kN, R_2 = 200 kN.
(c) M_A = 250 Nm, R_1 = 200 kN, R_2 = 400 kN.
(d) Cannot be determined using equilibrium equations.

2. Idealisation : Assume cylinders and box to be rigid. Reactions are all point force.



Consider FBD of cylinder 1.



W = 900 N

$\Sigma M_{G1} = 0$. Satisfied considering there is no friction at P and C. F_p and F_c are radial.

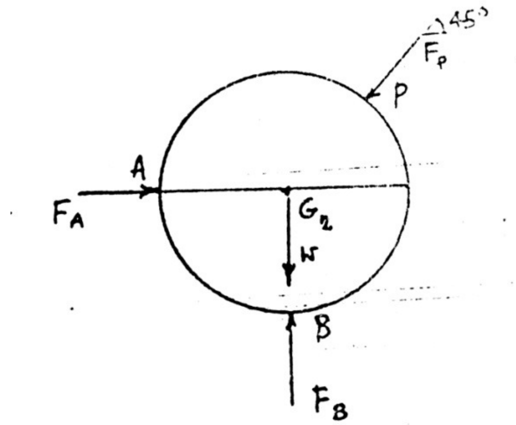
$\Sigma Fy = 0$.Hence $F_p \sin 45^\circ = W$

$$Fp = \frac{2W}{\sqrt{2}}$$

$\Sigma Fx = 0$. Hence $F_p \cos 45^\circ = Fc$.

$F_c = W$.

Free body of cylinder II



$\Sigma Fx = 0$. Hence, $F_A = F_p\cos45^\circ = W$.

$\Sigma Fy = 0$. Hence, $F_B = W + F_p\sin45^\circ = 2W$.

Hence

$F_A = 900$ N

$F_B = 1800$ N

$F_C = 900$ N

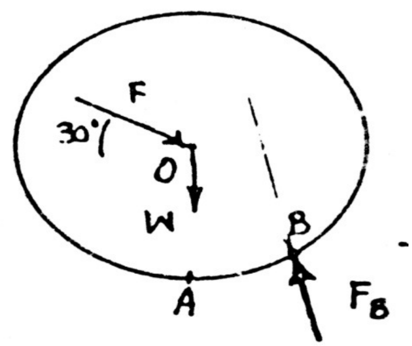
Options – (a)

(a) $F_A = 900$ N, $F_B = 1800$ N, $F_C = 900$ N
(b) $F_A = 1000$ N, $F_B = 1800$ N, $F_C = 1000$ N
(c) $F_A = 800$ N, $F_B = 1600$ N, $F_C = 800$ N
(d) $F_A = 1000$ N, $F_B = 1700$ N, $F_C = 1000$ N

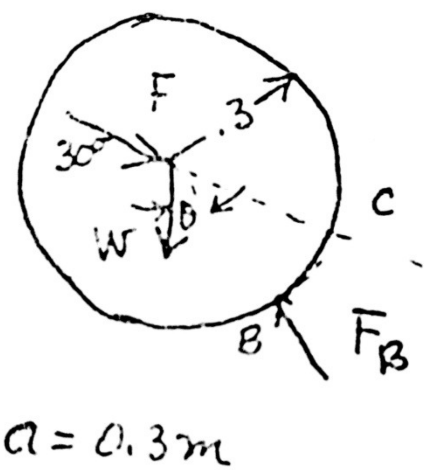
3.

Idealisation - Inelastic contact. No friction at A. No slip at B. At instant when roller begins to rise, force at A = 0. If F is just enough to cause the roller to rise, it is still in static equilibrium.

(a) Pushing



Σ Mo = 0. This requires F_B to pass through O. Thus the free body diagram appears as in Figure below.



Equilibrium : $\Sigma M_B = 0$.

W x asinθ = F x $\overline{BC}$ = F x asin(60 – θ).

$F = \frac{W\sin\theta}{\sin(60-\theta)}$ = 1866 N.

$\cos\theta = \frac{300-75}{300}$. Hence θ = 41.4°

(b) PULLING

$\Sigma M_B = 0$.

W x asinθ = F x asin(90 – θ + 30)

F = 607 N.

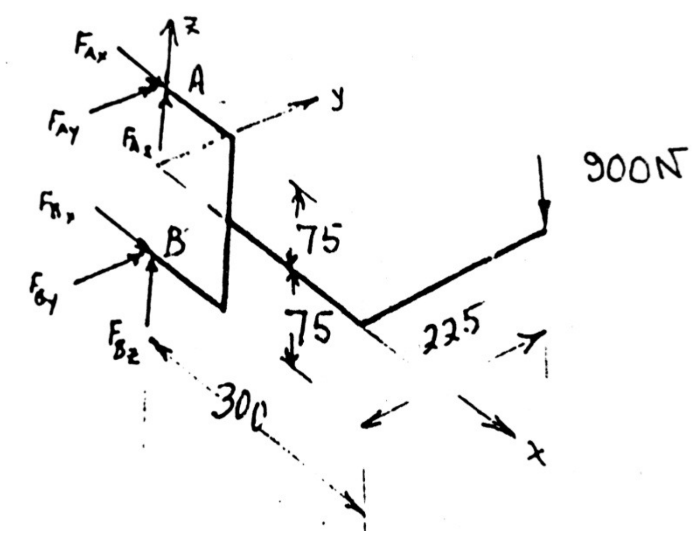
Pushing F = 1866 N.

Pulling F = 607 N.

Options – (b)

(a) Pushing F = 1890 N, Pulling F = 690 N.
(b) Pushing F = 1866 N, Pulling F = 607 N.
(c) Pushing F = 1750 N, Pulling F = 500 N.
(d) Pushing F = 1966 N, Pulling F = 707 N.

4.



Idealisation : Assume that the bearings at A and B can transmit no moments.

Equilibrium of a free body.

$\Sigma Fx = 0$: $F_{AX} + F_{BX} = 0$ ….(i)

$\Sigma Fy = 0$: $F_{AY} + F_{BY} = 0$ ….(ii)

$\Sigma Fz = 0$: $F_{AZ} + F_{BZ} = 900$ N ….(iii).

From Configuration , $F_{AZ} = 0$. $F_{BZ} = 900$N.

$\Sigma M_{BX} = 0$.

$-900x225 – F_{AY}x150 = 0$.

$\Sigma M_{BY} = 0$.

$-900x300 – F_{AX}x150 = 0$.

Similarly use for $M_{BZ} = 0$.

Solving we get.

F_{BZ} = 900 N.

F_{BX} = 1800 N.

F_{BY} = 1350 N.

F_{AZ} = 0.

F_{AX} = -1800 N.

F_{AY} = -1350 N.

Options – (b)

(a) F_{AX} = -2000 N, F_{AY} = -1350 N, F_{AZ} = 0. F_{BX} = 2000 N, F_{BY} = 1350 N, F_{BZ} = 900 N.

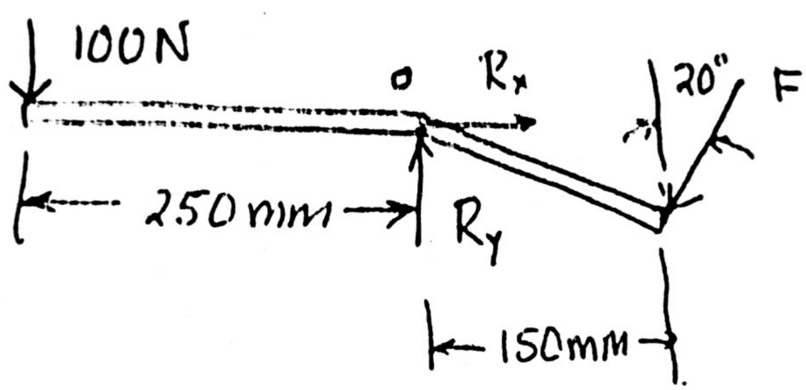
(b) F_{AX} = -1800 N, F_{AY} = -1350 N, F_{AZ} = 0. F_{BX} = 1800 N, F_{BY} = 1350 N, F_{BZ} = 900 N.

(c) F_{AX} = -1800 N, F_{AY} = -1550 N, F_{AZ} = 0. F_{BX} = 1800 N, F_{BY} = 1550 N, F_{BZ} = 900 N.

(b) F_{AX} = -2000 N, F_{AY} = -1550 N, F_{AZ} = 0. F_{BX} = 2000 N, F_{BY} = 1550 N, F_{BZ} = 900 N.

5.

FBD of the link.



$\Sigma Mo = 0$. Hence , 100 x 250 – F x 150cos20° = 0.

F = 177.4 N.

$\Sigma Fx = 0$. Hence , Rx – Fsin20° = 0

Rx = 60.67 N

ΣFy = 0. Hence .. Ry -100 – Fcos20˚ = 0.

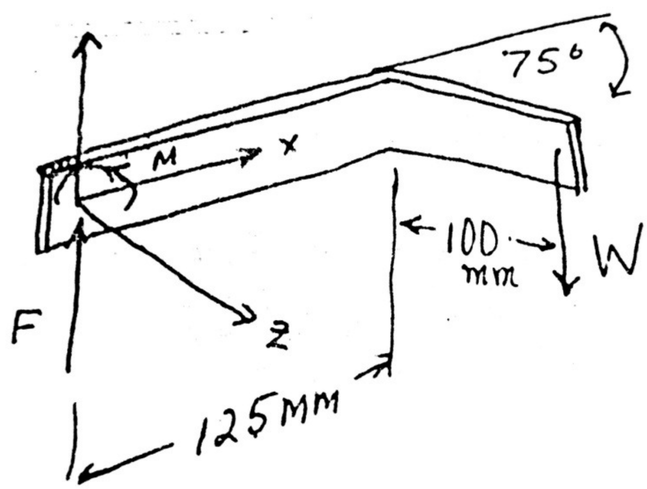
Ry = 266.7 N.

Options- (c)

(a) F = 187.4 N, Rx = 70.67 N, Ry = 276.7 N
(b) F = 167.4 N, Rx = 50.67 N, Ry = 256.7 N
(c) F = 177.4 N, Rx = 60.67 N, Ry = 266.7 N
(d) F = 197.4 N, Rx = 60.67 N, Ry = 286.7 N

6.

FBD of the bracket.



Σ Mz = 0.

M_A – W x (125 + 100cos75˚) = 0.

M_A = 100 Nm.

W = 662 N.

Options – (c)

(a) W = 632 N

(b) W = 622 N
(c) W = 662 N
(d) W = 692 N