

PROBLEM 3-3

Statement:

Draw a free-body diagram of the pedal-arm assembly from a bicycle with the pedal-arms in the horizontal position and dimensions as shown in Figure P3-1. (Consider the two arms, pedals, and pivot as one piece.). Assuming a rider-applied force of 1500 N at the pedal, determine the torque applied to the chain sprocket and the maximum bending moment and torque in the pedal arm.

Solution:

See Figure 3-3 and the TKSolver file P03-03.

Rule Sheet:

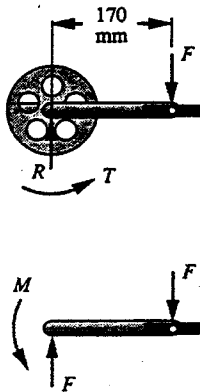
$$T = F \cdot l$$

$$T_a = F \cdot a$$

$$M = F \cdot l$$

Variable Sheet:

St	Input	Name	Output	Unit	Comment
	170	l		mm	distance from pedal to sprocket
	60	a		mm	length of pedal arm
	1500	F		N	applied force
		T	255	N-m	torque on chain sprocket
		T _a	90	N-m	torque on pedal arm
		M	255	N-m	bending moment on pedal arm



PROBLEM 3-4

Statement:

The trailer hitch from Figure 1-1 (p. 12) has loads applied as shown in Figure P3-2. The tongue weight of 100 kg acts downward and the pull force of 4 905 N acts horizontally. Using the dimensions of the ball bracket in Figure 1-5 (p. 15), draw a free-body diagram of the ball bracket and find the tensile and shear loads applied to the two bolts that attach the bracket to the channel in Figure 1-1.

Solution:

See Figure 3-4 and the TKSolver file P03-04.

Rule Sheet:

* moments

$$M_{ball} = F_{pull} \cdot a \quad \text{"moment on ball shank"}$$

$$M_{brack} = M_{ball} + W_{tongue} \cdot c \quad \text{"moment on bracket at bolt"}$$

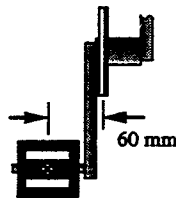
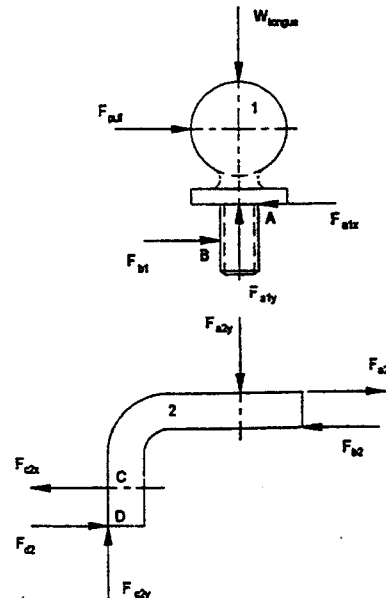
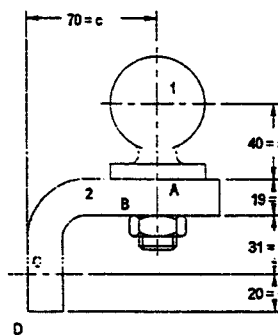


FIGURE 3-3

Free Body Diagrams for Problem 3-3

Variable Sheet: (3.4)

St	Input	Name	Output	Unit	Comment
4,905.	F _{pull}			N	pull force
981.	W _{tongue}			N	tongue weight
26.	D _a			mm	ball shank diameter
19.	t			mm	bracket thickness
40.	a			mm	height between bracket top and force
31.	b			mm	distance to bolt centerline
70.	c			mm	x dist between bracket base and ball
20.	d			mm	distance bolt to edge
	F _{bolt}	30,411.		N	axial force on 2 bolts
	F _{shear}	981.		N	shear force on 2 bolts
	M _{ball}	196.		N-m	bending moment applied to ball shank
	M _{brack}	265.		N-m	bending moment applied to ball bracket



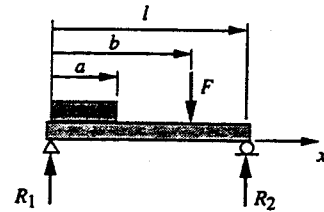
3.4

3-4, 3-5, 3-6 Courtesy of Professor Thomas A. Cook, Mercer

PROBLEM 3-23

Statement: A beam is supported and loaded as shown in Figure P3-11a. Find the reactions, maximum shear, and maximum moment for the data given in the row(s) assigned from Table P3-1.

Solution: See Figures 3-23 and Table 3-23 for solution data to all rows of the problem statement. Only the variable sheet for row *a* is shown here. Also see the *TKSolver* file P03-23 which contains solutions for all rows.

**FIGURE 3-23A**

Free Body Diagram for Problem 3-23

Table 3-23 Summary of results for all rows of Problem 3-23

param	R1	R2	Vmin	Vmax	Mmin	Mmax
units	N	N	N	N	N-m	N-m
Row						
a	264	316	-316	264	0.0	126
b	378	488	-488	378	0.0	146
c	192	308	-308	192	0.0	31
d	85	198	-198	85	0.0	40
e	336	448	-448	336	0.0	156
f	256	775	-775	256	0.0	77
g	95	225	-225	95	0.0	22
h	205	335	-335	205	0.0	23
i	56	151	-151	56	0.0	15
j	31	64	-64	31	0.0	3
k	229	662	-662	229	0.0	66
l	86	536	-536	86	0.0	53
m	79	429	-429	79	0.0	43
n	29	100	-100	29	0.0	15

PROBLEM 3-24

Statement: A beam is supported and loaded as shown in Figure P3-11b. Find the reactions, maximum shear, and maximum moment for the data given in the row(s) assigned from Table P3-1.

Solution: See Figures 3-24 and Table 3-24 for solution data to all rows of the problem statement. Only the variable sheet for row *a* is shown here. Also see the *TKSolver* file P03-24 which contains solutions for all rows.

Table 3-24 Summary of results for all rows of Problem 3-24

param	R1	M1	Vmin	Vmax	Mmax
units	N	N	N	N	N-m
Row					
a	620	584	500	620	-584
b	890	613	850	890	-613
c	550	155	450	550	-155
d	270	213	0	270	-213
e	798	666	0	798	-666
f	1094	524	950	1094	-524
g	330	185	250	330	-185
h	540	106	0	540	-106
i	213	83	0	213	-83
j	95	18	0	95	-18
k	897	357	0	897	-357
l	659	574	0	659	-574
m	548	369	500	548	-369
n	162	123	0	162	-123