Problem 5.22

Torque on an S-bend
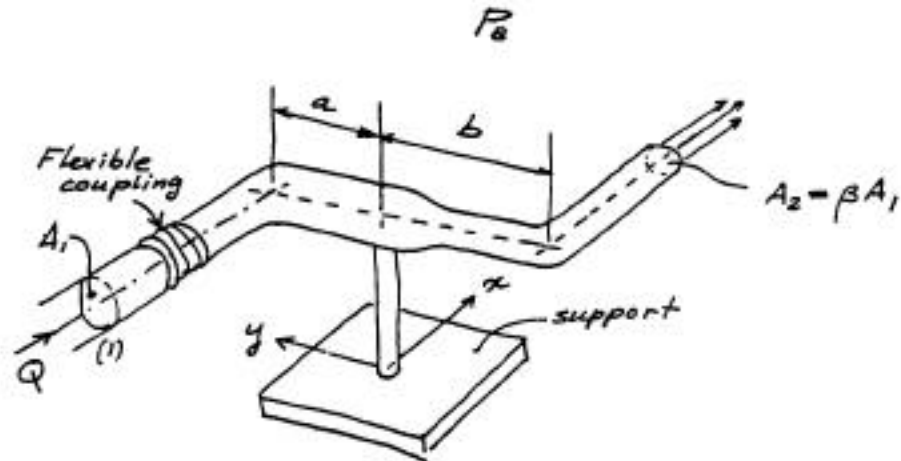
P_a

Flexible coupling

A_1

(1)

Q

a

b

$A_2 = \beta A_1$

x

support

y

An incompressible liquid (density ρ) flows through an S-bend in a pipe with an area contraction, as shown in the sketch. The volume flow rate through the bend is Q, the pressure at station 1 is p_1, and station 2 is open to the atmosphere, which is at pressure p_a. Find expressions for the x and y components of force and the counter-clockwise torque exerted on the support. The flexible coupling (a bellows) allows a pressure difference between the inside and outside, but transmits no axial force.

Express your answers in terms of a, b, A_1, , Q, and .

HINT   ANSWER