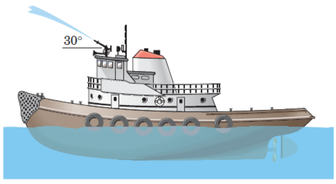
Engineering Mechanics | (8th Edition)

Problem

The fire tug discharges a stream of salt water (density 1030 kg/m^3) with a nozzle velocity of 40 m/s at the rate of 0.080 m^3/s. Calculate the propeller thrust T which must be developed by the tug to maintain a fixed position while pumping.



Problem 4/41

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Step-by-step solution

Step 1 of 2

Given

Density of the salt water, $\rho = 1030\,\text{kg/m}^3$

Velocity of the nozzle, $v = 40\,\text{m/s}$

Angle, $\theta = 30°$

Flow rate, $Q = 0.08\ \text{m}^3/\text{s}$

Comment

Step 2 of 2

Horizontal velocity of salt water moving out, $v_x = v\cos\theta$

$= 40\cos(30°)$

$= 40\times\frac{\sqrt{3}}{2}$

$= 20\sqrt{3}$

Mass flow rate $\dot{m} = \rho Q$

$= 0.08\times 1030$

$= 82.4\,\text{kg/s}$

Change in momentum/s, $\Delta M = 0 - \dot{m}v_x$

$= -82.4\times 20\sqrt{3}$

Force on the boat in opposite direction to the exit of salt water $= 82.4\times 20\sqrt{3}\ \text{N}$

Thrust to be developed to keep the tag stationary, $T = 82.4\times 20\sqrt{3}\ \text{N}$

$T = 82.4\times 20\sqrt{3}$

$= 2854.42\,\text{N}$

$= 2.85442\,\text{kN}$

$\boxed{T = 2.85\,\text{kN}}$

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Recommended solutions for you in Chapter 4

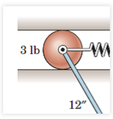
Chapter 4, Problem 11P

The two spheres, each of mass m, are connected by the spring and hinged bars of negligible mass. The spheres are free to slide...

See solution

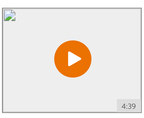
Chapter 4, Problem 5P

The system consists of the two smooth spheres, each weighing 3 lb and connected by a light spring, and the two bars of...



See solution

Videos related to **Chapter 4**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Matrix Multiplication
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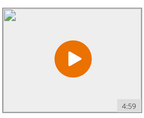
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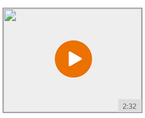
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TEXTBOOK SOLUTION
Force Transmissibility
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Examples related to **Chapter 4**

Example 1

The system of four particles has the indicated particle masses, positions, velocities, and external forces. Determine $\bar{r}$, $\dot{\bar{r}}$, $\ddot{\bar{r}}$, T, G, $\dot{H}_O$, $\dot{H}_G$, and $\ddot{H}_G$.

Show more

Example 2

Example 3

Example 4

Example 5