

## Chapter 2, Question 5: Integral Momentum Equation

A fighter aircraft is being refueled in mid-air by a tanker. The refueling boom enters the aircraft at an angle of 30 degrees from its flight path. The fuel flow rate through the boom is 20kg/s at a velocity of 30m/s relative the two aircraft. The density of the fuel is 700kg/m<sup>3</sup>. What additional lift force is necessary to overcome the force on the fighter due to the momentum transfer during refueling?

1)  $20 \cdot 30 \cdot (\sin 30)^2$

2)  $20 \cdot (30 \cdot \sin 30)^2$

3)  $20 \cdot 30 \cdot \sin 30$

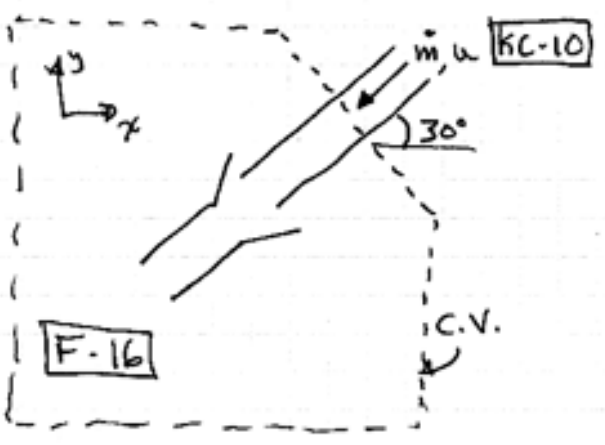
4) I don't know

# Chapter 2, Question 5 Answer:

The correct answer is 3)  $\Delta F_y = \text{massflow} * \text{velocity} * \sin(\theta) = 20 * 30 * \sin(30)$

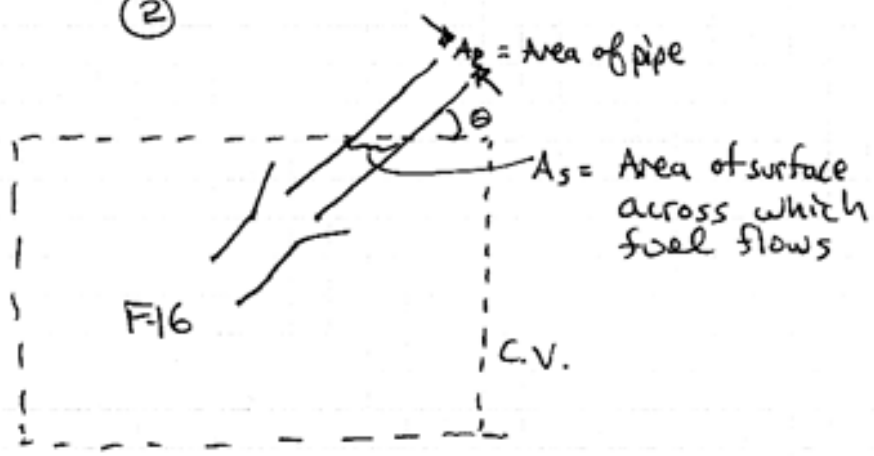
There are two ways to arrive at this.:

①



FORCE IS DUE TO MOMENTUM FLUX INTO C.V.  
 MAGNITUDE OF FORCE =  $\dot{m}u$   
 COMPONENT IN y-DIR =  $\dot{m}u \sin 30^\circ$

②



$$A_s = \frac{A_p}{\sin \theta}$$

$$\Delta F_y = \int_{A_s} p u_y \vec{u} \cdot \vec{n} dA$$

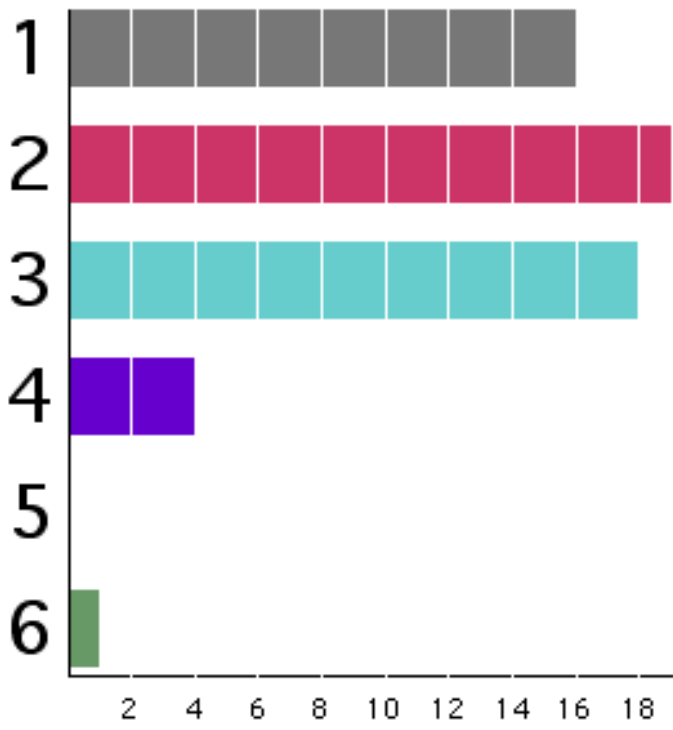
(no fluxes across any other area of C.V.)

$$= -p u \sin \theta (-u \sin \theta) A_s$$

$$= \int p u \sin \theta (u \sin \theta) A_p / \sin \theta = \int p u A_p u \sin \theta = \dot{m} u \sin \theta \checkmark$$

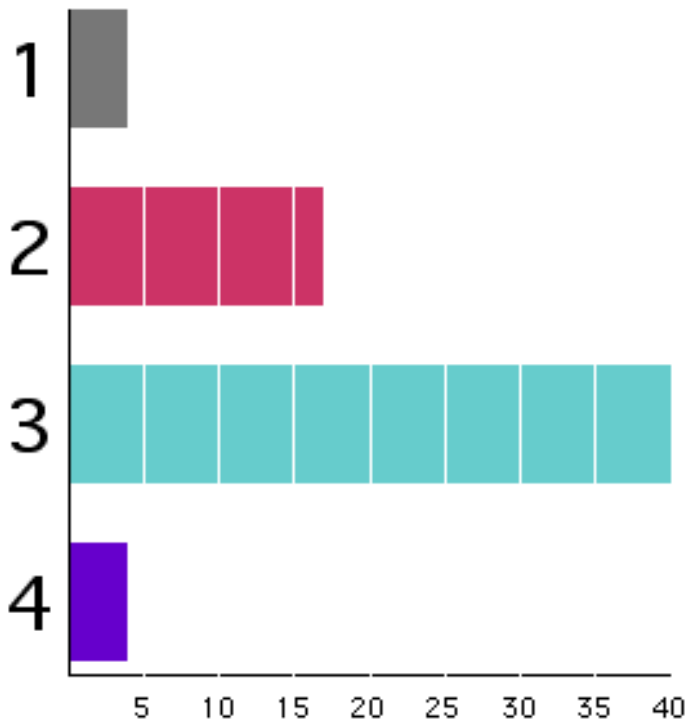
Class performance (2004):

Question 1 : Question 1



Class performance (2003):

Question 1 : Question 1



# Class performance (2001):

