Finish fluids today

Read 11.1 - 11.4

This week's clickers are Bonus to allow you to make up for some missed clickers (up to 100%) max 103

Bonus H.W available (can go over 100%)

No group this week

Reminder

Archimedes $\Rightarrow$ $F_{Buoyant} = w_f$

$$= m_f g$$

$$= \rho_f V_f g$$

object submerged in a fluid

Ex) what is buoyant force on a balloon filled with 1.0 m^3 Helium at sea level?

b) what is gravitational force on the balloon?

a) $F_B = w_f = \rho_A V_A g = \rho_A V_{balloon} g$

$(1.29\ kg/m^3)(1\ m^3)(9.8\ m/s^2)$

$= \boxed{12.6\ N}$

b) $F_g = mg = \rho_{He} V_{He}\, g$

$(.179\ kg/m^3)(1\ m^3)(9.8\ m/s^2)$

$= \boxed{1.75\ N}$

ex) If a crown weighed on a scale is 9.8N and crown weighed in water is 9.0N, is crown pure gold?

$$F_B = m_w g = \rho_w V_w g = \underline{\rho_w V_c g}$$

$$F_B = 9.8N - 9.0N = 0.8N$$

$$V_c = \frac{F_B}{\rho_w g}$$

$$\rho_c = \frac{m_c}{V_c} = \frac{m_c}{\frac{F_B}{\rho_w g}} = \frac{m_c g \rho_w}{F_B} = \frac{W_c \rho_w}{F_B}$$

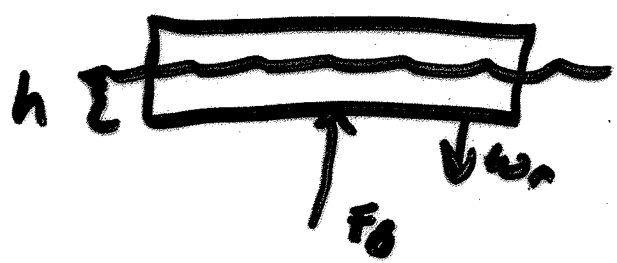
$$\rho_c = \frac{(9.8N)(1000\,kg/m^3)}{.8N}$$

$$1.2 \times 10^4\,kg/m^3$$

$$\rho_{gold} = 1.9 \times 10^4\,kg/m^3$$

<u>No</u>

EX) A raft is made of wood having a density of 600 kg/m³. Its surface area is 5.7 m² and its volume is 0.6 m³. How much of it is below water level?



$F_B - w_r = 0$

$F_B = w_r$ (Newton)

$F_B = w_w$ (Archimedes)

$w_r = \rho_r V_r g$
$w_w = \rho_w V_w g$ ⇒ set equal $\rho_r V_r g = \rho_w V_w g$

$\rho_r V_r = \rho_w V_w = \rho_w h A_w$

$$h = \frac{\rho_r V_r}{\rho_w A_w} = \frac{(600\ kg/m^3)(0.6\ m^3)}{(1000\ kg/m^3)(5.7\ m^2)}$$

$h = .063\ m$

Volume = L x w x H

Area = L x w

$$\text{Height of raft} = \frac{L \times w \times H}{L \times w} = \frac{\text{Volume}}{\text{Area}}$$

$$= \frac{.6\,m^3}{5.7\,m^2} = .1\,m$$

fraction of raft under water

$$\frac{.063\,m}{.1\,m} = \underline{.6}$$

$$\frac{\text{Density of wood}}{\text{Density of water}} = \frac{600\,kg/m^3}{1000\,kg/m^3} = \underline{.6}$$

Fraction submerged = ratio of densities

ice density = 900 kg/m^3

what fraction of iceberg above water?

$$\text{fraction submerged} = \frac{900\ kg/m^3}{1000\ kg/m^3} = .9$$

<u>10%</u> above water

Interactive Question

A boat carrying a large boulder is floating on a lake. The boulder is thrown overboard and sinks. The water level in the lake, with respect to the shore

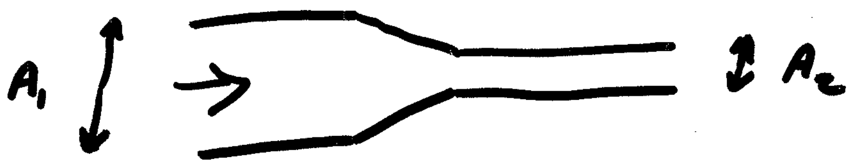
A) rises.
B) drops.
C) remains the same.

Interactive Question

Consider an object that floats in water but sinks in oil. When the object floats in water, half of it is submerged. If we slowly pour oil on top of the water so it completely covers the object, the object

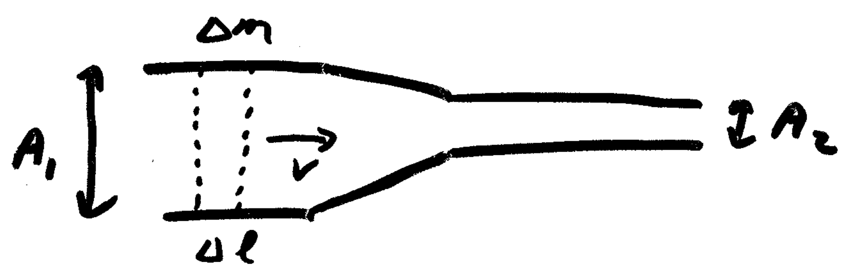
A) moves up.
B) stays in the same place.
C) moves down.

fluids in motion



Lets look at fluids that cannot be compressed (water, blood, oil ...)

Determine how much fluid moves in a given time



$$\frac{\Delta m}{\Delta t} = \rho \frac{\Delta V}{\Delta t} = \rho A \frac{\Delta l}{\Delta t} = \rho A v$$

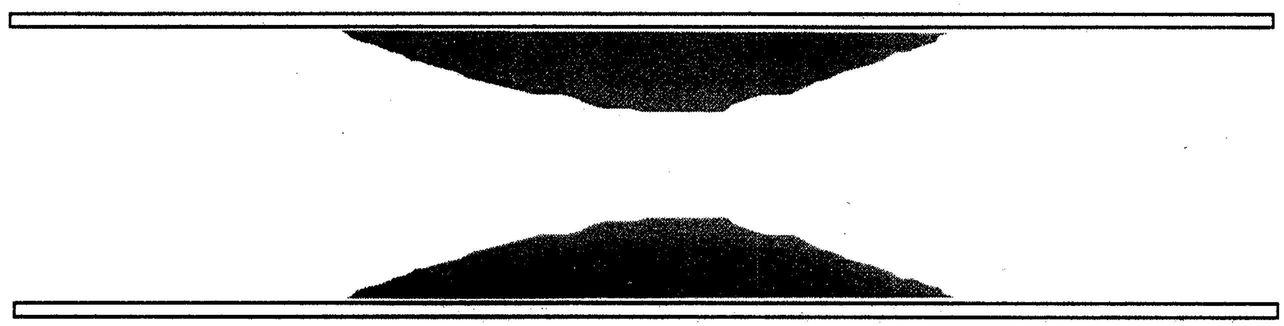
since fluid incompressible, the amount passing any point along pipe must be the same

$$\rho_1 A_1 v_1 = \rho_2 A_2 v_2$$

$$\boxed{A_1 v_1 = A_2 v_2}$$

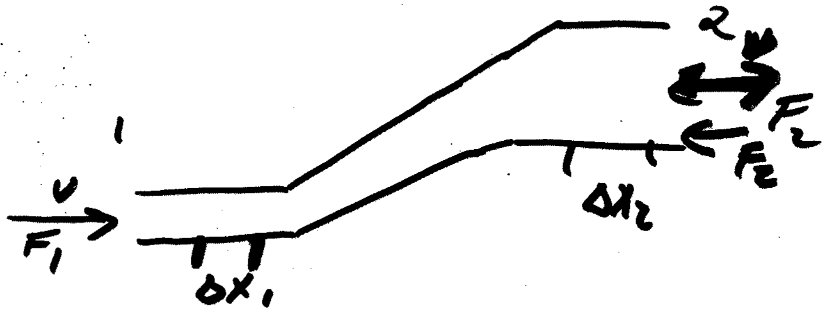
Interactive Question

Blood flows through a coronary artery that is partially blocked by deposits along the artery wall. Through which part of the artery is the flow speed largest?



A) The narrow part
B) The wide part
C) The speed is the same in both parts

Bernoulli's Equation



$$W_{ext} = \Delta K + \Delta U$$

$$W_{ext} = W_1 + W_2$$

$$= F_1 \Delta x_1 - F_2 \Delta x_2$$

$$= P_1 A_1 \Delta x_1 - P_2 A_2 \Delta x_2$$

$$= P_1 V_1 - P_2 V_2$$

$$\Delta K = \frac{1}{2} m v_2^2 - \frac{1}{2} m v_1^2$$

$$= \frac{1}{2} \rho V_2 v_2^2 - \frac{1}{2} \rho V_1 v_1^2$$

$$\Delta U = mgy_2 - mgy_1 = \rho V_2 g y_2 - \rho V_1 g y_1$$

$$P_1 V_1 - P_2 V_2 = \frac{1}{2} \rho V_2 v_2^2 - \frac{1}{2} \rho V_1 v_1^2 + \rho V_2 g y_2 - \rho V_1 g y_1$$

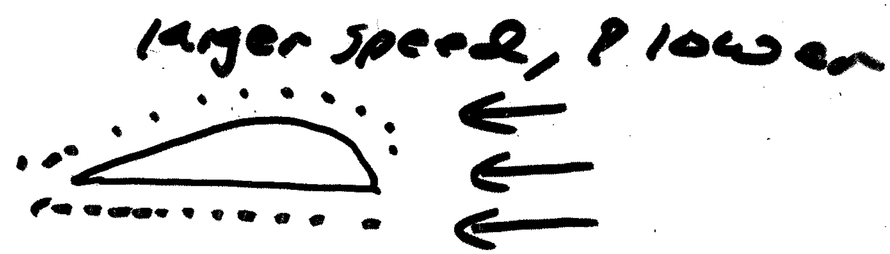
since fluid incompressible $V_1 = V_2$

$$P_1 - P_2 = \frac{1}{2} \rho v_2^2 - \frac{1}{2} \rho v_1^2 + \rho g y_2 - \rho g y_1$$

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$$

Note if velocity larger, Pressure lower

Airplane wing



Curve ball