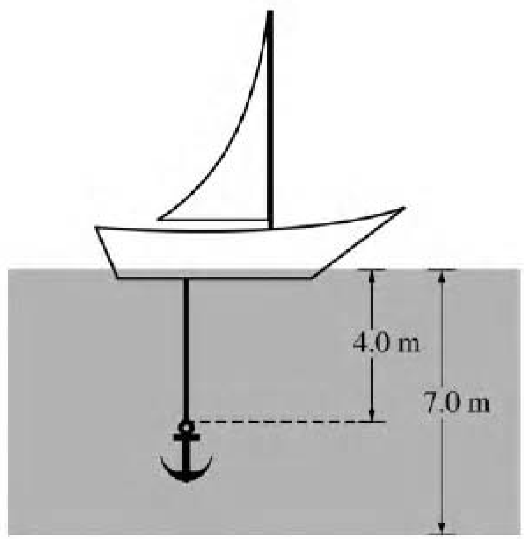
AF2: Adult FIZZIX 2 EXAM #1 2015 SA BL3

SA / Free Response / Harder / Tuffer / Math-Based / Icky Section

There are five problems; choose THREE for a total of THREE (3, ONE more than a couple, MINIMUM for a "few", $\sqrt{9}$, # of Stooges, The Trinity, # of Strikes, # of Coins in a Fountain, # of French Hens, # Miles in a League, # in a Hat Trick, # of Little Pigs, The # of Billy Goats Gruff, # of Bears Goldilocks had to fight off, # minutes an egg needs, # English feet in a yard, # Books in LOTR Trilogy, # in ANY Trilogy, # Rings in a Circus, # Ships Columbus Sailed, #Witches in Macbeth, # Blind Mice, #Musketeers, # Bee Gees, # Branches of US Government, # Sides to a Triangle, # Races in the Triple Crown (DUH), # Cousins of Donald Duck, # Dog Nights, # Stars in Orion's Belt, # Fake Parts to the Atom you've been taught, # Quarks in a baryon (LIKE A PROTON…), # Earth Layers, # Barleycorns in an Inch, # King Lear's Daughters, # Holes in a Bowling Ball, # Colors of a US Stop Light, # Lines in Haiku, # Lifeline in Millionaire, # Leaves on a Shamrock, # Scruple in a Dram, # Minutes in a Pro Boxing Match, # Teaspoons in a Tablespoon, # MegaJoules in a KwHr, # Newton's Laws of Motion, # Points for a Field Goal, # Wise Men, # Tenors, # Gorgons, # Roman Furies, #Rings in a Notebook, # Times one can say "Betelgeuse" before all heck breaks loose, #Level of Truth (It, Whole, & Nothing But), # of representations hands can have to decide a dispute, # Sounds Rice Crispies make, # Levels of human attributes in Clint Eastwood's 1st REAL movie, # Chipmunks, … Get it Yet? 3.) All count the same, so…

Show all work and MAKE REASONING CLEAR! *No credit for "Then a Miracle Occurs and…"*

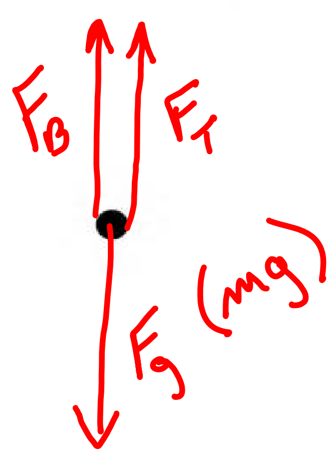


1. (10 points)

A sailboat at rest on a calm lake has its anchor dropped a distance of 4.0 m below the surface of the water. The anchor is suspended by a rope of negligible mass and volume. The mass of the anchor is 50 kg, and its volume is $6.25 \times 10^{-3}\ \text{m}^3$. The density of water is $1000\ \text{kg/m}^3$.

(a) On the dot below that represents the anchor, draw and label the forces (not components) that act on the anchor.

3



(b) Calculate the magnitude of the buoyant force acting on the anchor. If you need to draw anything other than what you have shown in part (a) to assist in your solution, use the space below. DO NOT add anything to the figure in part (a).

2

$F_B = DVg = (1000)(6.25\times10^{-3})(10)$

$\boxed{F_B = 62.5\,N}$

(c) Calculate the tension in the rope. If you need to draw anything other than what you have shown in part (a) to assist in your solution, use the space below. DO NOT add anything to the figure in part (a).

2

$\Sigma F = 0$

$F_T + F_B = mg$

$F_T = (50)(10) - 62.5$

$\boxed{F_T = 438\,N}$

(d) The bottom of the boat is at a depth d below the surface of the water. Suppose the anchor is lifted back into the boat so that the bottom of the boat is at a new depth d' below the surface of the water. How does d' compare to d?

2

____ $d' < d$ ____ $d' = d$ _X_ $d' > d$

Justify your answer.

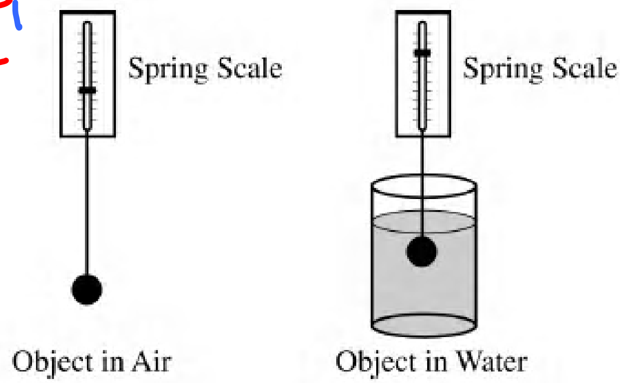
WITH ANCHOR ON BOAT, F_B MUST SUPPORT ITS ADDITIONAL WEIGHT. THIS MAKES $F_B \uparrow$ SO $V_{H_2O} \uparrow$ SO $d \uparrow$

2. (10 pts)

$\textcircled{2}$ $\Sigma F = 0$ 1

a) $F_B = 17.8 - 16.2$

$\boxed{F_B = 1.6\,N}$ 1



(10 points)

An object is suspended from a spring scale first in air, then in water, as shown in the figure above. The spring scale reading in air is 17.8 N, and the spring scale reading when the object is completely submerged in water is 16.2 N. The density of water is 1000 kg/m^3 .

(a) Calculate the buoyant force on the object when it is in the water.

(b) Calculate the volume of the object.

(c) Calculate the density of the object.

(d) How would the absolute pressure at the bottom of the water change if the object was removed? 1

$\textcircled{2}$

___ It would increase. __X__ It would decrease 1 ___ It would remain the same.

Justify your answer. → $h\downarrow$ or $P = Dgh$ 1

$\textcircled{3}$ b) $F_B = m_w g$ 1

$m_w = DV$

$V_w = V_o$ 1

$F_B = D_w V_w g = D_w V_o g$

$V_o = \frac{F_B}{D_w g} = \frac{1.6}{(1000)(10)}$ 1

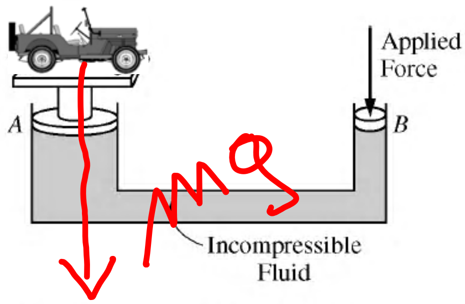
$\boxed{V_o = 1.6 \times 10^{-4}\,m^3}$

$\textcircled{3}$ c) $D_o = \frac{M}{V} = \frac{W_o/g}{V_o}$ 1

$D_o = \frac{17.8}{10(1.6 \times 10^{-4})}$ 1

$\boxed{D_o = 1.1 \times 10^4\,kg/m^3}$ 1

3. (10 pts)



Note: Figure not drawn to scale.

A Jeep, of mass 1200 kg, sits on a hydraulic lift; the mechanic is repairing massive damages done by the Fizzix class in the "Weighing a Jeep Lab." The diameter of the piston under the car (A) is 1 m and the radius of the "applied" piston (B) on the right is 5 cm.

Piston B is pushed down a distance of 2.5m which raises the car at a constant speed. Calculate:

(4) i. The magnitude of the applied force on piston B.

PASCAL: $P_1 = P_2$ so:

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$F_2 = \frac{F_1 A_2}{A_1} = \frac{(12{,}000\,N)(\pi(.05^2))}{\pi(.5)^2} = \boxed{120\,N}$$

(4) ii. The vertical distance moved by the jeep.

CONS of E (BERNOULLI:)

$$W_i = W_o$$

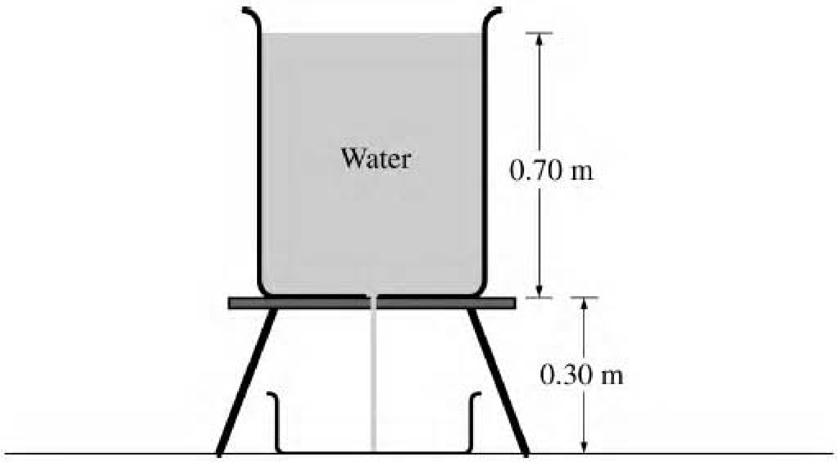
$$F_1 d_1 = F_2 d_2$$

$$d_1 = \frac{F_2 d_2}{F_1} = \frac{(120)(2.5)}{12{,}000} = \boxed{0.025\,m}$$

(2) iii. The work done by the applied force in lifting the jeep.

$$W = Fd = (120)(2.5)$$

$$\boxed{W = 300\,J}$$



4. (10 points)

A cylindrical tank containing water of density $1000\ \mathrm{kg/m^3}$ is filled to a height of 0.70 m and placed on a stand as shown in the cross section above. A hole of radius 0.0010 m in the bottom of the tank is opened. Water then flows through the hole and through an opening in the stand and is collected in a tray 0.30 m below the hole. At the same time, water is added to the tank at an appropriate rate so that the water level in the tank remains constant.

(a) Calculate the speed at which the water flows out from the hole.

(b) Calculate the volume rate at which water flows out from the hole.

(c) Calculate the volume of water collected in the tray in $t = 2.0$ minutes.

(d) Calculate the time it takes for a given droplet of water to fall 0.25 m from the hole.

3pts

a) APPLY B's EQ:

$P_1 + Dgy_1 + \frac{1}{2}Dv_1^2 = P_2 + Dgy_2 + \frac{1}{2}Dv_2^2$ $\quad [P_1 = P_2 = P_{ATM}]$

$v_1 = 0$ SO,

$Dg(y_1 - y_2) = \frac{1}{2}Dv_2^2$ (1)

$v_2 = \sqrt{2g(y_1 - y_2)} = \sqrt{2(10)(.7)}$ (1)

$\boxed{v_2 = 3.7\ m/s}$ (1)

-OR- TORICELLI'S THEOREM: $v = \sqrt{2gh}$

b) 2pts $\frac{V}{t} = \frac{Ah}{t} = Av$ (1) $= \pi r^2 v = \pi(.001^2)(3.7) = \boxed{1.2 \times 10^{-5}\ m^3/s}$ (1)

c) 2pts $V = \frac{V}{t} \times t$ (1) $= (1.2 \times 10^{-5}\ m^3/s)(120\ sec)$ (1) $= \boxed{1.4 \times 10^{-3}\ m^3}$

d) 3pts $d = v_i t + \frac{1}{2}at^2$ (1) $\rightarrow -.25 = 3.7t - 5t^2$ (1) (1) $\rightarrow \boxed{t = 0.062\ sec}$

5. (10 pts) Here is an image of the absolutely breathtakingly fantastical Hudson River.

Yummy, right? Anyway, at a location in upstate NY, the Hudson is a mere 60m wide and has a depth of only 3m. At that location, the water flows at a pokey 1.5 m/s.

2 (A) Calculate the number of kilograms of water that passes this point each second.

$\frac{m}{t} \Rightarrow \frac{V}{t}$ then CONVERT 1

$\frac{V}{t} = Av = (60m)(3m)(1.5\ m/s)$ 1

$= 270\ m^3/s$

$1\ m^3$ WATER = 1000 Kg 1

so $\boxed{270{,}000\ \text{Kg/s}}$

At a point a little downstream near Poughkeepsie, the river narrows to 50m just before a waterfall and the depth is only 1.6m.

(B) Calculate the speed of the water at this downstream point just before going over the famous Poughkeepsie waterfalls.

2

$A_1 v_1 = A_2 v_2$ 1

$v_2 = \frac{A_1 v_1}{A_2} = \frac{270}{80} = \boxed{3.4\ m/s}$ 1

(C) The waterfalls causes the water to drop a vertical; distance of 40m. The depth of 1.6m at the top of the waterfalls is sufficiently small compared to the height of the falls that it can be ignored.

3 i. Find the speed the water has just before it hits the bottom of the waterfalls.

3 ii. Find the horizontal distance as measured from the edge of the falls the water strikes the bottom after falling.

i: $P_T + K_T = K_B$ 1

$\cancel{m} g h_T + \frac{1}{2}\cancel{m} v_T^2 = \frac{1}{2}\cancel{m} v_B^2$ 1

$v_B^2 = 2gh + v_T^2$

$v_B^2 = 2(10)(40) + 3.4^2 = 811.6$ 1

$\boxed{v = 28.5\ m/s}$

ii: $d_H = v_H t = v_H \sqrt{\frac{2h}{g}}$ 1 1

$d_H = 3.4\sqrt{\frac{2(40)}{10}}$ 1

$\boxed{d_H = 9.6m}$