KARABUK UNIVERSITY, ENGINEERING FACULTY, AUTOMOTIVE ENGINEERING, FLUID MECHANICS, MIDTERM EXAM, 21.11.2013

Attention: Forbidden to use extra paper. You can use the blank spaces and back of page as a draft. Everyone's questions and options are different from others. Time is net 75 minutes. The draft solutions on the page will not read. Only will looked the options. If you think there is a mistake in the questions, tick the last option and write answer. Then it will be evaluated in your benefit.I wish you success... Asist.Prof.Dr.İbrahim Çayıroğlu

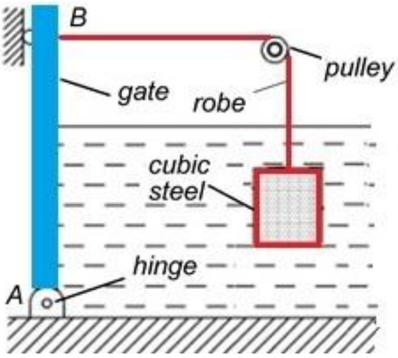
1) What is the force exerted by the mass of steel in the figure to open the gate by the robe? (The cube edge length 0,5m, relative density of steel is 7.6) // ©7355,6 ©8275,05 ©9194,5 ©11952,85 ©12872,3 ©13791,75 ©14711,2 ©15630,65 ©16550,1 ©17469,55 ©18389 ©...............

2) The robe force tried to open the gate by 2500N force as shown in the Figure. The gate's wide is 2,5m and its height 5m.Find the height of the water required for the gate is not opened.(Relative density of steel is 7.6) // ©0,58 ©0,725 ©0,87 ©1,015 ©1,16 ©1,305 ©1,45 ©2,465 ©2,61 ©2,755 ©2,9 ©...............

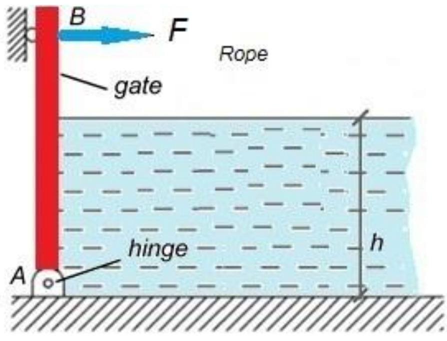
3) A block of wood (SG=0,62) floats in fluid X in the figure such that 0,83% of its volume is submerged in fluid X. Estimate the gage pressure of the air in the tank that get off to air.(hA=0,25m hB=0,5m)(If you need standart atmospheric pressure 101300 Pa // ©99468,01 ©109414,811 ©119361,612 ©129308,413 ©139255,214 ©149202,015 ©159148,816 ©169095,617 ©179042,418 ©188989,219 ©198936,02 ©...............

4) The tank of liquid in the figure accelerates to the right with the fluid in rigid-body motion. Find the highest pressure that occurs in the water (Pmax=? Pa)(A= 2,5 m, B=12,5m, C=1m). // ©39240 ©43164 ©47088 ©51012 ©54936 ©58860 ©62784 ©66708 ©70632 ©74556 ©78480 ©...............

5) The figure shows a river scow (size L=25 m x Wmin x H=6,25 m) used to carry bulk materials. Assume that the scow's center of gravity is at its centroid and that it floats with Hsub=2,08 m submerged. Determine the minimum width that will ensure rotational stability in seawater. // ©7,21399 ©7,935 ©8,657 ©9,378 ©10,1 ©10,821 ©11,542 ©12,264 ©12,985 ©13,707 ©14,428 ©...............

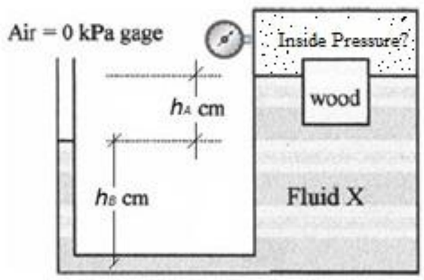


1)

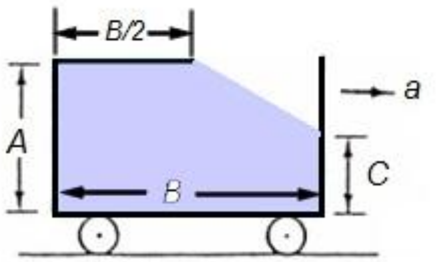


2)

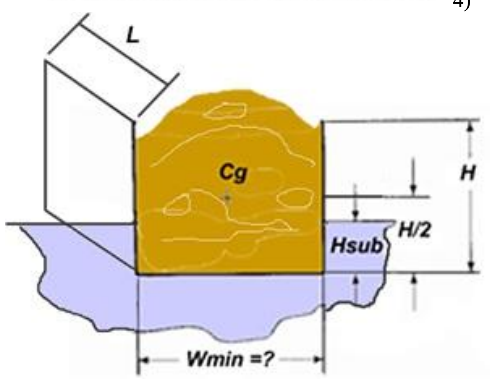
3)



4)



5)

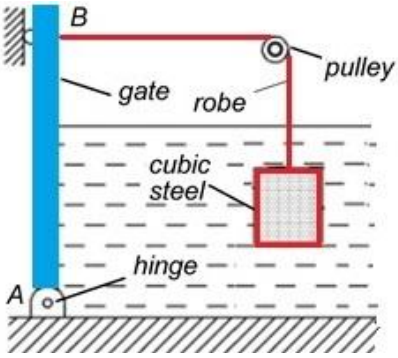


CORRECT OPTIONS

1)=9194,5 (right answer=**8093,25 N)** 2)=1,45 3)=99468,01 4)=39240 5)=7,21399

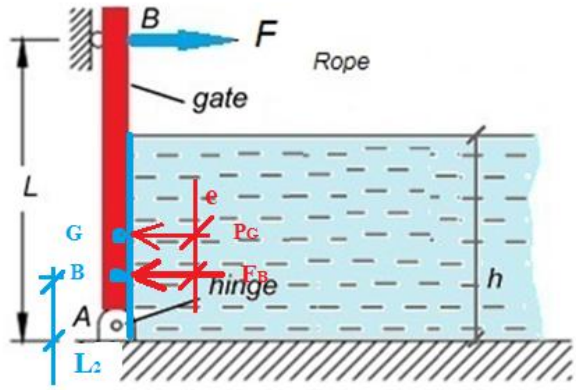
SOLUTIONS OF THE QUESTIONS

1) What is the force exerted by the mass of steel in the figure to open the gate by the robe? (The cube edge length 0,5m, relative density of steel is 7.6) // ©7355,6 ©8275,05 ©9194,5 ©11952,85 ©12872,3 ©13791,75 ©14711,2 ©15630,65 ©16550,1 ©17469,55 ©18389 ©........... 8093,25 N



Cube volume = V_{cube}= $Edge^3$ = 0.5^3 =0,125 m^3
Cube weight = G_{cube} = V_{cube} * ρ_{cube} * g = 0,125 m^3 * 7600 kg/m^3 * 9.81 m/s^2 = 9319,5 N
Water's buoyancy = F_b = V_{cube} * ρ_{water} * **g** = 0,125 m^3 * 1000 kg/m^3 * 9.81 m/s^2 = 1226,25 N
Rope force = Cube weight –water's buoyancy = 9319,5 N – 1226,25 N = **8093,25 N** (Ther is no answer in choises. I forgot to put the gravitational acceleration g in the program. It must be filled the last option).

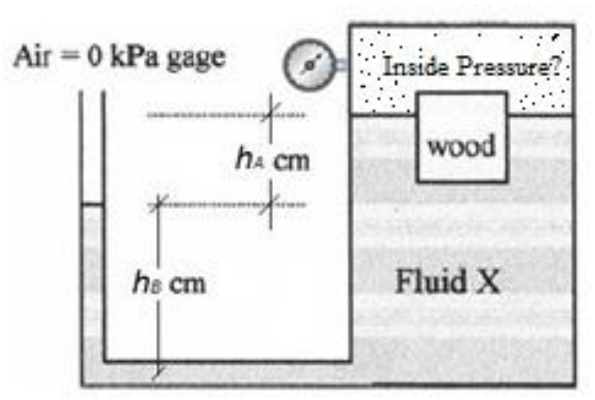
2) The robe force tried to open the gate by 2500N force as shown in the Figure. The gate's wide is 2,5m and its height 5m.Find the height of the water required for the gate is not opened.(Relative density of steel is 7.6 No need!**) // ©0,58 ©0,725 ©0,87 ©1,015 ©1,16 ©1,305 ©1,45 ©2,465 ©2,61 ©2,755 ©2,9 ©...............**



Width of gate = W=2,5 m
Moment of inertia of gate = I_{gate} = $(bh^3/12)$ = W h^3 /12 = 2,5 m * h^3 / 12 (h unknown?)
Gate area inside the water = A = W* h = 2,5 m * h (h unknown)
Pressure at G point = P_G = ρ * g * h/2 = 1000 kg/m^3 * 9.81 m/s^2 * h/2 (h unknown)
e Distance = e = Igate / (h_G *A) = (2,5 m * h^3 / 12) / (h/2 * 2,5 m * h) = h / 6 (h unknown yet)
The force action on the gate = F_B = P_G * A = (1000 kg/m^3 * 9.81 m/s^2 * h/2) * (2,5 m * h) = 12162,5 h^2 (h unknown yet)

If we take moments at point A
F * L = F_B * L_2
F * L = F_B * (h/2 –e)
2500 N * 5 m = 12162,5 h^2 (h/2 – h/6)
h = (2500 * 5* 3 /12162,5 $)^{1/3}$ = **1,45 m** (There is the answer in the options)

3) A block of wood (SG=0,62) floats in fluid X in the figure such that 0,83% of its volume is submerged in fluid X. Estimate the gage pressure of the air in the tank that get off to air.(hA=0,25m hB=0,5m)(If you need standart atmospheric pressure 101300 Pa // ©99468,01 ©109414,811 ©119361,612 ©129308,413 ©139255,214 ©149202,015 ©159148,816 ©169095,617 ©179042,418 ©188989,219 ©198936,02 ©..............



One side of the container open to the atmosphere and the other side closed

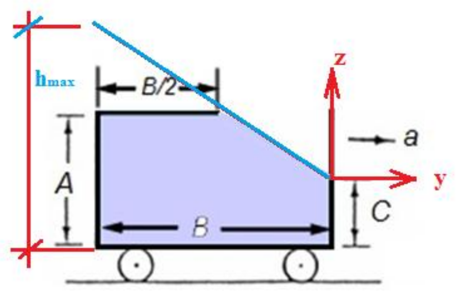
$P_{atm} - (\rho_X * g * h_A) - P_{inside} = 0$

$P_{inside} = P_{atm} - (\rho_X * g * h_A)$ = 101300 N/m^2 - ρ_X * 9,81 m/s^2* 0,25 m (but unknown the ρ_X, let's find)

The weight of the sinking portion of wood as filled Fluid X = The weight of the entire wood (We're actually setting up proportions)
83 * ρ_X * g = 100* ρ_{wood} * g
ρ_X = 100 * 0,62 /83
ρ_X = 0.74698 (relative density= Specific gravity) = 746,98 kg/m^3 (Let's continue where we left off above)

P_{inside} = 101300 N/m^2 – 746,98 kg/m^3* 9,81 m/s^2* 0,25 m
P_{inside} =**99468,03 Pa** (There is the answer in the options approximately)

4) The tank of liquid in the figure accelerates to the right with the fluid in rigid-body motion. Find the highest pressure that occurs in the water (Pmax=? Pa)(A= 2,5 m, B=12,5m, C=1m). // ©33164 ©39240 ©43164 ©47088 ©51012 ©54936 ©58860 ©62784 ©66708 ©70632 ©74556 ©..............



The coordinate system is put where the water exist definite point on the surface. These point may be either point C or upper midpoint

For y= -B/2 = - 12,5/2 = -6,25 z=A-C = 2,5 m – 1m = 1,5 m

These two values are put the surface equations then "a" accelaration is found.

$$z = -\frac{a}{g}y$$

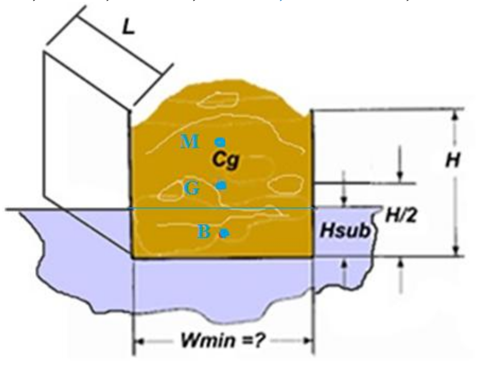
a = - z* g / y = -1,5 m * 9,81 m/s^2 / -6,25 m
a = 2,3544 m/s^2

the highest point of water found for y=-B distance. This point is imaginary due to container is covered.

$z = - a * y / g = - 2{,}3544\ m/s^2 * -12{,}5\ m / 9{,}81\ m/s^2$
z = 3 m. From origin to top point distance
$h_{max} = C + 3\ m = 1\ m + 3\ m = 4\ m$

$P_{max} = \rho * g * h_{max} = 1000\ kg/m^3 * 9{,}81\ m/s^2 * 4\ m$
P_{max} = **39240 Pa** (There is the answer in the options)

5) The figure shows a river scow (size L=25 m x Wmin x H=6,25 m) used to carry bulk materials. Assume that the scow's center of gravity is at its centroid and that it floats with Hsub=2,08 m submerged. Determine the minimum width that will ensure rotational stability in seawater. // ©4,328 ©5,05 ©5,771 ©6,493 ©7,21399 ©10,821 ©11,542 ©12,264 ©12,985 ©13,707 ©14,428 ©..............



BG distance = $(H / 2) - (H_{sub} / 2) = 6{,}25\ m /2 – 2{,}08 / 2 = 3{,}125 – 1{,}04 = 2{,}085\ m$
Vsub = L * Wmin * H_sub

For rotational stability BM = BG must be. M must be over G or equal. For standart formula is

$$MB = \frac{I_o}{V_{sub}}$$

$I_0 = (bh^3/12) = L * W_{min}^3 / 12$ (but W_{min} unknown)

$MB = BG \Rightarrow BG = (L * W_{min}^3 / 12) / (L * W_{min} * H_{sub})$

$W_{min} = (BG * 12 * H_{sub})^{1/2}$
$W_{min} = (2{,}085 * 12 * 2{,}08)^{½}$
W_{min} = **7,213 m.** (There is the answer in the options)