KARABUK UNIVERSITY, ENGINEERING FACULTY, AUTOMOTIVE ENGINEERING, FLUID MECHANICS, MIDTERM EXAM, 20.11.2012

Attention: Forbidden to use extra paper. You can use the blank space on the page. Everyone's questions and options are different from others. Time is 45 minutes. The draft solutions on the page will not read. Only will looked the options. If you think ther is a mistake in the questions, tick to the nearest answer. Then it will be evaluated in your benefit to.You can use the back of page as a draft.I wish you success... Asist.Prof.Dr.İbrahim Çayıroğlu

@Question-1: As shown in the figure, the pressure in the tube P=25000Pa. d1 (density)=975kg/m3, d2 (density)=950kg/m3, h1=0,5m, h2=0,25m, A (area) =0,025m2. Accordingly, What is the F force as Newton?
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@Question-2: In Figure the tank contains water and immiscible oil at 20°C. What is h in meter if the density of the oil is =875kg/m3 ? The density of water (you must be know). h1=0,5m. h2=0,25m.
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@Question-3: Gate AB in Figure is W= 5m wide into the paper, hinged at A, and restrained by a stop at B. The water is at 20 C compute the force (N) on stop B if the water depth h= 25m. and L =8,33m.
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@Question-4: A uniform block of steel (density= 7,6) will float at a mercury-water interface as in Figure. What is the distance a for this condition h=25cm? (mercury density=13,81)
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@Question-5: As shown in the figure we make a pycnometer from wood which density = 0,5 diameter d=2,5 cm and height h1=25 cm . When we put it into water, we want to h2 =6,25 cm. Accordingly what is the amount of the Lead as kg ? (Lead density=11,25)
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@Question-6: An iceberg can be idealized as a cube of side length L =25m, as in Figure. If seawater is denoted by d1=1,025, then glacier ice (which forms icebergs) has d2=0,75. Determine the MG distance for this 'cubic' iceberg is stable or not for the position shown in figure.
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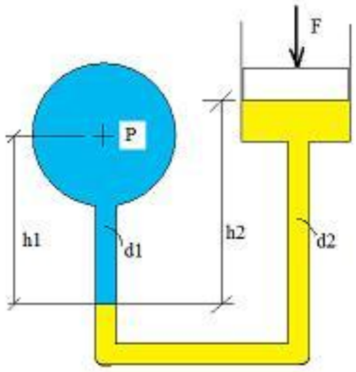
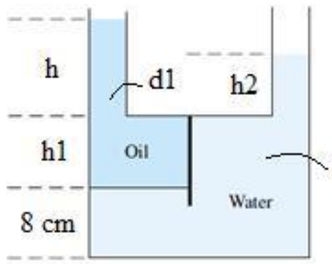
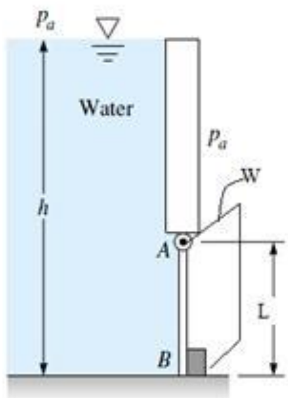
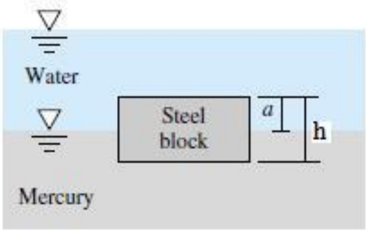
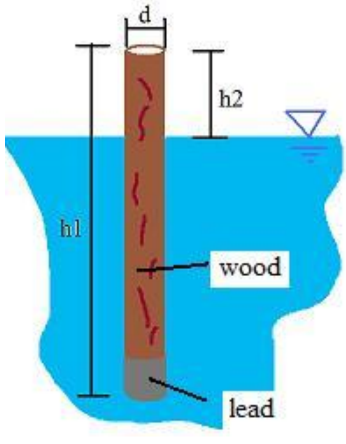
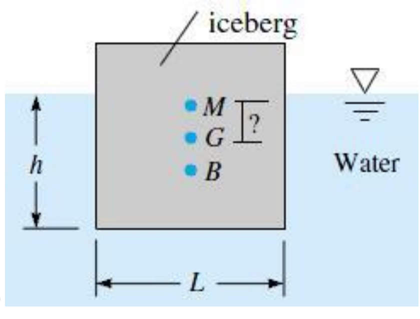
1) 

2) 

3) 

4) 

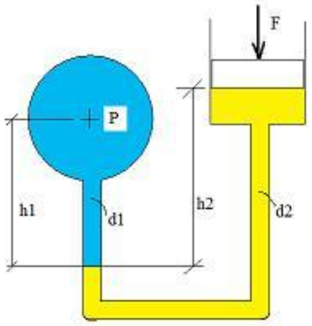
5) 

6) 

ANSWERS

1) As shown in the figure, the pressure in the tube P=25000Pa. d1 (density)=975kg/m3, d2 (density)=950kg/m3, h1=0,5m, h2=0,25m, A (area) =0,025m2. Accordingly, What is the F force as Newton?

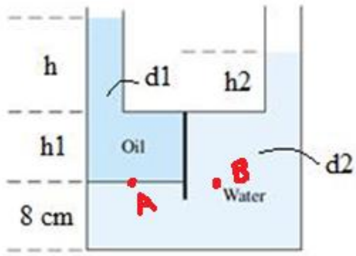
P=25000 Pa
d1 =975kg/m3 (density)
d2 =950kg/m3
h1=0,5m,
h2=0,25m
A =0,025m2
F=?



P + (d1 * 9.81 * h1) – (d2 * 9.81 * h2) –F/A= 0
F = A * (P + (d1 * 9.81 * h1) – (d2 * 9.81 * h2))
F= 0.025 * (25000 + (975 * 9.81 * 0.5) – (950*9.81*0.25))
F=0.025 * (25000 + (4782,37) – (2329,87))
F=<u>686,31 N</u>

2) In Figure the tank contains water and immiscible oil at 20°C. What is h in meter if the density of the oil is =875kg/m3 ? The density of water (you must be know). h1=0,5m. h2=0,25m.

d1 = 875kg/m3
h1 = 0,5m
h2 = 0,25m
d2 = 1000 kg/m3
h=?



$P_A = P_B$
d1*g*(h+h1) = d2*g*(h1+h2)
d1*h + d1* h1 = d2* (h1+h2)

h = (d2*(h1+h2) - d1*h1) / d1
h = (1000 * (0,5 + 0,25) – 875*0,5) / 875
h = (750 – 437,5)/875
h = <u>0,357 m</u>

3) Gate AB in Figure is W= 5m wide into the paper, hinged at A, and restrained by a stop at B. The water is at 20 C compute the force (N) on stop B if the water depth h= 25m. and L =8,33m.

W= 5m
L = 8,33m;
h = h= 25m

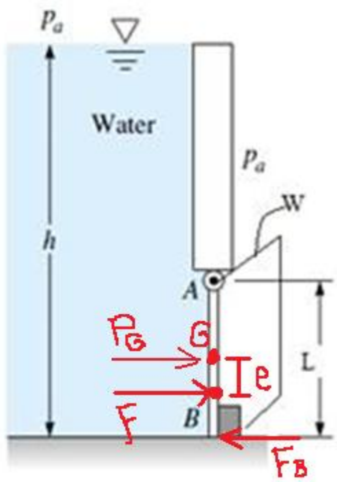
P_G = d * g* (h- L/2)
P_G = 1000*9.81*(25-8,33/2)
P_G = 1000*9.81*(20,83)
P_G = 204391,35 Pa

F = P_G * A
F = P_G * (L*W)
F = 204391,35 (8,33 * 5)
F = 8512899,72 N

$$e = \frac{I_G}{z_G A}$$

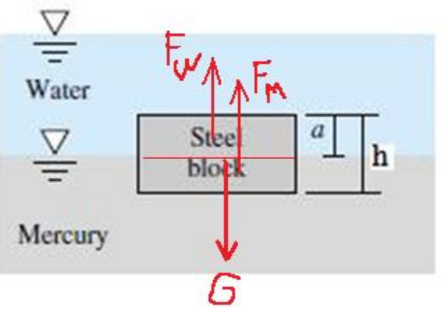
e = (w* L^3 / 12) / [(h-L/2) *(L*W)]
e= (5 * $8,33^3$ /12) / [(25-8,33/2) *(8,33*5)]
e= (240,83) / [(20,83) *(41,65)]
e= (240,83) / [867,56]
e= 0,277 m

F* (L/2 + e) = F_B* L
F_B = [F* (L/2 + e)] / L
F_B = [8512899,72* (8,33/2 + 0,277)] / 8,33
F_B = [8512899,72* (4,442)] / 8,33
F_B = [37814300,55] / 8,33
F_B = <u>4 539 531,87 N</u>
There is no answer in options. Therefore, the answer had to written in extra option.



4) A uniform block of steel (density= 7,6) will float at a mercury-water interface as in Figure. What is the distance a for this condition h=25cm? (mercury density=13,81)

d1 = 7,6 * 1000 kg/m3
d2 =13,81 *1000 kg/m3
d3 = 1* 1000 kg/m3
h = 25cm
a=?



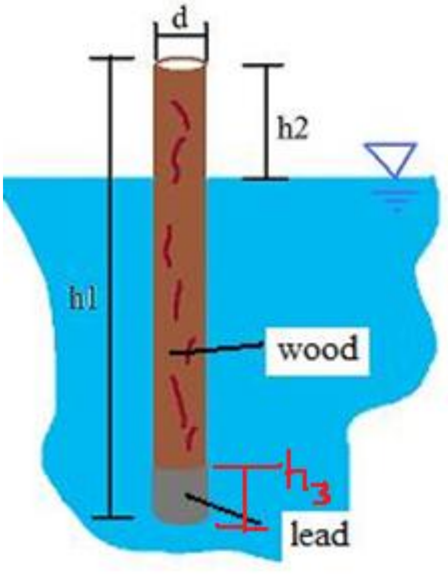
G = d1 * g* (L? * W? * h)
Fw = d3* g* (L? * W? * a)
Fm = d2* g* (L? * W? * (h-a))

G = Fw + Fm
d1 * g* (L? * W? * h) = d3* g* (L? * W? * a) + d2* g* (L? * W? * (h-a))
d1 * h = d3*a + d2* (h-a)
d1 * h = d3*a + d2* h - d2* a
d1 * h = a(d3 –d2) + d2* h
(d1 * h)- (d2* h) = a(d3 –d2)

a= ((d1 * h)- (d2* h)) / (d3 –d2)
a= ((7600 * 0,25)- (13810* 0,25)) / (1000 –13810) (Note: We can use relative density here, Then it would be much simpler)
a= ((1900)- (3452,5)) / (-12810)
a= (-1552,5) / (-12810) =0,121 m
a= 0,121 m =12,1 cm

5) As shown in the figure we make a pycnometer from wood which density = 0,5 diameter d=2,5 cm and height h1=25 cm . When we put it into water, we want to h2 =6,25 cm. Accordingly what is the amount of the Lead as kg ? (Lead density=11,25)

d = 2,5 cm   // diameter of the wood
h1 = 25 cm
h2 = 6,25 cm
d1 = 0,5   // wood density
d2 = 11,25   //lead density



//converted to meters.
d = d / 100 = 0,025 m
h1 = h1 / 100 = 0,25 m
h2 = h2 / 100 = 0,0625 m

area = 3.14 * $(d / 2)^2$ = 0,000499625 m2
Vsubmerged = area * (h1- h2)
Vsubmerged =0,000499625 * (0,25- 0,0625) = 0,00009199 m3

Fbuoyancy = 1000 * 9.81 * Vsubmerged
Fbuoyancy = 1000 * 9.81 * 0,00009199
Fbuoyancy = 0,90244 N

weight = Fbuoyancy
weight = 0,90244 N

AverageDensity = mass / volume ,=> mass =weight/g => mass =0,90244 / 9,81 =0,0919921 kg.
AverageDensity = mass / (3.14 * r^2 *h1)
AverageDensity = 0,0919921 / (3.14 * $0,0125^2$ *0,25)
AverageDensity =750 kg/m3 =>as relatif =0,75

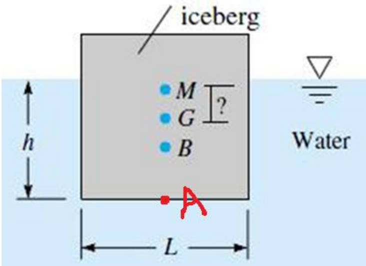
ObjectMass = WoodMass + LeadMass
AverageDensity *ObjectVolume = WoodDensity*WoodVolume+ LeadDensity*LeadVolume
0,750 * (area *h1) = 0,500 * (area *(h1-h3)) + 11,250*(area *h3)
0,750 * h1 = 0,500 * (h1-h3) + 11,250 *h3
0,750 * h1 = 0,500 * h1 - 0,500 h3 + 11,250 *h3
0,750 * h1 - 0,500 * h1= 10,75 *h3
h3 = (0,750 * h1 - 0,500 * h1) / 10,75

h3 = (0,750 * 0,25 - 0,500 * 0,25) / 10,75
h3 = 0,005813 m

LeadMass = Vkursun * d2 * 1000
LeadMass = Alan*h3 * d2 * 1000
LeadMass = 0,000499625 *0,005813 * 11,25 * 1000
LeadMass = **0,03267** kg = 32,67 gr

6) An iceberg can be idealized as a cube of side length L =25m, as in Figure. If seawater is denoted by d1=1,025, then glacier ice (which forms icebergs) has d2=0,75. Determine the MG distance for this 'cubic' iceberg is stable or not for the position shown in figure.

L= CubeEdge = 25m
d1= WaterDensity = 1,025
d2= IcebergDensity = 0,75



$F_{bouyancy} = G_{iceberg}$
Hsubmerged* WaterDensity = IcebergDensity* CubeEdge
Hsubmerged= IcebergDensity* CubeEdge/ WaterDensity
h= d2*L /d1
h= 0,75*25 /1,025
h = 18,292 m

BAdistance = h / 2 = 9,146 m
GAdistance = L / 2 =12,5 m
I= MomentofInertia = L * L^3 / 12
I=25^4 /12 = 32552 m^4

VolumeSubmerged = L * L * h
VolumeSubmerged = 25 * 25 * 18,292
VolumeSubmerged = 11432,5 m^3

MBdistance = I / VolumeSubmerged
MBdistance = 32552 / 11432,5
MBdistance = 2,847 m

GBdistance = GAdistance - BAdistance
GBdistance = 12,5 - 9,146 = 3,354 m

MGdistance = MBdistance - GBdistance
MGdistance = 2,847 – 3,354
MGdistance = **-0,507 m** **the iceberg tilt over**