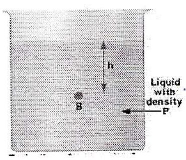
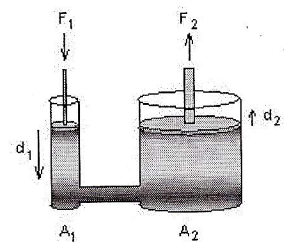
Fluid Mechanics: Hydrostatic Pressure Problems 2

Name: ______________________________ Period: _______ Date: ________

Density & Specific Gravity	Pressure	Hydrostatic Pressure	Pascal's Principle
$\rho = \frac{m}{V}$ Units $[\frac{g}{cm^3}, \frac{kg}{m^3}]$ $S.G. = \frac{\rho_{substance}}{\rho_{water}}$ No Units **Density of water:** 1 g/cm^3=1000 kg/m^3 **Density of air:** 0.0012 g/cm^3=1.2 kg/m^3	$P = \frac{F}{A}$ Units $[\frac{N}{m^2} = Pa]$	**P=Po + ρgh +...** Po=1atm= 1.013x10^5 Pa Po=Atmospheric pressure 	$\frac{F_1}{A_1} = \frac{F_2}{A_2}$ 

Hydrostatic Pressure

1. A container is filled to a depth of 20cm with water. On top of the water floats a 30cm thick layer of oil with a density 0.700g/cm^3.
   a) What is the absolute pressure at the bottom of the container? 1.04×10^5 Pa
   b) What is the absolute pressure between the oil and water? 1.021×10^5 Pa
   c) What is the absolute pressure at the top surface? 1×10^5 Pa

a) $P = Po + \rho gh + \rho gh$
$P = 1\times10^5 + (700)(10)(.3) + (1000)(10)(.2)$
$P = 1.04\times10^5$ Pa

b) $P = Po + \rho gh$
$P = 1\times10^5 + 2100$
$P = 1.021\times10^5$ Pa

c) $P = Po = 1\times10^5$ Pa

2. What is the hydrostatic gauge pressure at a point 10m below the surface of the ocean? ($\rho_{seawater}$=1.025g/cm^3) 1.025×10^5 Pa

$\rho_{sw} = 1025 kg/m^3$
$P_{gauge} = Po + \rho gh$ (Po = 0)
$P_{gauge} = (1025)(10)(10)$
$P_{gauge} = 1.025\times10^5$ Pa

3. A swimming pool has a depth of 4m. What is the hydrostatic gauge pressure at a point 1m below the surface? 1×10^4 Pa

$P_{gauge} = \rho gh = (1000)(10)(1)$
$P_{gauge} = 1\times10^4$ Pa

4. A flat piece of wood of area 0.5m^2 is lying at the bottom of the lake. If the depth of the lake is 30m, what is the force on the wood due to the pressure? 4×10^5 Pa

$P = Po + \rho gh$
$P = 1\times10^5 + (1000)(10)(30)$
$P = 4\times10^5$ Pa

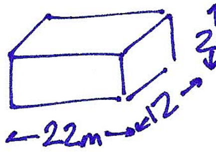
5. Consider a closed container, partially filled with a liquid of density ρ=1200kg/m^3, and a Point X that's 0.5m below the surface of the liquid.
   a. If the space above the surface of the liquid is vacuum, what's the absolute pressure at Point X? 6×10^3 Pa
   b. If the space above the surface of the liquid is occupied by a gas whose pressure is 2.4X10^{4}Pa, what's the absolute pressure at point X? 3×10^4 Pa

a)
$P_{ABS} = \rho gh$
$P_{ABS} = (1200)(10)(.5)$
$P_{ABS} = 6\times10^3 Pa = 6300 Pa$

b) $P_{ABS} = P_{gas} + \rho gh$
$P_{ABS} = 2.4\times10^4 Pa + 6300$
$P_{ABS} = 3\times10^4 Pa$

6. What is the total force and the absolute pressure on the bottom of a swimming pool 22.0m by 12m whose uniform depth is 2.0 m? What will be the pressure against the side of the pool near the bottom?

Force= 3.17×10^7 N
Absolute pressure= 1.2×10^5 Pa
Pressure @ bottom= 1.2×10^5 Pa



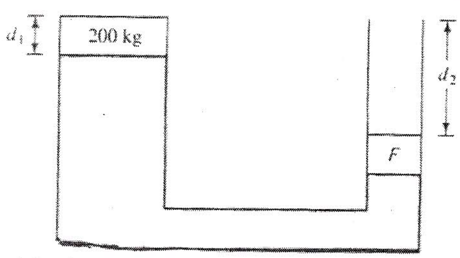
$P_{ABS} = P_0 + \rho gh$
$P_{ABS} = 1\times10^5 + (1000)(10)(2)$
$P_{ABS} = 1.2\times10^5 Pa$

$F = P\cdot A$
$F = (1.2\times10^5 Pa)(22\cdot12)$
$F = 3.17\times10^7 N$

Pascal's Principle

7. In the hydraulic system shown, the 200kg cylinder has a cross-sectional area of 100cm^2. The cylinder on the right has a cross sectional area of 10 cm^2.
   a. Determine the weight (force) required to hold the system in equilibrium. 200N
   b. If the left-hand cylinder is pushed down 5.0cm, determine through what distance F will move. 0.5m

$100cm^2\left[\frac{1m}{100cm}\right]^2 = 0.01m^2$

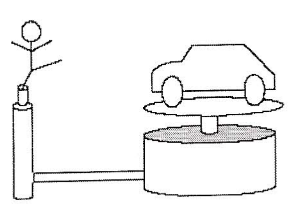


$10cm^2\cdot\left[\frac{1m}{100cm}\right]^2 = 0.001$

a) $\frac{F_1}{A_1} = \frac{F_2}{A_2}$
$\frac{2000}{.01} = \frac{F_2}{.001}$
$F_2 = 200 N$

b) Volume1=Volume2
$A_1 h_1 = A_2 h_2$
$.01(.05) = .001\cdot h_2$
$h_2 = 0.5m$

8. Consider the hydraulic system shown below. A person on a piston that pushes down on a thin cylinder full of water. This cylinder is connected via pipes to a wide platform on top of which rest a 1-ton (1000kg) car. The area of the platform under the car is 25m^2 while the person stands on a 0.3m^2 piston.
   a. What is the lightest weight of a person who could successfully lift the car? 120N



$\frac{F_1}{A_1} = \frac{F_2}{A_2}$
$\frac{F_1}{.3} = \frac{10,000}{25}$
$F_1 = 120 N$