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## Module 1: The Nature of Fluids/Pressure Measurement (CIVL 318)

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Some useful results:

<b>Pressure:</b>	$P = \frac{F}{A}$	$\left( \frac{\text{Force}}{\text{Area}} \right)$
<b>Pascal's Laws:</b>	Pressure acts uniformly in all directions on a small volume of liquid. Pressure acts perpendicularly to the solid boundaries of a fluid.	
<b>Density:</b>	$\rho \text{ (rho)} = \frac{m}{V}$	$\left( \frac{\text{Mass}}{\text{Volume}} \right)$
<b>Specific Weight:</b>	$\gamma \text{ (gamma)} = \frac{w}{V}$	$\left( \frac{\text{Weight}}{\text{Volume}} \right)$
<b>Specific Gravity:</b>	$\text{sg} = \frac{\rho_s}{\rho_w @ 4^\circ\text{C}} = \frac{\gamma_s}{\gamma_w @ 4^\circ\text{C}}$	
<b>Density &amp; Specific Weight:</b>	$\gamma = \rho g$	
<b>Pressure Relationship:</b>	$p_{abs} = p_{atm} + p_{gauge}$	
<b>Pressure-Elevation Relationship:</b>	$\Delta p = \gamma h$	

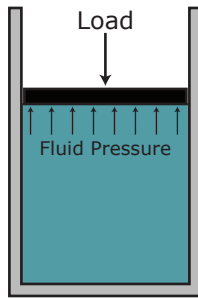
**Table A: Properties of Water**

Temperature	Specific Weight	Density	Dynamic Viscosity
	$\gamma$	$\rho$	$\eta$
(°C)	(kN/m <sup>3</sup> )	(kg/m <sup>3</sup> )	(Pa · s)
0	9.81	1000	$1.75 \times 10^{-3}$
5	9.81	1000	$1.52 \times 10^{-3}$
10	9.81	1000	$1.30 \times 10^{-3}$
15	9.81	1000	$1.15 \times 10^{-3}$
20	9.79	998	$1.02 \times 10^{-3}$
25	9.78	997	$8.91 \times 10^{-4}$
30	9.77	996	$9.00 \times 10^{-4}$
35	9.75	994	$7.18 \times 10^{-4}$
40	9.73	992	$6.51 \times 10^{-4}$
45	9.71	990	$5.94 \times 10^{-4}$
50	9.69	988	$5.41 \times 10^{-4}$
55	9.67	986	$4.98 \times 10^{-4}$
60	9.65	984	$4.60 \times 10^{-4}$
65	9.62	981	$4.31 \times 10^{-4}$
70	9.59	978	$4.02 \times 10^{-4}$
75	9.56	975	$3.73 \times 10^{-4}$
80	9.53	971	$3.50 \times 10^{-4}$
85	9.50	968	$3.30 \times 10^{-4}$
90	9.47	965	$3.11 \times 10^{-4}$
95	9.44	962	$2.92 \times 10^{-4}$
100	9.40	958	$2.82 \times 10^{-4}$

**Table B: Properties of Common Liquids**

(at 101 kPa and 25°C)

Liquid	Specific Gravity	Specific Weight	Density	Dynamic Viscosity
		$\gamma$	$\rho$	$\eta$
		(kN/m <sup>3</sup> )	(kg/m <sup>3</sup> )	(Pa · s)
Acetone	0.787	7.72	787	$3.16 \times 10^{-4}$
Alcohol, Ethyl	0.787	7.72	787	$1.00 \times 10^{-3}$
Alcohol, Methyl	0.789	7.74	789	$5.60 \times 10^{-4}$
Alcohol, Propyl	0.802	7.87	802	$1.92 \times 10^{-3}$
Benzene	0.876	8.59	876	$6.03 \times 10^{-4}$
Carbon Tetrachloride	1.590	15.60	1590	$9.10 \times 10^{-4}$
Castor Oil	0.960	9.42	960	$6.51 \times 10^{-1}$
Ethylene Glycol	1.100	10.79	1100	$1.62 \times 10^{-2}$
Gasoline	0.68	6.67	680	$2.87 \times 10^{-4}$
Glycerine	1.258	12.34	1258	$9.60 \times 10^{-1}$
Kerosene	0.823	8.07	823	$1.64 \times 10^{-3}$
Linseed Oil	0.930	9.12	930	$3.31 \times 10^{-2}$
Mercury	13.54	132.8	13540	$1.53 \times 10^{-3}$
Propane	0.495	4.86	495	$1.10 \times 10^{-4}$
Seawater	1.030	10.10	1030	$1.03 \times 10^{-3}$
Turpentine	0.870	8.53	870	$1.37 \times 10^{-3}$
Fuel Oil, medium	0.852	8.36	852	$2.99 \times 10^{-3}$
Fuel Oil, heavy	0.906	8.89	906	$1.07 \times 10^{-1}$

**Example 1:****Solution:**

A piston confines oil in a closed circular cylinder. The maximum operating pressure for the piston is 17.8 MPa. The piston has a diameter of 62.5 mm. What is the maximum load that the piston can support?

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**Exercise 1:**

A press used to produce coins requires a force of 8.20 kN.  
The hydraulic cylinder has a diameter of 63.5 mm.

**Solution:**

What is the oil pressure needed to generate this force?

**Example 3:**

An empty barrel with an inside diameter of 900 mm weighs 205 N.

What does the barrel weigh when it is filled to a depth of 750 mm with water at 25°C?

**Solution:**

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**Example 4:**

Calculate the density and the specific weight of benzene if it has a specific gravity of 0.876.

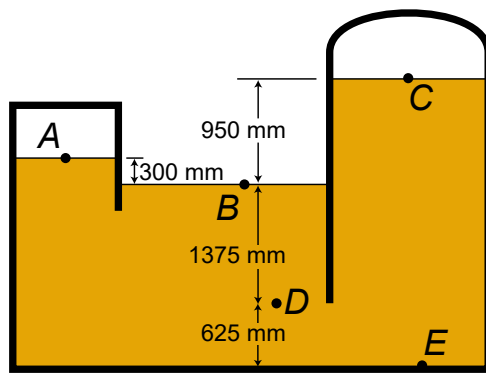
**Solution:**

**Example 5:**

An open cylindrical tank with diameter 5.75 m and depth 3.30 m is filled to the top with water at 10°C. The water is heated to 55°C. Assuming that the tank dimensions remain constant and there are no losses due to evaporation, calculate the mass of water that overflows.

**Solution:**

**Example 6:**

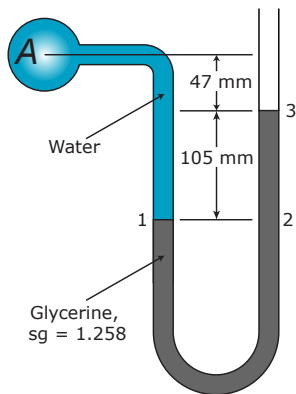


A tank, open to the atmosphere in the centre, contains medium fuel oil. Atmospheric pressure is 102.1 kPa. Calculate the gauge pressure and the absolute pressure for locations *A*, *B*, *C*, *D* and *E*.

**Solution:**

**Example 7:**

Determine the pressure at  $A$  given that the temperature of the water is  $25^\circ\text{C}$ .

**Solution:****Example 8:**

Find the pressure difference between  $A$  and  $B$ .

**Solution:**