Fluid pressure S33

1. It depends upon
   b) planet where the fluid is (e.g. moon, earth, venus etc)
   e) depth below the liquid's surface
   f) the fluid's density

2. The pressure in a fluid increases with depth, due to the weight of the fluid. The difference in pressure due to depth is tiny compared to the pressure caused by a force exerted on a piston and can be neglected.

3. Because the liquid is completely enclosed and the same amount of atmospheric pressure is exerted on all pistons.

4. $p = \rho_{\text{sea water}} \cdot g \cdot h = 1'030\ \frac{\text{kg}}{\text{m}^3} \cdot 9.81\ \frac{\text{m}}{\text{s}^2} \cdot 10.0\text{ m} = \underline{\underline{1.01\text{ bar}}}$ (at a depth of 10.0 m)

   $p = \rho_{\text{sea water}} \cdot g \cdot h = 1'030\ \frac{\text{kg}}{\text{m}^3} \cdot 9.81\ \frac{\text{m}}{\text{s}^2} \cdot 20.0\text{ m} = \underline{\underline{2.02\text{ bar}}}$ (at a depth of 20.0 m)

5. a) $p = \rho_{\text{alcohol}} \cdot g \cdot h = 789\ \frac{\text{kg}}{\text{m}^3} \cdot 9.81\ \frac{\text{m}}{\text{s}^2} \cdot 0.100\text{ m} = \underline{\underline{774\text{ Pa}}} = \underline{\underline{7.74\text{ mbar}}}$

   b) $p = \rho_{\text{mercury}} \cdot g \cdot h = 13.55 \cdot 10^3\ \frac{\text{kg}}{\text{m}^3} \cdot 9.81\ \frac{\text{m}}{\text{s}^2} \cdot 0.100\text{ m} = \underline{\underline{13'292\text{ Pa}}} = \underline{\underline{133\text{ mbar}}}$

6. a) $h = \frac{p}{\rho_{\text{alcohol}} \cdot g} = \frac{2'000\text{ Pa}}{789\ \frac{\text{kg}}{\text{m}^3} \cdot 9.81\ \frac{\text{m}}{\text{s}^2}} = 0.258\text{ m} = \underline{\underline{25.8\text{ cm}}}$

   b) $h = \frac{p}{\rho_{\text{mercury}} \cdot g} = \frac{2'000\text{ Pa}}{13.55 \cdot 10^3\ \frac{\text{kg}}{\text{m}^3} \cdot 9.81\ \frac{\text{m}}{\text{s}^2}} = 0.0150\text{ m} = \underline{\underline{1.50\text{ cm}}}$

7. $\rho = \frac{p}{g \cdot h} = \frac{1'098\text{ Pa}}{1.62\ \frac{\text{m}}{\text{s}^2} \cdot 0.0500\text{ m}} = 13'556\ \frac{\text{kg}}{\text{m}^3} = \underline{\underline{13.6 \cdot 10^3\ \frac{\text{kg}}{\text{m}^3}}}$ mercury

8. a) 0.5 bar + 1.0 bar = $\underline{\underline{1.5\text{ bar}}}$
   b) 1.0 bar + 1.0 bar = $\underline{\underline{2\text{ bar}}}$
   c) 10 bar + 1.0 bar = $\underline{\underline{11\text{ bar}}}$

9. a) $p_{\text{fluid}} = \rho \cdot g \cdot h = 1'030\ \frac{\text{kg}}{\text{m}^3} \cdot 9.81\ \frac{\text{m}}{\text{s}^2} \cdot 10'907\ \text{m} = 110'207'600\ \text{Pa} = 1'102\ \text{bar}$

$p_{\text{total}} = p_{\text{fluid}} + p_{\text{atmospheric}} = 1'102\ \text{bar} + 1.00\ \text{bar} = \underline{1'103\ \text{bar}}$

b) $F = p_{\text{gauge}} \cdot A = 110'207'600\ \frac{\text{N}}{\text{m}^2} \cdot 0.126\ \text{m}^2 = 13'886157\ \text{N} = \underline{\underline{13.9 \cdot 10^6\ \text{N}}}$

10. a) $p_{\text{fluid}} = \rho_{\text{water}} \cdot g \cdot h = 998\ \frac{\text{kg}}{\text{m}^3} \cdot 9.81\ \frac{\text{m}}{\text{s}^2} \cdot 0.400\ \text{m} = 3'916\ \text{Pa} = 0.03916\ \text{bar}$

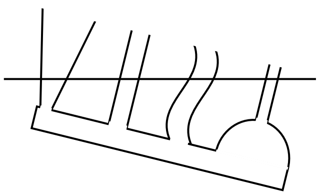
$p_{\text{total}} = p_{\text{fluid}} + p_{\text{atmospheric}} = 0.03916\ \text{bar} + 1.00\ \text{bar} = \underline{1.039\ \text{bar}} = \underline{103916\ \text{Pa}} = \underline{1'039\ \text{mbar}}$

b) $p_{\text{fluid}} = \rho_{\text{water}} \cdot g \cdot h = 998\ \frac{\text{kg}}{\text{m}^3} \cdot 9.81\ \frac{\text{m}}{\text{s}^2} \cdot 0.200\ \text{m} = \underline{1'958\ \text{Pa}}$

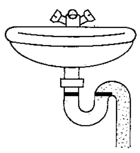
c) $F = p \cdot A = 1'958\ \frac{\text{N}}{\text{m}^2} \cdot 0.240\ \text{m}^2 = \underline{\underline{470\ \text{N}}}$

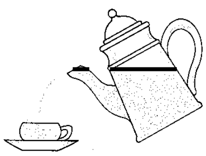
d) Because atmosperic pressure acts on both sides of the aquarium.

11.



12. a)

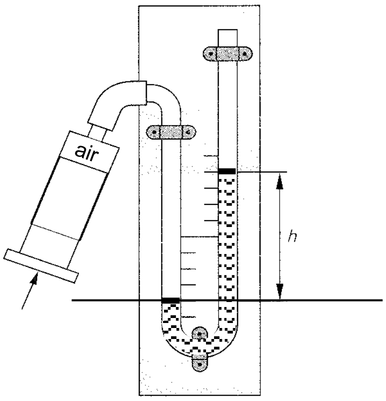




b) The U-shaped part is always filled with water, preventing bad smells from sewage from entering the house.
Tea pot: When pouring tea, the liquid's surface is at the same height on the inside as on the outside of the tea pot.

13. The liquids‘ densities are different. They need to produce the same amount of pressure on both sides, therefore the liquid to the left has a lower density than the liquid to the right. For example olive oil on the left side, water on the right side.

14. a)



b)

c) $p_{fluid} = \rho_{water} \cdot g \cdot h = 998 \ \frac{kg}{m^3} \cdot 9.81\ 1 \frac{m}{s^2} \cdot 0.55\ m = 5384.7\ Pa = 0.054\ bar = 54\ mbar$

d) $p_{total} = p_{atmospheric} + p_{fluid} = 1.00\ bar + 0.054\ bar = 1.054\ bar$

e) pressure is equal on both side at the same level. As it is an enclosed gas, Pascal's principle applies and the pressure is transmitted to all points of the gas: 1.054 bar

f) $p_{gauge} = p_{inside} - p_{outside} = 1.054\ bar - 1.00\ bar = 0.054\ bar$