Homework Solutions to HW Set # 9.5 due Sun 11 / 16 / 03

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By [signature]
On 11 / 10 / 03

1. CQ9.4 The force on either dam face at a point h meters below the water level is equal to the Pressure x Area, and the pressure is $P = P_{ATM} + \rho_{H_2O}\, g\, h$. Then BOTH dams (equally long & high) must withstand the same pressures and forces ... they must be equally strong. [Note that the shoreline is holding back the wider dam's extra water, not the dam face itself.]

* 2. P9.14 $\vec{F}_{up} = 4 \times P \times A$ is upward force of road on car's 4 wheels

$= -\vec{W}_{car}$ ... because car is not accelerating:

$a = 0 \Rightarrow \vec{F}_{up} + \vec{W} \equiv 0$.

$|W_{car}| = 4 \times 2 \times 10^5 \frac{N}{m^2} \times 0.024\, m^2 = 0.19 \times 10^5 =$ $\boxed{1.9 \times 10^4 N = \text{Weight}}$

{i.e. car is about 2000 kg ~ 4400 lbs.}

* 3. P9.18 $P_{ABS} = P_0 + \rho g h$ at distance h below waterline.

& $P_{Gauge} = \rho g h = \frac{10^3 kg}{m^3} \cdot (9.80) \frac{m}{sec^2} \times 1200\, ft \times \frac{1 m}{3.281\, ft}$

$= \boxed{3.58 \times 10^6 \frac{N}{m^2}}$ {1 N = 1 kg m/sec²; 1 N/m² = 1 Pa.}

[Check: P is ~ 35 x PATM & height is ~ 35 X 10m height of H₂O Barometer]

4. P9.23 $P_{Abs} = P_{ATM} + \rho_{oil}\, g\, h_{oil} + \rho_{H_2O}\, g\, h_{H_2O}$.

because pressure of oil is added to pressure of water, just as weight of atmosphere is added.

$P_{ABS} = (1.013 \times 10^5 + 10^3 (9.8) [(0.7)(0.30) + (1.0)(0.20)]$

↑ P_{ATM}. ↑ density of H₂O $= \rho_{H_2O}$ ↑ g. ↑ Sp. Gravity of oil $= \frac{\rho_{oil}}{\rho_{H_2O}}$; Sp Grvt H₂O = 1.0

$= [10.13 \times 10^4 + 0.2058 \times 10^4 + 0.1960 \times 10^4] = \boxed{1.053 \times 10^5 Pa}$

[Note 20 cm of H₂O & 30 cm of oil are light compared w. Atmosphere]

By [initials]
On 11 / 10 / 03

*5. P9.24 $F = |\vec{F}_{down}|$: How is it related to F_1 on piston 1?

Since pivot of handle is fixed, TORQUE about pivot must be zero if handle is fixed $-F \cdot d_F + F_1 \cdot d_1 = \tau^{NET} = 0$

i.e $F = \frac{F_1 d_1}{d_F}$ Also Pressure inside jack is $P = P_1 = P_2$ (same throughout)

so that $\frac{F_2}{A_2} = \frac{500\ lb}{\pi \cdot (1.5)^2/4} = P_2 = P = P_1 = F_1/A_1 \Rightarrow F_1 = A_1 P = \frac{A_1 \cdot F_2}{A_2}$

Therefore, $F = \frac{F_1 d_1}{d_F} = \frac{A_1}{A_2} \frac{d_1}{d_F} F_2 = \frac{(0.25)^2}{(1.5)^2} \cdot \frac{(2.0)}{(10+2.0)} \cdot 500\ lbs. = \boxed{2.3\ lbs = F}$

since $d_1 = 2.0$ in, $d_F = 12.0$ in, & $A_1/A_2 = (\text{diameter } 1)^2/(\text{diameter } 2)^2$

6. QQ 9.1 (p 264) Better off getting stepped on by basketball sneaker than spike heel: $P = F/A$ is much greater when area (here of heel tip) is small, and damage to foot beneath could be much more severe. More quantitatively, Area ratio might be ~ $(5cm/1cm)^2 \sim 25X$, whereas weight ratio is likely to be $\lesssim 2X. \ll 25X$.