Fluids

- Terms
- Pascal's Law
  - Any change in pressure is transmitted throughout a fluid and enclosing walls
- Archemedes' Law
  - The buoyant force on an object is equal to the weight it displaces in that fluid.

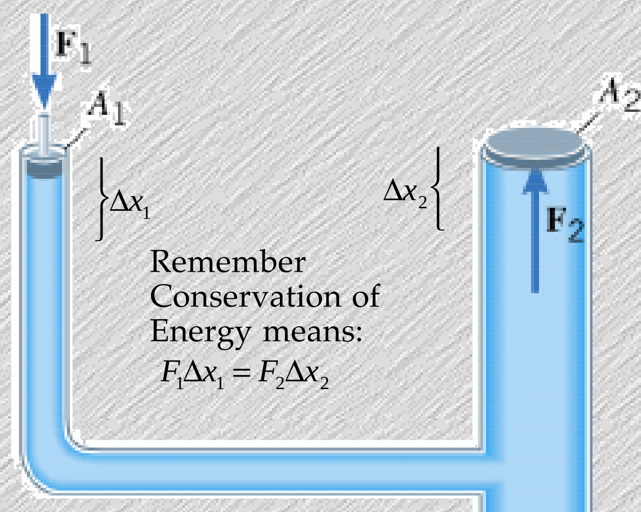
Terms and Definitions

- Terms
  - Mass Density $\rho = \dfrac{mass}{Volume} \quad \dfrac{kg}{m^3}, \dfrac{gm}{cm^3}$
  - Pressure $P = \dfrac{Force}{Area} \quad \dfrac{Nt}{m^2}, pascal, bar$
  - Flow $Q = Area \cdot velocity \quad \dfrac{m^3}{s}$

Pascal's Law

Any change in pressure is transmitted throughout a fluid its enclosing walls

- Apply a force, F_1, to a piston of area, A_1, and the force felt on the other piston, F_2, will be proportional to the ratios of the areas of the two pistons.



$$\frac{F_1}{A_1} = p_1$$

$$p_2 = \frac{F_2}{A_2} \because p_1 = p_2 \therefore$$

$$F_2 = A_2 \frac{F_1}{A_1}$$

Illustration

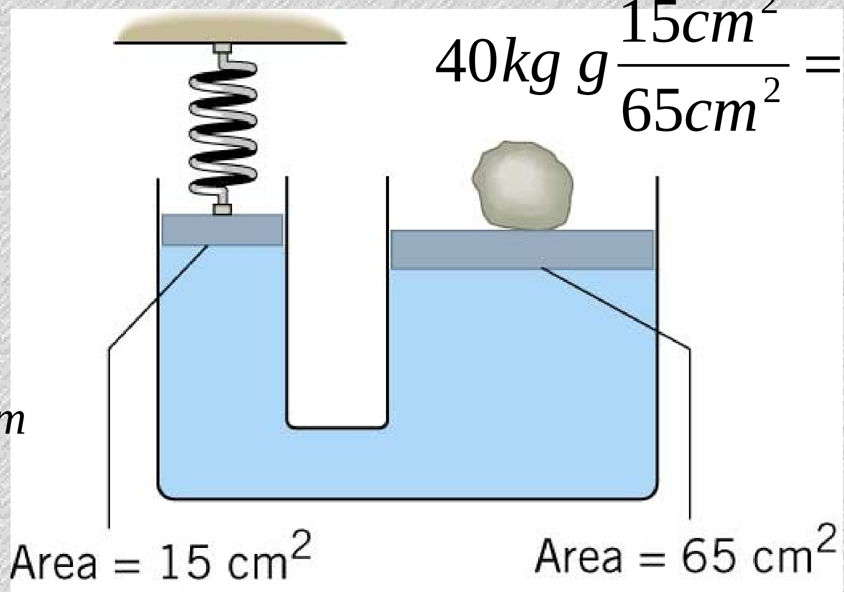
Rock is 40 kg, how much is applied to the spring?

What is the displacement?

k=1600 Nt/m

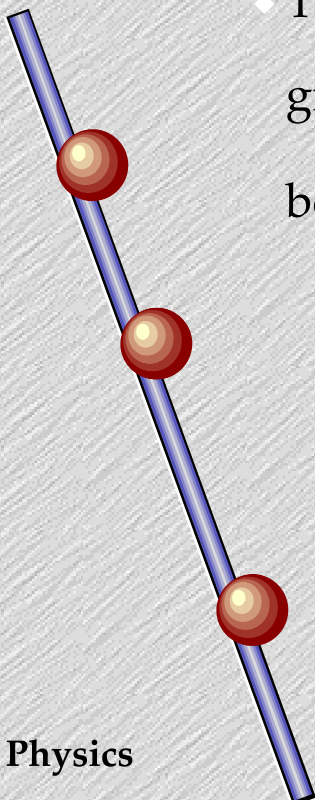
$$\frac{90.5Nt}{1600\,Nt/m} = 5.7cm$$

$$40kg\,g\,\frac{15cm^2}{65cm^2} = 90.5Nt$$



Archemedes' Principal

The buoyant force is equal to the weight of the displaced fluid.



- The buoyant force on the cylinder is simply given by the difference in pressure on the bottom vs. the pressure on top.

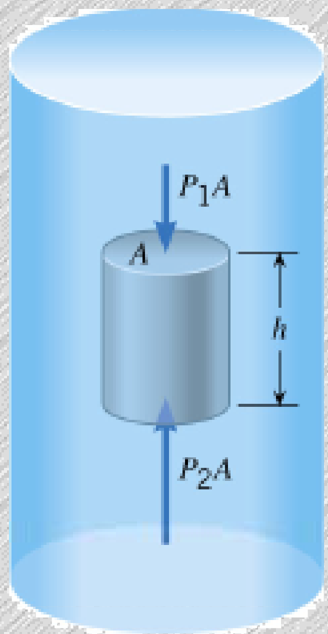
$$F_B = P_2A - P_1A$$

$$P(y) = \rho\, g\, y$$

$$F_B = (\rho\, g\, h)A$$

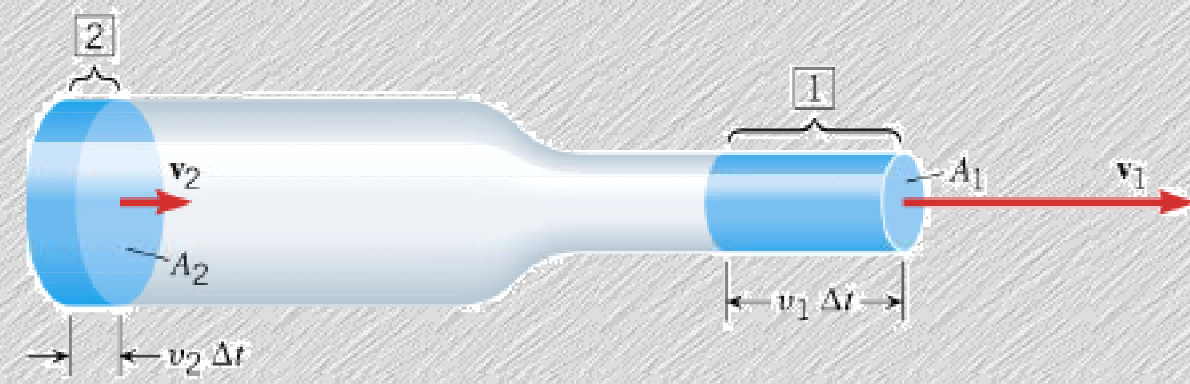
$$\because hA = V$$

$$F_B = m_{fluid}\, g$$



Fluid in Motion

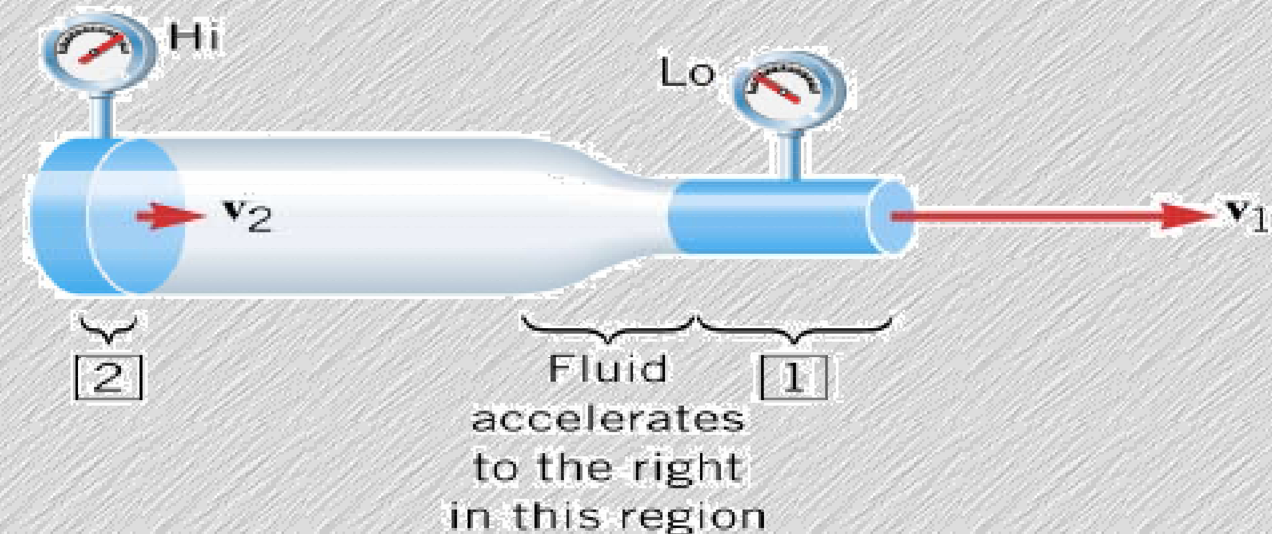
- Continuity (conservation of mass, momentum)



$$mass\ \ flow\ rate = \rho Q = \rho A v$$

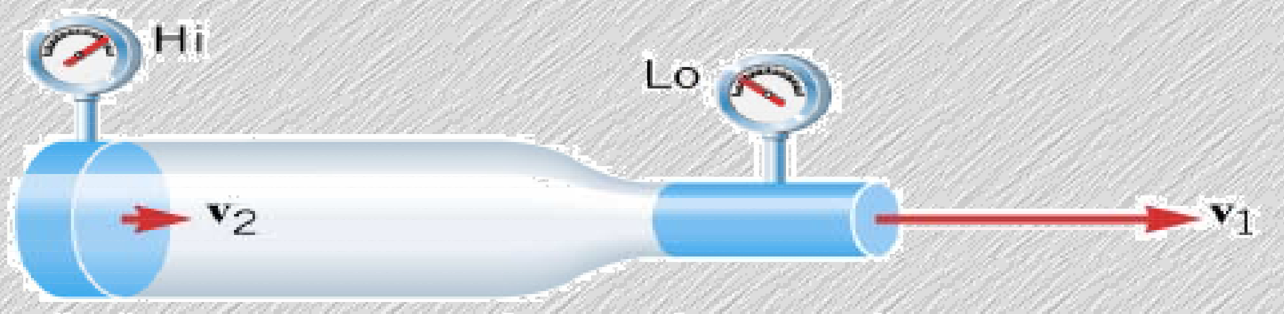
$$continuity: \quad \rho Q_1 = \rho Q_2$$

Bernoulli's Equation



What happens when the velocity increases?

Bernoulli's Equation



Pressure Drops.
Work is done on the fluid by the walls to increase the flow…

$$W_{nc} = \Delta(PV) = (P_2 - P_1)V = \Delta E$$

$$\Delta E = mg\Delta h + \tfrac{1}{2}m({v_2}^2 - {v_1}^2)$$

$$P_1 + \tfrac{1}{2}\rho {v_1}^2 + \rho g y_1 = P_2 + \tfrac{1}{2}\rho {v_2}^2 + \rho g y_2$$

Consequences