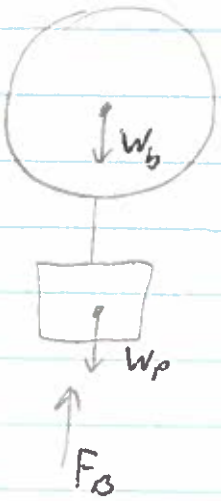
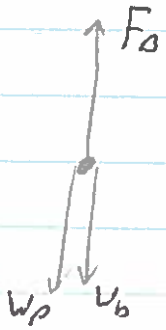
Ex 13.5 Calculate weight that can be lifted by a hot air balloon.



FBD:



W_p = weight of payload
W_b = weight of balloon full of 100°C air
F_B = buoyant force due to 20°C air.

For balloon not to drop we require the system to be (at least) in equilibrium:

$$\sum F_y = 0 = F_B - W_p - W_b$$

$$\therefore \quad W_p = F_B - W_b$$

Buoyant force, $F_B = \rho_{20}\, g\, V_b$ (V_b is air volume displaced by balloon)

Balloon weight, $W_B = \rho_{100}\, g\, V_b$

V_b = balloon volume.

$$\therefore W_p = \rho_{20} g V_b - \rho_{100} g V_b$$

$$= (\rho_{20} - \rho_{100}) g V_b$$

$$= (1.2054\ kg\,m^{-3} - 0.9466\ kg\,m^{-3})(9.81\ ms^{-2})(2200\ m^3)$$

$$W_p = 5590\ N$$