2) If the temperature is constant at all altitudes: then the density is directly proportional with the pressure.

If (ρ_o) and (P_o) are values of density and pressure at sea level and (ρ) and (P) are values of density and pressure at any altitude (y) above sea level, then

$$\frac{\rho}{\rho_o} = \frac{P}{P_o} \quad \rightarrow\rightarrow \quad \rho = \rho_o \frac{P}{P_o} \quad \dots\dots\dots\dots\dots\dots\dots (2-14)$$

Put (ρ) from eq. (2-14) in eq. (2-9) we will get

$$\frac{dP}{dy} = -\frac{\rho_o}{P_o} gP$$

Integrate from the pressure (P_o) at sea level (y=0) to the pressure (P) at (y)

$$\int_{P_o}^{P} \frac{dP}{P} = -g\frac{\rho_o}{P_o} \int_0^y dy$$

$$ln\frac{P}{P_o} = -\frac{g\rho_o}{P_o}\, y$$

$$\frac{P}{P_o} = e^{-\frac{g\rho_o}{P_o} y}$$

$$P = P_o e^{-\frac{g\rho_o}{P_o} y}$$

However, $g=9.8\ m/sec^2$, $\rho_o=1.2\ kg/m^3$, $P_o=1.013\times10^5\ n/m^2$

Then, $\frac{g\rho_o}{P_o} = 1.16 \times 10^{-4}\, m^{-1} = 0.116\, (km)^{-1} = a$

Hence,

$$P = P_o e^{-ay} \quad \dots\dots\dots\dots\dots\dots\dots (2-15)$$

At y = 0, P = P_o = 1 atm

At y = 20 km, P = 0.1 atm

y = 40 km, P = 0.01 atm

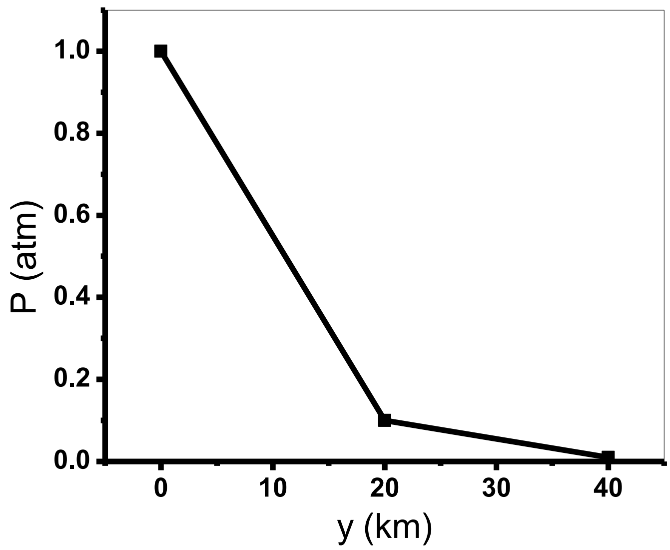

Figure 2-5 show the changes of pressure with altitude

Example 13: a) Find the total pressure in **lb/in^2**, **500 ft** below the surface of the ocean. The relative density of seawater is **1.03.**
b) Find the pressure in the atmosphere **10 mile** above sea level.

Example 14: Find the pressure in **torr** acts on a man at **20 m** below the surface of the sea. The density of seawater is **1.03x10^3 kg/m^3**.