1) $P_{piston} = \frac{F}{A}$

$= \frac{5 \times 9.81}{\pi (6 \times 10^{-2})^2}$

$= 4336.972199 Pa$

$P_{atm} = P_{gas} - P_{piston}$

$= 100 \times 10^3 - 4336.972199 Pa$

$= 95663.0278$

$\approx 95.7 kPa$

Let the mass of weights required be $m_{weights}$

$2P_{gas} - P_{gas} = P_{weights}$

$P_{gas} = P_{weights}$

$P_{weights} = P_{gas}$

$\frac{9.81 m_{weights}}{\pi (6 \times 10^{-2})^2} = 100 \times 10^3$

$m_{weights} = 115.2878038$

$\approx 115.29 kg$

2) $P_{cylinder} = P_{piston} + P_{spring} + P_{atm}$

$$= \frac{3.2 \times 9.8}{35 \times 10^{-4}} + \frac{150}{35 \times 10^{-4}} + 95 \times 10^{3}$$

$$= 146817.1429 Pa$$

$$\approx 147 kPa$$

$$3)\ P_{atm} + P_{piston} = 100\times10^3 + \frac{5\times9.8}{\pi\left(\frac{100}{2}\times10^{-3}\right)^2}$$

$$= 100\times10^3 + \frac{19600}{\pi}$$

$$\text{Height of air} = \frac{0.4\times10^{-3}}{\pi(0.05)^2}$$

$$= \frac{4}{25\pi}$$

$$P_{Fig\,3} = P_{atm} + P_{piston} + P_{spring}$$

$$400\times10^3 = 100\times10^3 + \frac{19600}{\pi} + \frac{k\Delta x}{\pi(0.05)^2}$$

$$300\times10^3 - \frac{19600}{\pi} = \frac{64k}{\pi^2}$$

$$k = 45301.65788\,Nm^{-1}$$

$$P_{new} = P_{atm} + P_{piston} + P_{spring}$$

$$= 100\times10^3 + \frac{19600}{\pi} + \frac{45301.65788\left(\frac{4}{25\pi} + 2\times10^{-2}\right)}{\pi(0.05)^2}$$

$$= 515359.7245$$

$$\approx 515.3\,kPa$$