Three 60-litre high-pressure gas cylinders contain gaseous fire suppressants. The suppressants are:
IG-100 (which is 100% N_2),
Carbon dioxide (CO_2),
IG-55 (50% vol. N_2 and 50% vol. Ar).
The suppressants are stored in gaseous form under the pressure 170 atm (1 atm=101325 Pa) and at normal temperature (T=293K).

(i) Mass fraction of nitrogen and argon in gas mixture IG-55

Atomic masses of Nitrogen: M_N=14 kg/kmol x 2 =28 kg/kmol

$x_{N_2} = 0.5$, $x_{Ar} = 0.5$, $M_{N_2} = 28\ kg/kmol$, $M_{Ar} = 40\ kg/kmol$

To calculate mass fraction:

$$y_i = \frac{x_i M_i}{\sum(x_i M_i)}$$

$$y_{N_2} = \frac{x_{N_2} M_{N_2}}{x_{N_2} M_{N_2} + x_{Ar} M_{Ar}}$$

$$y_{N_2} = \frac{0.5 \cdot 28\ kg/kmol}{(0.5 \cdot 28\ kg/kmol) + (0.5 \cdot 40\ kg/kmol)}$$

$$= 0.41$$

To find mass fraction of Argon

$$\sum yi = y_{N_2} + y_{Ar} = 1$$

$$y_{Ar} = 1 - y_{N_2}$$

$$y_{Ar} = 1 - 0.41$$

$$y_{Ar} = 0.59$$

(ii) Mass of the gas contained in each cylinder

1) IG-100 (which is 100% N_2)
2) Carbon dioxide (CO_2)
3) IG-55 (50% vol. N_2 and 50% vol. Ar).

$P = 1atm,\ R = 8{,}3145\ J/kmol.K, V = 60\ Litre, T = 293K$

$$PV = nRT$$

$$n = \frac{PV}{RT}$$

$$n = \frac{1 \times 60}{83145 \times 293}$$

Or

atomic masses of IG-100 $\mathrm{M_{N_2}} = 14\ \mathrm{kg/kmol}\ \mathrm{x2} = 28\ \mathrm{kg/kmol}$

atomic mass of $CO_2 = 12\ kg/kmol\ + (16\ \times 2\ kg/kmol)$

$= 44\ kg/kmol$

Molecular mass of IG-55

$$M = \sum(x_i M_i)$$

$$= x_{N_2} M_{N_2} + x_{Ar} M_{Ar}$$

$$= (0.5 \cdot 28\ kg/kmol) + (0.5 \cdot 40\ kg/kmol)$$

$= 34\ kg/kmol$

(iii) What volume will be occupied by each suppressant after their release into the environment?

$PV = nRT$

$V = \frac{nRT}{P}$

Volume of IG-100