Q3 A gaseous fuel has the following percentage composition by volume:
CO 13%, H_2 42%, CH_4 25%, O_2 2%, CO_2 3%, N_2 15%

Determine the wet and dry volumetric and gravimetric analyses of the products of combustion if 15% excess air is used. State all assumptions made and take air as 21% O_2 and 79% N_2 by volume. The relative atomic masses are hydrogen l, carbon 12, nitrogen 14 and oxygen 16.

VOLUMETRIC

CARBON MONOXIDE
$2CO + O_2 \rightarrow 2CO_2$
$2\ m^3 + 1\ m^3 \rightarrow 2\ m^3$
$0.13\ m^3 + 0.065\ m^3 \rightarrow 0.13\ m^3$
HYDROGEN
$2H_2 + O_2 \rightarrow 2H_2O$
$2\ m^3 + 1\ m^3 \rightarrow 2\ m^3$
$0.42\ m^3 + 0.21\ m^3 \rightarrow 0.42\ m^3$
METHANE
$CH_4 + 2O_2 \rightarrow 2H_2O + CO_2$
$1\ m^3 + 2\ m^3 \rightarrow 2\ m^3 + 1\ m^3$
$0.25\ m^3 + 0.5\ m^3 \rightarrow 0.5\ m^3 + 0.25\ m^3$
Total oxygen required is $0.065 + 0.21 + 0.5 - 0.02 = 0.755\ m^3$
Air required = $0.755/0.21 = 3.595\ m^3$
Air supplied = $3.595 \times 1.15 = 4.135$

PRODUCTS			WET	DRY
H_2O	0.42 + 0.5 =	0.920 m^3	18.9%	0
O_2	0.21 x 4.135 – 0.755 =	0.113 m^3	2.3%	2.9%
N_2	0.79 x 4.135 + 0.15 =	3.417 m^3	70.3%	86.7%
CO_2	0.13 + 0.25 + 0.03 =	0.410 m^3	8.4%	10.4
Total		4.86/3.94	100%	100

GRAVIMETRIC

We convert volumes to masses using the formula $\frac{m_i}{m} = \frac{(V_i/V)\tilde{m}_i}{\sum\{(V_i/V)\tilde{m}\}_i}$

i	V_i/V	$\tilde{m}_i$	$(V_i/V)\,\tilde{m}_i$	WET $\tilde{m}_i / m$
H_2O	0.189	18	3.40	12.3%
O_2	0.023	32	0.74	2.7%
N_2	0.703	28	19.7	71.5%
CO_2	0.084	44	3.7	13.4%
Total	1.0		27.54	100

i	V_i/V	$\tilde{m}_i$	$(V_i/V)\,\tilde{m}_i$	DRY $\tilde{m}_i / m$
O_2	0.029	32	0.928	3.1%
N_2	0.867	28	24.276	81.5%
CO_2	0.104	44	4.576	15.4%
Total	1.0		29.78	100