Question 16

At room temperature the following reactions proceed nearly to completion : ***(1992 - 4 Marks)***

$$2NO + O_2 \rightarrow 2NO_2 \rightarrow N_2O_4$$

The dimer, N_2O_4, solidifies at 262 K. A 250 ml flask and a 100 ml. flask are separated by a stop-cock. At 300 K, the nitric oxide in the larger flask exerts a pressure of 1.053 atm. and the smaller one contains oxygen at 0.789 atm. The gases are mixed by opening the stopcock and after the end of the reaction the flasks are cooled at 220K. Neglecting the vapour pressure of the dimer, find out the pressure and composition of the gas remaining at 220 K. (Assume the gases to behave ideally).

Question 16

$2NO + O_2 \rightarrow 2NO_2 \rightarrow N_2O_4$

Calculating the number of moles of NO and O_2 by applying the formula, $n = \frac{PV}{RT}$

$$\text{Moles of NO in the larger flask} = \frac{1.053 \times 0.250}{0.082 \times 300} = 0.0107$$

[250 mL = 0.250 L]

$$\text{Moles of } O_2 \text{ in the smaller flask} = \frac{0.789 \times 0.100}{0.082 \times 300} = 0.0032$$

[100 mL = 0.100 L]

The reaction takes place as follows.

	$2NO$	+ O_2	$\longrightarrow$ N_2O_4
Mols before reaction	0.0107	0.0032	0
Mole after reaction	$(0.0107 - 2 \times .0032)$	0	0.0032

Hence moles of NO reacting completely with 0.0032 moles of $O_2 = 2 \times 0.0032 = 0.0064$

Moles of NO left = $0.0107 - 0.0064 =$ **0.0043**

NOTE : Oxygen will be completely changed into NO_2 which in turn is completely converted into N_2O_4 which solidifies at 262 K. Hence at 220 K, the dimer is in the solid state and only NO present in excess will remain in the gaseous state occupying volume equal to 350 ml.

Hence pressure (P) of NO gas left

$$= \frac{nRT}{V} = \frac{0.0043 \times 0.082 \times 220}{0.350} = \textbf{0.221 atm}$$

[Total volume = 0.250 + 0.100 = 0.350 L]