- At 21.0 °C, a solution of 18.26 g of a non-volatile, non-polar compound in 33.25 g of bromoethane, CH_3CH_2Br, has a vapour pressure of 4.42×10^4 Pa. The vapour pressure of pure bromoethane at this temperature is 5.26×10^4 Pa. What is the molar mass of the compound?

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The molar mass of CH_3CH_2Br is:

$$\text{molar mass} = (2 \times 12.01\ (C) + 5 \times 1.008\ (H) + 79.90\ (Br))\ \text{g mol}^{-1} = 108.96\ \text{g mol}^{-1}$$

The number of moles of CH_3CH_2Br in 18.26 g is therefore:

$$n_{solvent} = \text{mass} / \text{molar mass} = 33.25\ \text{g} / 108.96\ \text{g mol}^{-1} = 0.305\ \text{mol}$$

From Raoult's law, the vapour pressure of a solution, $P_{solution}$, is related to the vapour pressure of the pure solvent, $P^o_{solvent}$ and its mole fraction, $X_{solvent}$:

$$P_{solution} = X_{solvent} \times P^o_{solvent}$$

Using $P_{solution} = 4.42 \times 10^4$ Pa and $P^o_{solvent} = 5.26 \times 10^4$ Pa, the mole fraction must be:

$$X_{solvent} = P_{solution} / P^o_{solvent} = (4.42 \times 10^4 / 5.26 \times 10^4) = 0.840$$

The mole fraction of solvent is given by the number of moles of solvent divided by the total number of moles of solvent and solute:

$$X_{solvent} = n_{solvent} / (n_{solvent} + n_{solute}) = 0.840$$

Using $n_{solvent} = 0.305$ mol from above,

$$n_{solvent} / (n_{solvent} + n_{solute}) = 0.305 / (0.305 + n_{solute}) = 0.840$$

$$n_{solute} = (0.305 / 0.840 - 0.305)\ \text{mol} = 0.0581\ \text{mol}$$

As this corresponds to a mass of 18.26 g, the molar mass is:

$$\text{molar mass} = \text{mass} / \text{number of moles} = 18.26\ \text{g} / 0.0581\ \text{mol} = 315\ \text{g mol}^{-1}$$

	Answer: **315 g mol^{-1}**