

6. Answer the following questions related to $\text{HBr}(l)$ and $\text{HF}(l)$.

a) In the following table, list all of the types of intermolecular forces present in pure samples of $\text{HBr}(l)$ and $\text{HF}(l)$.

Liquid	$\text{HBr}(l)$	$\text{HF}(l)$
Intermolecular forces present	LONDON DISPERSION FORCES (LIKE EVERYTHING) DIPOLE-DIPOLE FORCES	LONDON DISPERSION FORCES HYDROGEN FORCES

(1 Pt)

b) The enthalpy of vaporization, $\Delta H_{\text{vap}}^{\circ}$, for each liquid is provided in the following table.

Liquid	$\text{HBr}(l)$	$\text{HF}(l)$
$\Delta H_{\text{vap}}^{\circ}$	17.3 kJ/mol	25.2 kJ/mol

(i) Based on the types and relative strengths of intermolecular forces, explain why $\Delta H_{\text{vap}}^{\circ}$ of $\text{HF}(l)$ is greater than that of $\text{HBr}(l)$.

THE HYDROGEN BONDING FOUND IN $\text{HF}(l)$ IS SIGNIFICANTLY STRONGER THAN THE RELATIVELY WEAK DIPOLE-DIPOLE FORCES IN $\text{HBr}(l)$. SINCE THE FORCES BETWEEN THE $\text{HF}(l)$ MOLECULES ARE SO MUCH STRONGER, IT REQUIRES MORE ENERGY TO VAPORIZE $\text{HF}(l)$ THAN IT DOES TO VAPORIZE $\text{HBr}(l)$.

(1 Pt)

(ii) Calculate the amount of thermal energy, in kJ, required to vaporize 6.85 g of $\text{HF}(l)$.

$$\frac{6.85 \text{ g HF}}{20.01 \text{ g HF}} \times \frac{1 \text{ mol HF}}{1 \text{ mol}} \times \frac{25.2 \text{ kJ}}{1 \text{ mol}} = 8.63 \text{ kJ}$$

= 8.63 kJ

(1 Pt)

c) Based on the arrangement of electrons in the Br and F atoms, explain why the bond length in an HBr molecule is greater than that in an HF molecule.

Br HAS TWO MORE OCCUPIED e^{-} SHELLS THAN F. AS A RESULT, THE DISTANCE FROM THE NUCLEUS OF Br TO ITS VALENCE e^{-} IS HIGHER/GREATER THAN THAT OF F. DUE TO THE HIGHER ATOMIC RADIUS OF Br, THE BOND LENGTH BETWEEN H AND Br IN THE H-Br BOND IS LONGER THAN THE BOND LENGTH BETWEEN H AND F IN THE H-F BOND.

(1 Pt)