

2. In the gas phase, AlCl_3 is a molecular substance. A reaction of gaseous AlCl_3 at high temperature is represented by the following balanced equation.



(a) How many grams of $\text{Cl}(g)$ can be formed from 1.25 mol of $\text{AlCl}_3(g)$?

Additional reactions that involve Al or Cl are shown in the following table.

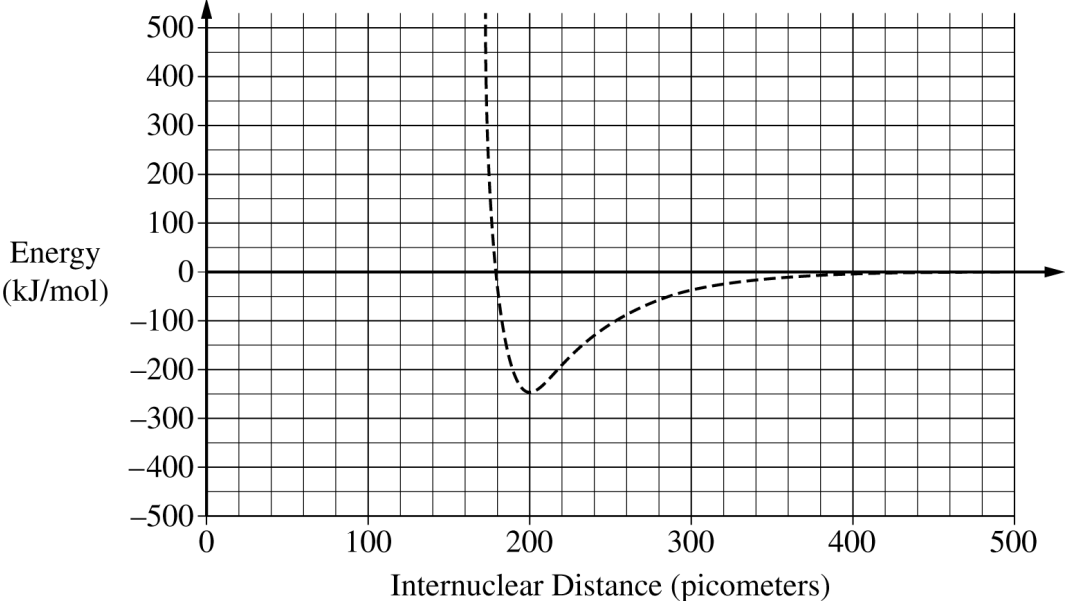
Reaction Number	Equation	ΔH_{rxn}° (kJ/mol _{rxn})
2	$\text{Al}(s) + \frac{3}{2} \text{Cl}_2(g) \rightarrow \text{AlCl}_3(g)$	−583
3	$\text{Al}(s) \rightarrow \text{Al}(g)$	+326
4	$\text{Cl}_2(g) \rightarrow 2 \text{Cl}(g)$	+243

(b) Calculate the value of ΔH_1° , in kJ/mol_{rxn}, for reaction 1 above using reactions 2, 3, and 4.

GO ON TO THE NEXT PAGE.

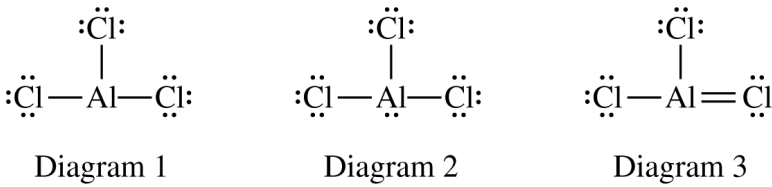
Continue your response to **QUESTION 2** on this page.

(c) A potential energy diagram for Cl_2 is shown in the following graph.



(i) Based on the graph, what is the bond length, in picometers, for Cl_2 ? _____

(d) Three proposed Lewis diagrams for the $\text{AlCl}_3(g)$ molecule are shown.



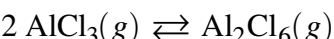
(i) The $\text{AlCl}_3(g)$ molecule has a trigonal planar geometry. Which diagram (1, 2, or 3) can be eliminated based on geometry? Justify your choice based on VSEPR theory.

GO ON TO THE NEXT PAGE.

Continue your response to **QUESTION 2** on this page.

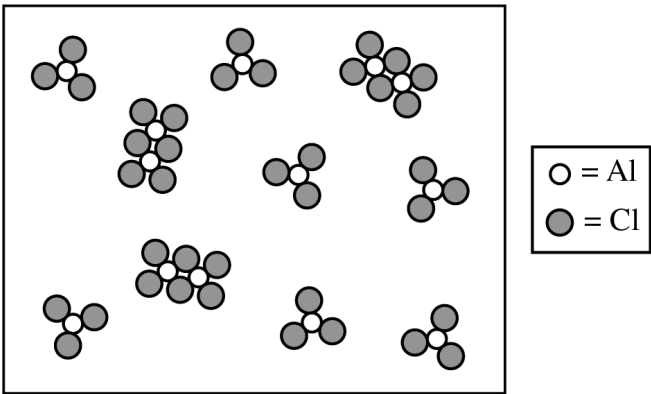
(ii) Which of the three diagrams is the best representation for the bonding in AlCl_3 ? Justify your choice based on formal charges.

AlCl_3 is known to dimerize reversibly in the gas phase. The dimerization equilibrium is represented by the following equation.



(e) Write the expression for the equilibrium constant, K_p , for this reaction.

A particle-level diagram of an equilibrium mixture of $\text{AlCl}_3(g)$ and $\text{Al}_2\text{Cl}_6(g)$ at 400°C in a 25 L closed container is shown.



(f) Using the particle-level diagram, calculate the value of K_p for the reaction if the total pressure in the container is 22.1 atm.

GO ON TO THE NEXT PAGE.