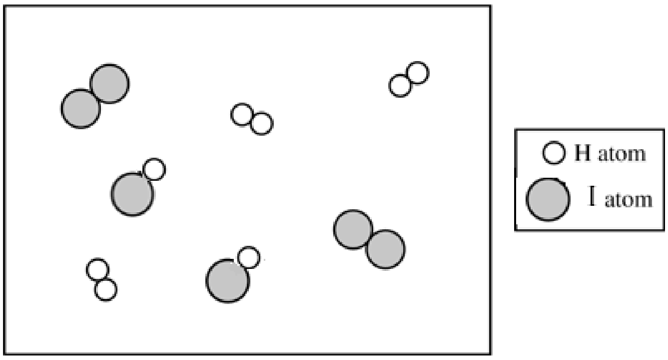
Question 5: Short Answer — 4 points

(a) For the correct expression: **1 point**

$$K_c = \frac{[HI]^2}{[H_2][I_2]}$$

(b) (i) For the correct drawing consistent with part (a): **1 point**



(ii) For a valid hypothesis: **1 point**

Accept one of the following:

- *Decreased the temperature.*
- *Added more* H_2 *and/or* I_2 *to the reaction vessel.*

(iii) For the correct answer and a valid justification: **1 point**

Accept one of the following:

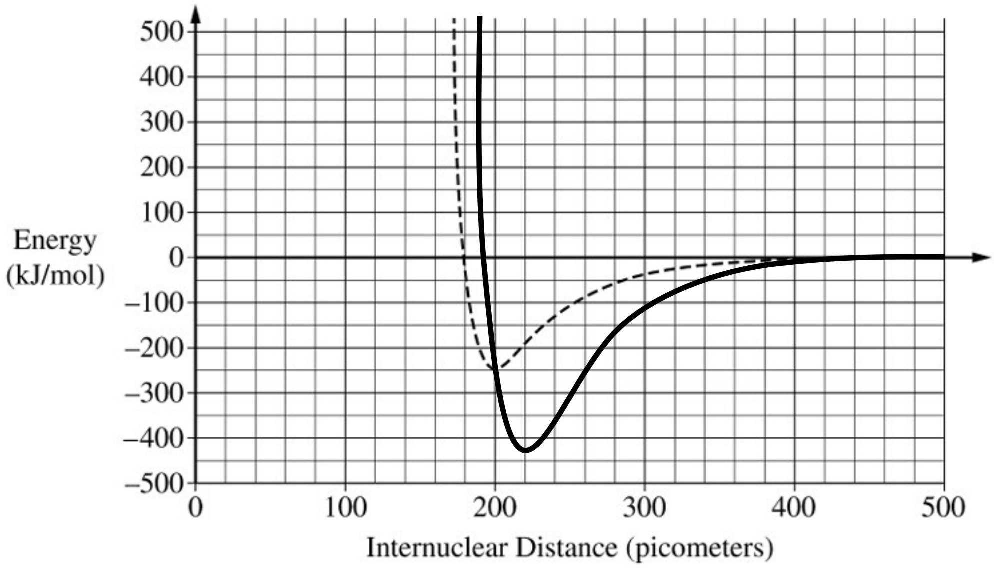
- *Remain unchanged. The number of moles in the numerator and denominator of* Q *(or* K *) are equal; changing the volume of the container would not alter the value of* Q *, which is still equal to* K *, so the number of moles of* HI *will remain the same.*
- *Remain unchanged. The increase in volume will decrease the concentration of reactants and products by an equal proportion. Because there are equal moles of gaseous reactants and products in the balanced chemical equation, there is no shift in the equilibrium position, and the number of moles of* HI *will remain the same.*

Total for part (b) 3 points

Total for question 5 4 points

Question 2: Long Answer — 10 points

(a)	For the correct calculated value reported with the correct number of significant figures: $1.25 \text{ mol AlCl}_3 \times \frac{3 \text{ mol Cl}}{1 \text{ mol AlCl}_3} \times \frac{35.45 \text{ g Cl}}{1 \text{ mol Cl}} = 133 \text{ g Cl}$	**1 point**
(b)	For the correct algebraic manipulation of either ΔH_2° or ΔH_4° (may be implicit): Accept one of the following: • *Reversing reaction 2:* $AlCl_3(g) \rightarrow Al(s) + \frac{3}{2}Cl_2(g) \quad \Delta H_{rxn}^\circ = -(-583) = +583 \text{ kJ/mol}_{rxn}$ • *Multiplying reaction 4 by* $\frac{3}{2}$*:* $\frac{3}{2}(Cl_2(g) \rightarrow 2\,Cl(g)) \quad \Delta H_{rxn}^\circ = \frac{3}{2}(+243) = +365 \text{ kJ/mol}_{rxn}$	**1 point**
	For the correct calculated value: $\Delta H_1^\circ = -\Delta H_2^\circ + \Delta H_3^\circ + 1.5(\Delta H_4^\circ) = -(-583) + 326 + 1.5(243) = 1274 \text{ kJ/mol}_{rxn}$	**1 point**
	Total for part (b)	**2 points**
(c) (i)	For the correct answer: *200 picometers (±10 pm)*	**1 point**
(ii)	For a curve with a minimum at an internuclear distance of 220 ± 10 pm: *See sample curve below*	**1 point**
	For a curve with a minimum energy value of -425 ± 20 kJ/mol that approaches zero as the internuclear distance approaches 500 pm:	**1 point**



Total for part (c) — **3 points**

(d) (i) For the correct answer and a valid justification: **1 point**

Diagram 2. Al has four electron domains in Diagram 2, which would be trigonal pyramidal, not trigonal planar.

(ii) For the correct answer and a valid justification: **1 point**

Diagram 1. All atoms in diagram 1 have a formal charge of zero, whereas atoms in diagrams 2 and 3 have nonzero formal charges.

Total for part (d) 2 points

(e) For the correct answer: **1 point**

$$K_p = \frac{P_{Al_2Cl_6}}{(P_{AlCl_3})^2}$$

(f) For the correct calculated value, consistent with part (e): **1 point**

$$K_p = \frac{\chi_{Al_2Cl_6}(P_{total})}{\left(\chi_{AlCl_3}(P_{total})\right)^2} = \frac{\frac{3}{10}(22.1)}{\left(\frac{7}{10}(22.1)\right)^2} = 0.0277$$

Total for question 2 10 points

Question 7: Short Answer 4 points

(a) For a correct answer: **1 point**

Accept one of the following:

- *The student's drawing shows an incorrect ratio of* Sr^{2+} *and* OH^- *ions.*
- *The student's drawing is not charge-balanced.*

(b) (i) For the correct calculated value: **1 point**

$$\frac{0.043 \text{ mol } Sr^{2+}}{1 \text{ L}} \times \frac{2 \text{ mol } OH^-}{1 \text{ mol } Sr^{2+}} = 0.086\ M\ OH^-$$

(ii) For the correct calculated value, consistent with (b)(i): **1 point**

$$K_{sp} = [Sr^{2+}][OH^-]^2 = (0.043)(0.086)^2 = 3.2 \times 10^{-4}$$

Total for part (b) 2 points

(c) For the correct answer and a valid justification: **1 point**

Less than. Because the $Sr(NO_3)_2(aq)$ *solution already contains a common ion,* $Sr^{2+}(aq)$*, the solubility of* $Sr(OH)_2$ *will be decreased, resulting in a lower value of* $[OH^-]$.

Total for question 7 4 points