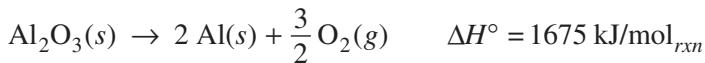


2015 AP[®] CHEMISTRY FREE-RESPONSE QUESTIONS

7. Aluminum metal can be recycled from scrap metal by melting the metal to evaporate impurities.
- (a) Calculate the amount of heat needed to purify 1.00 mole of Al originally at 298 K by melting it. The melting point of Al is 933 K. The molar heat capacity of Al is 24 J/(mol·K), and the heat of fusion of Al is 10.7 kJ/mol.
- (b) The equation for the overall process of extracting Al from Al₂O₃ is shown below. Which requires less energy, recycling existing Al or extracting Al from Al₂O₃? Justify your answer with a calculation.



STOP

END OF EXAM

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2015 SCORING GUIDELINES**

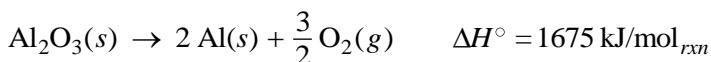
Question 7

Aluminum metal can be recycled from scrap metal by melting the metal to evaporate impurities.

- (a) Calculate the amount of heat needed to purify 1.00 mole of Al originally at 298 K by melting it. The melting point of Al is 933 K. The molar heat capacity of Al is 24 J/(mol·K), and the heat of fusion of Al is 10.7 kJ/mol.

| | |
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| To raise the temperature from 298 K to 933 K: $q = \frac{24 \text{ J}}{\text{mol K}} \times 1.00 \text{ mol} \times 635 \text{ K} = 15,000 \text{ J} = 15 \text{ kJ}$ It takes 10.7 kJ to melt the Al at 933 K. $15 \text{ kJ} + 10.7 \text{ kJ} = 26 \text{ kJ}$ | 1 point is earned for calculating the amount of heat needed to raise the temperature to 933 K. 1 point is earned for adding the heat of fusion to the previous result to get a final answer. |
|--|---|

- (b) The equation for the overall process of extracting Al from Al₂O₃ is shown below. Which requires less energy, recycling existing Al or extracting Al from Al₂O₃? Justify your answer with a calculation.



| | |
|---|--|
| For extracting Al from ore: $1675 \text{ kJ/mol}_{rxn} \times \frac{1 \text{ mol of reaction}}{2 \text{ mol Al}} = 837.5 \text{ kJ per mol of Al}$ Producing 1.00 mol of Al from Al ₂ O ₃ requires 837.5 kJ. Because 26 kJ < 837.5 kJ, recycling requires less energy. | 1 point is earned for a calculation to get equal numbers of moles for comparison. 1 point is earned for a correct comparison. |
|---|--|