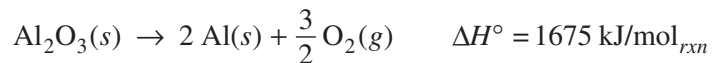


**2015 AP<sup>®</sup> CHEMISTRY FREE-RESPONSE QUESTIONS**

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 Al<sub>2</sub>O<sub>3</sub> is shown below. Which requires less energy, recycling existing Al or extracting Al from Al<sub>2</sub>O<sub>3</sub> ? Justify your answer with a calculation.



**STOP**

**END OF EXAM**

**AP<sup>®</sup> CHEMISTRY**  
**2015 SCORING GUIDELINES**

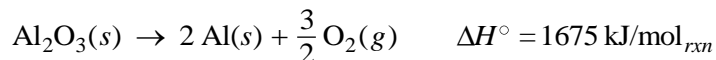
**Question 7**

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.

<p>To raise the temperature from 298 K to 933 K:</p> $q = \frac{24 \text{ J}}{\text{mol K}} \times 1.00 \text{ mol} \times 635 \text{ K} = 15,000 \text{ J} = 15 \text{ kJ}$ <p>It takes 10.7 kJ to melt the Al at 933 K.</p> <p>15 kJ + 10.7 kJ = 26 kJ</p>	<p>1 point is earned for calculating the amount of heat needed to raise the temperature to 933 K.</p> <p>1 point is earned for adding the heat of fusion to the previous result to get a final answer.</p>
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- (b) The equation for the overall process of extracting Al from Al<sub>2</sub>O<sub>3</sub> is shown below. Which requires less energy, recycling existing Al or extracting Al from Al<sub>2</sub>O<sub>3</sub> ? Justify your answer with a calculation.



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