Begin your response to **QUESTION 4** on this page.

$$4\,Fe(s) + 3\,O_2(g) \rightarrow 2\,Fe_2O_3(s) \qquad \Delta H^\circ = -\,1650\,kJ\,/\,mol_{rxn}$$

4. A student investigates a reaction used in hand warmers, represented above. The student mixes $Fe(s)$ with a catalyst and sand in a small open container. The student measures the temperature of the mixture as the reaction proceeds. The data are given in the following table.

Time (min)	Temperature of Mixture (°C)
0	22.0
1	25.1
2	34.6
3	37.3
4	39.7
5	39.4

(a) The mixture ($Fe(s)$, catalyst, and sand) has a total mass of 15.0 g and a specific heat capacity of 0.72 J/(g·°C). Calculate the amount of heat absorbed by the mixture from 0 minutes to 4 minutes.

(b) Calculate the mass of $Fe(s)$, in grams, that reacted to generate the amount of heat calculated in part (a).

GO ON TO THE NEXT PAGE.

Continue your response to **QUESTION 4** on this page.

(c) In a second experiment, the student uses twice the mass of iron as that calculated in part (b) but the same mass of sand as in the first experiment. Would the maximum temperature reached in the second experiment be greater than, less than, or equal to the maximum temperature in the first experiment? Justify your answer.

GO ON TO THE NEXT PAGE.

Question 4: Short Answer — 4 points

(a) For the correct calculated value with units: **1 point**

$$q = mc\Delta T = (15.0\text{ g})(0.72\text{ J/(g}\cdot{}^\circ\text{C}))(39.7^\circ\text{C} - 22.0^\circ\text{C}) = 190\text{ J}$$

(b) For the correct calculated value of the moles of reaction, consistent with part (a) (may be implicit): **1 point**

$$q_{sys} = -q_{surr}$$

$$-190\text{ J} \times \frac{1\text{ kJ}}{1000\text{ J}} \times \frac{1\text{ mol}_{rxn}}{-1650\text{ kJ}} = 0.00012\text{ mol}_{rxn}$$

For the correct calculated value of the mass of iron: **1 point**

$$0.00012\text{ mol}_{rxn} \times \frac{4\text{ mol Fe}}{1\text{ mol}_{rxn}} \times \frac{55.85\text{ g Fe}}{1\text{ mol Fe}} = 0.027\text{ g Fe}$$ *(0.026 g if decimals are carried)*

Total for part (b) **2 points**

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

Greater than. A greater mass of iron provides a greater number of moles of reaction, which would transfer a greater quantity of thermal energy to the same mass of sand and therefore lead to a greater maximum temperature.

Total for question 4 **4 points**