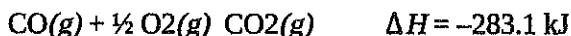
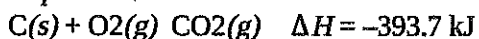


## Thermochemistry Unit Exam

Multiple Choice: Choose the best answer.

1. When an exothermic reaction occurs in a water solution, the temperature of the solution
  - a. increases because energy is released by the reaction
  - b. increases because energy is absorbed by the reaction
  - c. decreases because energy is released by the reaction
  - d. decreases because energy is absorbed by the reaction
2. Compound A and compound B were dissolved in separate beakers of water at 25°C. The temperature of the compound A solution decreased, and the temperature of the compound B solution increased. Based on these results, which conclusion is correct?
  - a. The water gained energy from compound A and lost energy to compound B
  - b. The water gained energy from both compound A and compound B
  - c. The water lost energy to compound A and gained energy from compound B
  - d. The water lost energy to both compound A and compound B

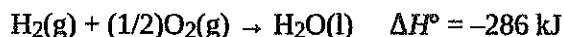
3. Consider the equations:



What is the heat of formation for CO?

- a. -566.2 kJ
  - b. -393.5 kJ
  - c. -172.5 kJ
  - d. -110.6 kJ
4. A 60.3 g sample of a metal is heated to 99.7°C and then placed in a calorimeter containing 100.0 g of water ( $c = 4.18 \text{ J/g}^\circ\text{C}$ ) at 23.6°C. The final temperature of the water is 25.7°C. Which metal was used?
    - a. aluminum ( $c = 0.89 \text{ J/g}^\circ\text{C}$ )
    - b. iron ( $c = 0.45 \text{ J/g}^\circ\text{C}$ )
    - c. copper ( $c = 0.20 \text{ J/g}^\circ\text{C}$ )
    - d. lead ( $c = 0.14 \text{ J/g}^\circ\text{C}$ )

5. Consider the reaction



Which of the following is true?

- a. The reaction is exothermic.
- b. The reaction is endothermic.
- c. The enthalpy of the products is greater than that of the reactants.
- d. Heat is absorbed by the system.

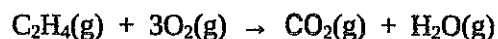
## Thermochemistry Unit Exam

6. For the reaction,



the energy released when 3.60 g of  $\text{H}_2\text{O}(g)$  is produced is

- a. 20.0 kJ
- b. 40.0 kJ
- c. 80.0 kJ
- d. 120 kJ



7. For the reaction of ethylene represented above,  $\Delta H$  is - 1,323 kJ.

What is the value of  $\Delta H$  if the combustion produced liquid water  $\text{H}_2\text{O}(l)$ , rather than water vapor  $\text{H}_2\text{O}(g)$ ? ( $\Delta H$  for the phase change  $\text{H}_2\text{O}(g) \rightarrow \text{H}_2\text{O}(l)$  is  $-44 \text{ kJ mol}^{-1}$ .)

- a. -1,235 kJ
- b. -1,279 kJ
- c. -1,367 kJ
- d. -1,411 kJ

Use the following information to answer questions 8-9:

Material	Specific Heat Capacity
Al	0.90
Fe	0.45
Cd	0.21
Pt	0.13

8. Four different materials, each at  $0^\circ\text{C}$  and each having a mass of 10 g, were placed into four separate beakers, each with 100 g of water initially at  $45^\circ\text{C}$ . In which beaker would the water experience the highest temperature change?

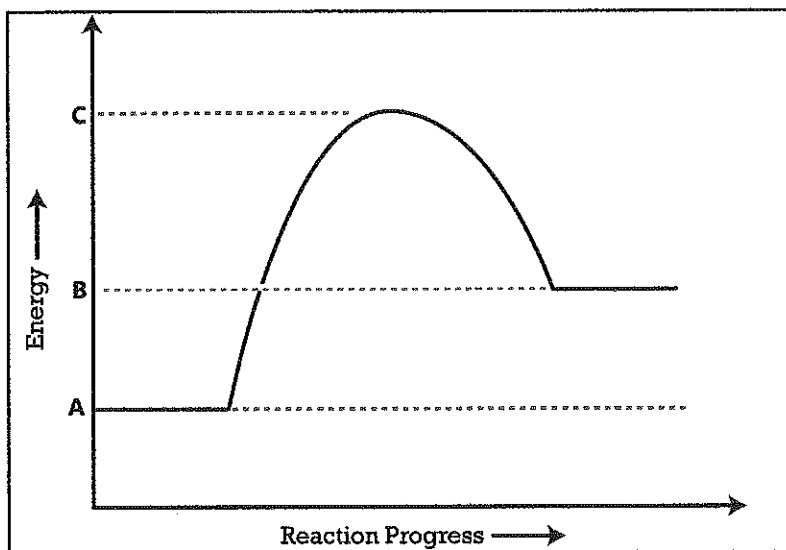
- a. aluminum
- b. cadmium
- c. iron
- d. platinum

9. In an experiment, 400 J of energy was absorbed by each of the four metals ( each having a mass of 10 g) in the above table. Which material experienced the greatest temperature change?

- a. aluminum
- b. cadmium
- c. iron
- d. platinum

## Thermochemistry Unit Exam

10. The following graph represents the energy changes in a chemical reaction.

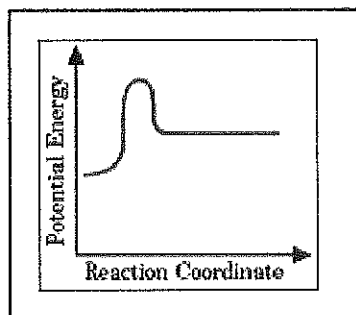


The heat of reaction would be calculated by:

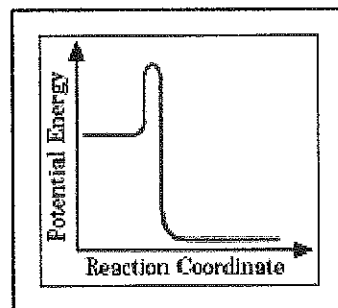
- a. Subtracting value A from C
- b. Subtracting value B from A
- c. Subtracting value A from B
- d. Subtracting value B from C

11. Which of the following is a graph that describes the pathway of reaction that is endothermic and has high activation energy?

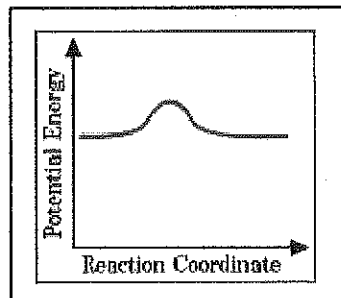
a.



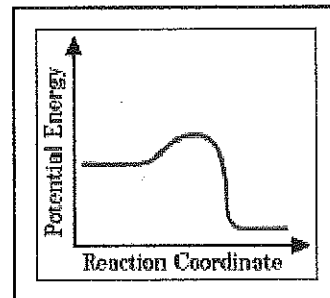
b.



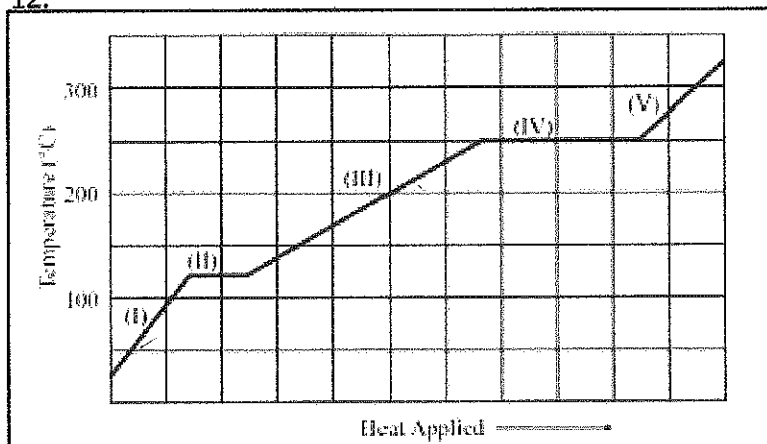
c.



d.



12.



A 100 g sample of benzoic acid was heated at a constant rate. The temperature was recorded and plotted resulting in the heating curve shown above. Which statement below best explains why the slope of segment (I) is greater than the slope of (III)?

- The specific heat capacity of the solid benzoic acid is greater than the specific heat capacity of liquid benzoic acid.
- The specific heat capacity of the solid benzoic acid is less than the specific heat capacity of liquid benzoic acid.
- The heat of vaporization of benzoic acid is greater than the heat of fusion of benzoic acid.
- The heat of vaporization of benzoic acid is less than the heat of fusion of benzoic acid.

## Thermochemistry Unit Exam

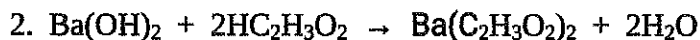
### Free Response

**DIRECTIONS:** Show all work, include units, and answer with the correct number of significant figures.

1. A student performed an experiment to determine the molar heat of reaction of solid zinc with a solution of copper (II) sulfate. This reaction was conducted in a 250 mL beaker. The initial temperature of the solution was 21 °C and the final temperature of the reaction mixture was 26 °C.

a. If the experiment had been conducted in a styrofoam (coffee cup) calorimeter, would the temperature change calculated during the experiment have been lower, the same as, or higher than the temperature change of the reaction as it occurred in the beaker? Justify your choice.

b. If the experiment had been conducted in a styrofoam (coffee cup) calorimeter, would the molar heat of reaction calculated during the experiment have been lower, the same as, or higher than the molar heat of reaction as it occurred in the beaker? Justify your choice.

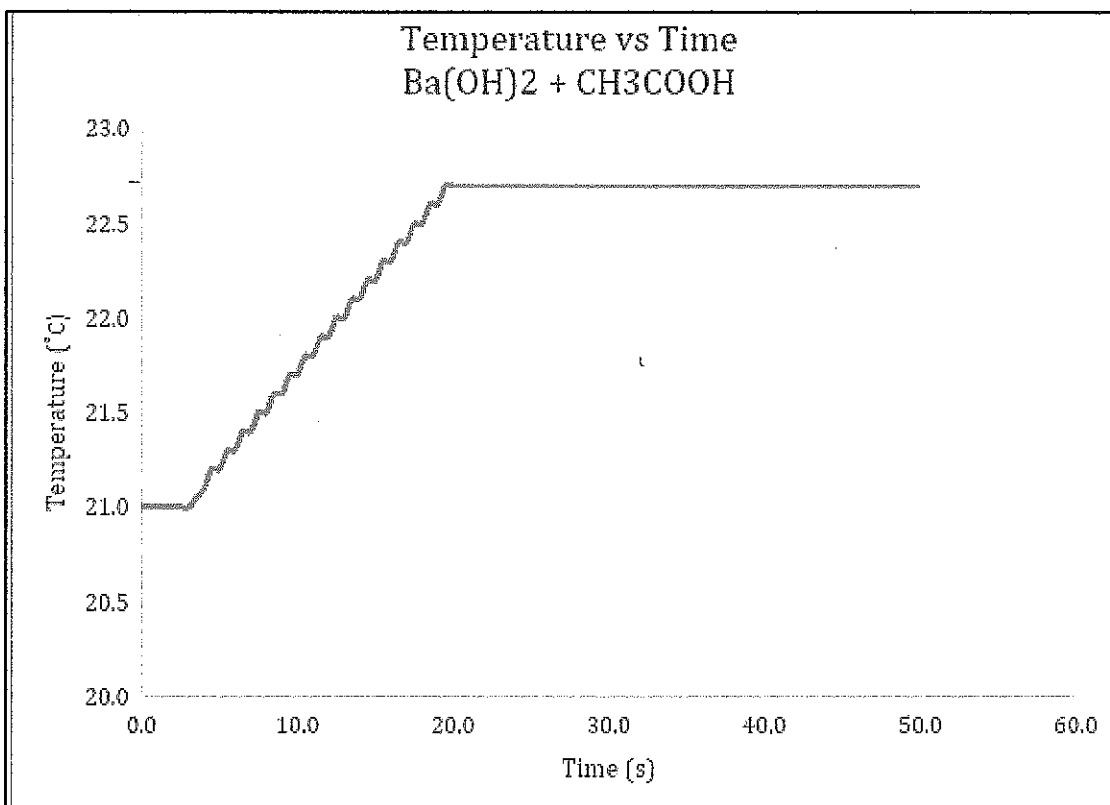


A student performed an experiment to determine the enthalpy change  $\Delta H$  for the reaction represented above. In the experiment the student reacted 25 mL of 0.25 M barium hydroxide with 25 mL of 0.25 M acetic acid.

a. Determine the limiting reactant. Justify your answer.

## Thermochemistry Unit Exam

b. The temperature data of the reaction is represented in the graph below:



Determine the temperature change that occurred over the course of the reaction.

c. Determine the enthalpy change, in joules, that occurs during the reaction.  
Use  $4.18 \text{ J/g}^\circ\text{C}$  as the specific heat of the reaction mixture.

d. Using the balanced equation, determine the enthalpy change of the reaction in  $\text{kJ/mole}$  of reaction.

3. Aluminum metal can be recycled from scrap metal by totally melting the metal to evaporate impurities. Calculate the amount of heat needed to purify  $1.00 \text{ mole}$  of Al originally at  $298 \text{ K}$  by totally melting it. The melting point of Al is  $933 \text{ K}$ . The molar heat capacity of Al is  $24 \text{ J}/(\text{mol}\cdot\text{K})$ , and the heat of fusion of Al is  $10.7 \text{ kJ/mol}$ .