



Unit 6: Thermochemistry

Review

Student: _____ | Due: _____, _____



Instructions:

- Complete all 10 problems (5 MCQ + 5 FRQ)
- Show ALL work for full credit
- Use the constants and formulas provided below
- Round answers to appropriate significant figures
- Include units in all final answers

12
34

Constants & Formulas

Heat Equations:

$$q = mc\Delta T \text{ (specific heat)}$$

$$q = nC_p\Delta T \text{ (molar heat capacity)}$$

$$q = m\Delta H_{fus} \text{ (melting/freezing)}$$

$$q = m\Delta H_{vap} \text{ (boiling/condensing)}$$

Calorimetry:

$$q_{\text{reaction}} = -q_{\text{surroundings}}$$

$$q_{\text{calorimeter}} = C_{\text{calorimeter}} \times \Delta T$$

Hess's Law:

$$\Delta H_{rxn} = \Sigma \Delta H_f(\text{products}) - \Sigma \Delta H_f(\text{reactants})$$

Constants:

Specific heat of water: $c_{\text{water}} = 4.18 \text{ J/g}^{\circ}\text{C}$

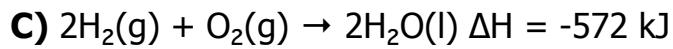
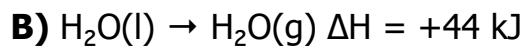
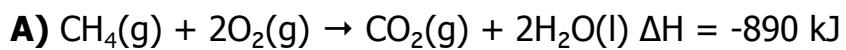
$\Delta H_{\text{fus}}(\text{H}_2\text{O}) = 334 \text{ J/g}$

$\Delta H_{\text{vap}}(\text{H}_2\text{O}) = 2260 \text{ J/g}$

PART A: Multiple Choice Questions (1-5)

Problem 1 (MCQ)

Which of the following processes is **endothermic**?



Show your work here:

Problem 2 (MCQ)

A 50.0 g sample of water is heated from 20.0°C to 80.0°C. How much energy is absorbed?

(Use $c_{\text{water}} = 4.18 \text{ J/g}^{\circ}\text{C}$)

A) 4,180 J

B) 12,540 J

C) 16,720 J

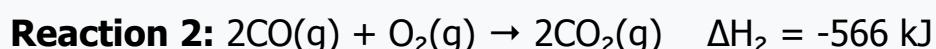
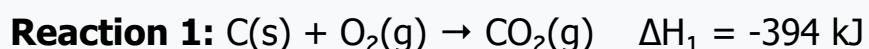
D) 20,900 J



Show your work here:

Problem 3 (MCQ)

Given the following reactions:



What is ΔH for the reaction: $\text{C(s)} + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{CO(g)}$?

A) -111 kJ

B) -172 kJ

C) +111 kJ

D) +172 kJ



Show your work here:

Problem 4 (MCQ)

When 2.00 g of methane (CH_4) burns completely, 111 kJ of heat is released. What is the molar enthalpy of combustion of methane?
(Molar mass of CH_4 = 16.0 g/mol)

A) -55.5 kJ/mol

B) -111 kJ/mol

C) -444 kJ/mol

D) -888 kJ/mol



Show your work here:

Problem 5 (MCQ)

Which statement about bond energy is TRUE?

- A)** Breaking bonds releases energy
- B)** Forming bonds requires energy
- C)** Breaking bonds requires energy
- D)** Exothermic reactions have more energy in bonds broken than formed



Show your work here:

PART B: Free Response Questions (6-10)

Problem 6 (FRQ - Calorimetry)

A student performs a calorimetry experiment by mixing 100.0 mL of 1.0 M HCl with 100.0 mL of 1.0 M NaOH in a coffee cup calorimeter. The initial temperature of both solutions is 22.5°C. After mixing, the maximum temperature reached is 29.3°C.

Assume:

- Density of solutions = 1.00 g/mL
- Specific heat capacity = 4.18 J/g°C
- Heat capacity of calorimeter is negligible

a) Calculate the heat released by the reaction (in kJ).

b) Calculate the molar enthalpy of neutralization (ΔH in kJ/mol).

c) Is this reaction endothermic or exothermic? Explain.



Show your work here:

Problem 7 (FRQ - Phase Changes)

Calculate the total energy required to convert 25.0 g of ice at -10.0°C to steam at 110.0°C.

Use the following data:

- Specific heat of ice: 2.09 J/g°C
- Specific heat of water: 4.18 J/g°C
- Specific heat of steam: 2.01 J/g°C
- $\Delta H_{fus} = 334 \text{ J/g}$
- $\Delta H_{vap} = 2260 \text{ J/g}$

Show all steps and calculations for each stage:

1. Heating ice from -10°C to 0°C
2. Melting ice at 0°C
3. Heating water from 0°C to 100°C

4. Vaporizing water at 100°C
5. Heating steam from 100°C to 110°C



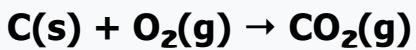
Show your work here:

Problem 8 (FRQ - Hess's Law)

Given the following thermochemical equations:



Use Hess's Law to calculate ΔH for:



Show all work including:

- How you manipulate the given equations
- How you combine them
- Final answer with proper sign and units



Show your work here:

Problem 9 (FRQ - Standard Enthalpy of Formation)

Calculate ΔH°_{rxn} for the combustion of propane:



Use the following standard enthalpies of formation (ΔH°_f):

| Substance | ΔH°_f (kJ/mol) |
|-------------|-----------------------------|
| $C_3H_8(g)$ | -104 |
| $O_2(g)$ | 0 |
| $CO_2(g)$ | -394 |
| $H_2O(l)$ | -286 |

Show your calculation using:

$$\Delta H^\circ_{rxn} = \sum \Delta H^\circ_f(\text{products}) - \sum \Delta H^\circ_f(\text{reactants})$$



Show your work here:

Problem 10 (FRQ - Bond Energy)

Calculate the enthalpy change (ΔH) for the reaction:



Use the following average bond energies:

| Bond | Bond Energy (kJ/mol) |
|------|----------------------|
| C-H | 413 |
| O=O | 498 |
| C=O | 799 |
| O-H | 463 |

Show:

- Total energy required to break bonds (reactants)
- Total energy released forming bonds (products)
- $\Delta H = \text{Energy (bonds broken)} - \text{Energy (bonds formed)}$
- Is the reaction endothermic or exothermic?



Show your work here:



Submission Checklist:

- All 10 problems completed
- Work shown for all calculations
- Answers include units
- Proper significant figures used

- Name and date at top

Due: Day. (), Date (_____), Year (_____)