



CHEMISTRY WORKSHEET

more worksheets
with solutions

THERMOCHEMISTRY STOICHIOMETRY

Course: Grade 12 Chemistry

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50 Practice Problems with Answers and Detailed Solutions

Full version of this worksheet contains 4 selected representative problems on:

- ✓ Limiting reagent thermochemistry, ✓ Formation enthalpy calculations, ✓ Bond energy estimates,
- ✓ Reversing and scaling thermochemical equations.

All problems are designed to reflect style and difficulty commonly seen on quizzes, tests, and final exams. Detailed solutions are included to help students understand the reasoning behind every step.

PART A - FUNDAMENTAL PROBLEMS

Problems 1-15. Simple calculations and basic applications

PART B - INTERMEDIATE PROBLEMS

Problems 16-30. Typical unit test questions involving multiple steps

PART C - ADVANCED PROBLEMS

Problems 31-40. More challenging calculations requiring deeper understanding

PART D - CHALLENGE PROBLEMS

Problems 41-50. Difficult exam-style questions combining multiple concepts

SUITABLE FOR:

quizzes, unit tests and final exam preparation

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Section 1 - Essential Information - included in full version

This page includes only the formulas and habits needed to solve calorimetry problems efficiently

Formula	Use
$q = m \cdot \Delta T$	Heat gained or lost by a substance
$\Delta T = T_f - T_i$	Temperature change with sign
$q_{\text{cal}} = C_{\text{cal}} \Delta T$	Heat absorbed by a calorimeter
$q_{\text{sys}} = -q_{\text{surrounds}}$	Sign convention for coffee-cup and bomb calorimetry
$q_{\text{cal}} + q_{\text{sys}} = 0$	Heat exchange between substances
$\Delta H = q_{\text{sys}}/n$	Molar enthalpy at constant pressure

Important definitions: coffee-cup calorimetry is usually constant pressure, so q_p can be used for ΔH . Bomb calorimetry is constant volume, so the result is commonly treated as ΔU for ICNMB-style calculations.

Fast method: identify what gains heat, identify what loses heat, convert volumes to masses when density is given, calculate ΔT carefully, include C_{cal} when provided, then apply the sign convention at the end.

Important notes: for dilute aqueous solutions, use density = 1.00 g/mL and $c = 4.184 \text{ J/g } ^\circ\text{C}$ only when stated or clearly assumed. For reactions, the solution and calorimeter are surroundings, while the chemical reaction is the system.

Common mistakes: using only one solution volume after mixing, forgetting that q_{sys} has the opposite sign of $q_{\text{surrounds}}$, ignoring the limiting reagent, mixing Δ and Δ_f , and using the sample mass instead of moles when a molar amount is requested.

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Section 2 - Practice Problems

PART A - FUNDAMENTAL PROBLEMS (PROBLEMS 1-15)

Problem 8

Ammonia forms according to the equation below

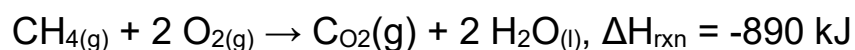


Calculate the heat released when 4.00 mol of NH_3 forms

PART B - INTERMEDIATE PROBLEMS (PROBLEMS 16-30)

Problem 16

Methane burns according to the equation below

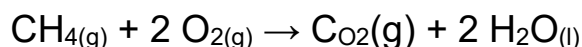


What mass of H_2O forms when 178 kJ of heat is released

PART C - ADVANCED PROBLEMS (PROBLEMS 31-40)

Problem 32

Methane combustion has $\Delta H_{\text{rxn}} = -890 \text{ kJ}$ for the reaction below

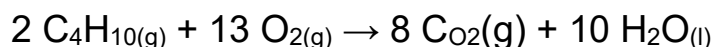


What mass of O_2 is required to release 500 kJ of heat

PART D - CHALLENGE PROBLEMS (PROBLEMS 41-50)

Problem 45

For butane combustion



Use $\Delta H^\circ_f[\text{C}_4\text{H}_{10(\text{g})}] = -125.6 \text{ kJ/mol}$, $\Delta H^\circ_f[\text{CO}_{2(\text{g})}] = -393.5 \text{ kJ/mol}$, and $\Delta H^\circ_f[\text{H}_2\text{O}_{(\text{l})}] = -285.8 \text{ kJ/mol}$ to calculate ΔH_{rxn}

Then calculate the mass of C_4H_{10} needed to release 250 kJ

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Section 3 - Solutions

Problem 8 Solution

Given: The reaction is $\text{N}_{2(g)} + 3 \text{H}_{2(g)} \rightarrow 2 \text{NH}_{3(g)}$, and $\Delta H_{\text{rxn}} = -92.4 \text{ kJ}$ for producing 2 mol NH_3 . The target amount is 4.00 mol NH_3

Find: The heat released when 4.00 mol of NH_3 forms

Method: The equation produces 2 mol NH_3 per -92.4 kJ. Since 4.00 mol NH_3 is double the equation amount, the enthalpy change is doubled

Formula: $q = n_{\text{NH}_3} \cdot (\Delta H / 2 \text{ mol NH}_3)$

Calculations: $q = (4.00 \text{ mol NH}_3)(-92.4 \text{ kJ} / 2 \text{ mol NH}_3) = -184.8 \text{ kJ}$

The value is negative because ammonia formation is exothermic. The final answer is rounded to three significant figures

Final answer: 185 kJ released

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Problem 16 Solution

Given: The reaction is $\text{CH}_4(\text{g}) + 2 \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{l})$, with $\Delta H_{\text{rxn}} = -890 \text{ kJ}$. A heat release of 178 kJ is given, and the equation forms 2 mol H_2O for each 890 kJ released

Find: The mass of H_2O produced when 178 kJ is released

Method: Use heat as the first conversion factor to find the reaction amount. Then use the coefficient ratio to find moles of H_2O and convert to mass

Formula: $n_{\text{H}_2\text{O}} = q \cdot (2 \text{ mol H}_2\text{O} / 890 \text{ kJ})$ and $m = n \cdot M$

Calculations: $n_{\text{H}_2\text{O}} = 178 \text{ kJ} \cdot (2 \text{ mol} / 890 \text{ kJ}) = 0.400 \text{ mol}$. $m_{\text{H}_2\text{O}} = (0.400 \text{ mol})(18.02 \text{ g/mol}) = 7.21 \text{ g}$

The heat value determines how much of the equation occurred. The final answer is rounded to three significant figures

Final answer: 7.21 g H_2O

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Problem 32 Solution

Given: The reaction $\text{CH}_{4(g)} + 2 \text{O}_{2(g)} \rightarrow \text{CO}_{2(g)} + 2 \text{H}_2\text{O}_{(l)}$ releases 890 kJ per 1 mol CH_4 and consumes 2 mol O_2 . The target heat release is 500 kJ

Find: The mass of O_2 needed to release 500 kJ

Method: Use heat to find moles of CH_4 burned, then use the 2:1 O_2 to CH_4 mole ratio, then convert O_2 moles to grams

Formula: $n_{\text{CH}_4} = q/|\Delta H|$, $n_{\text{O}_2} = 2n_{\text{CH}_4}$, and $m = n \cdot M$

Calculations: $n_{\text{CH}_4} = 500 \text{ kJ} / 890 \text{ kJ/mol} = 0.562 \text{ mol}$. $n_{\text{O}_2} = 2(0.562) = 1.12 \text{ mol}$. $m_{\text{O}_2} = (1.12 \text{ mol})(32.00 \text{ g/mol}) = 36.0 \text{ g}$

The heat value is given to three significant figures if 500 is interpreted as 500. kJ in an exam context. The final answer is reported to three significant figures

Final answer: 36.0 g O_2

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Problem 45 Solution

Given: The reaction is $2 \text{C}_4\text{H}_{10(g)} + 13 \text{O}_{2(g)} \rightarrow 8 \text{CO}_{2(g)} + 10 \text{H}_2\text{O}_{(l)}$. The given ΔH°_f values are for $\text{C}_4\text{H}_{10(g)}$, $\text{CO}_{2(g)}$, and $\text{H}_2\text{O}_{(l)}$. The target heat release is 250 kJ

Find: The combustion enthalpy for the equation and the mass of C_4H_{10} needed to release 250 kJ

Method: Calculate ΔH_{rxn} using formation enthalpies. Then divide by 2 to get the heat per mole of butane and convert the required moles into mass

Formula: $\Delta H^\circ_{\text{rxn}} = \sum n \cdot \Delta H^\circ_f(\text{products}) - \sum n \cdot \Delta H^\circ_f(\text{reactants})$, $n = q/|\Delta H \text{ per mol}|$, and $m = n \cdot M$

Calculations: Products: $8(-393.5) + 10(-285.8) = -6006.0 \text{ kJ}$. Reactants: $2(-125.6) + 13(0) = -251.2 \text{ kJ}$. $\Delta H^\circ_{\text{rxn}} = -6006.0 - (-251.2) = -5754.8 \text{ kJ}$ for 2 mol C_4H_{10} . Per mole C_4H_{10} , $\Delta H = -2877.4 \text{ kJ/mol}$. $n = 250 \text{ kJ} / 2877.4 \text{ kJ/mol} = 0.0869 \text{ mol}$. $m = (0.0869 \text{ mol})(58.12 \text{ g/mol}) = 5.05 \text{ g}$

The equation enthalpy belongs to 2 mol of butane, not 1 mol, so dividing by 2 is essential. The final mass is rounded to three significant figures

Final answer: $\Delta H_{\text{rxn}} = -5754.8 \text{ kJ}$; 5.05 g C_4H_{10}

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Section 4 - Answer Key

Problem	Answer
8	185 kJ released
16	7.21 g H ₂ O
32	36.0 g O ₂
45	$\Delta H_{\text{rxn}} = -5754.8 \text{ kJ}$; 5.05 g C ₄ H ₁₀

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