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CHEMISTRY WORKSHEET

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

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Section 2 - Practice Problems

PART A - FUNDAMENTAL PROBLEMS (PROBLEMS 1-15)

Problem 8

Ammonia forms according to the equation below

$$N_{2(g)} + 3\ H_{2(g)} \rightarrow 2\ NH_{3(g)},\ \Delta H_{rxn} = -92.4\ kJ$$

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

$$CH_{4(g)} + 2\ O_{2(g)} \rightarrow C_{O2}(g) + 2\ H_2O_{(l)},\ \Delta H_{rxn} = -890\ kJ$$

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 ΔH_{rxn} = -890 kJ for the reaction below

$$CH_{4(g)} + 2\ O_{2(g)} \rightarrow C_{O2}(g) + 2\ H_2O_{(l)}$$

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

$$2\ C_4H_{10(g)} + 13\ O_{2(g)} \rightarrow 8\ C_{O2}(g) + 10\ H_2O_{(l)}$$

Use $\Delta H^{\circ}_f[C_4H_{10(g)}]$ = -125.6 kJ/mol, $\Delta H^{\circ}_f[C_{O2}(g)]$ = -393.5 kJ/mol, and $\Delta H^{\circ}_f[H_2O_{(l)}]$ = -285.8 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 $N_{2(g)}$ + 3 $H_{2(g)}$ → 2 $NH_{3(g)}$, and ΔH_{rxn} = -92.4 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: $q = n_{NH3} \cdot (\Delta H / 2 \text{ mol } NH_3)$

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 $CH_{4(g)}$ + 2 $O_{2(g)}$ → C_{O2}(g) + 2 $H_2O_{(l)}$, with ΔH_{rxn} = -890 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: $n_{H2O} = q\cdot(2 \text{ mol } H_2O / 890 \text{ kJ})$ and $m = n\cdot M$

Calculations: n_{H2O} = 178 kJ·(2 mol / 890 kJ) = 0.400 mol. m_{H2O} = (0.400 mol)(18.02 g/mol) = 7.21 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 $CH_{4(g)} + 2\ O_{2(g)} \rightarrow C_{O2}(g) + 2\ H_2O_{(l)}$ 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: $n_{CH4} = q/|\Delta H|$, $n_{O2} = 2nCH4$, and $m = n \cdot M$

Calculations: n_{CH4} = 500 kJ / 890 kJ/mol = 0.562 mol. n_{O2} = 2(0.562) = 1.12 mol. m_{O2} = (1.12 mol)(32.00 g/mol) = 36.0 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 $C_4H_{10(g)}$ + 13 $O_{2(g)}$ → 8 C_{O2}(g) + 10 $H_2O_{(l)}$. The given ΔH°_f values are for $C_4H_{10(g)}$, C_{O2}(g), and $H_2O_{(l)}$. 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: $\Delta H^\circ_{rxn} = \Sigma\, n \cdot \Delta H^\circ_f(\text{products}) - \Sigma\, n \cdot \Delta H^\circ_f(\text{reactants})$, $n = q/|\Delta H \text{ per mol}|$, and $m = n \cdot M$

Calculations: Products: 8(-393.5) + 10(-285.8) = -6006.0 kJ. Reactants: 2(-125.6) + 13(0) = -251.2 kJ. ΔH°_{rxn} = -6006.0 - (-251.2) = -5754.8 kJ for 2 mol C_4H_{10}. Per mole C_4H_{10}, ΔH = -2877.4 kJ/mol. n = 250 kJ / 2877.4 kJ/mol = 0.0869 mol. m = (0.0869 mol)(58.12 g/mol) = 5.05 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: ΔH_{rxn} = -5754.8 kJ; 5.05 g C_4H_{10}

Section 4 - Answer Key

Problem	Answer
8	185 kJ released
16	7.21 g H_2O
32	36.0 g O_2
45	ΔH_{rxn} = -5754.8 kJ; 5.05 g C_4H_{10}

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