

HL Paper 2

Enthalpy changes depend on the number and type of bonds broken and formed.

The table lists the standard enthalpies of formation, $\Delta_f H^\ominus$, for some of the species in the reaction above.

	$\text{CH}_4(\text{g})$	$\text{H}_2\text{O}(\text{g})$	$\text{CO}(\text{g})$	$\text{H}_2(\text{g})$
$\Delta_f H^\ominus / \text{kJ mol}^{-1}$	-74.0	-242	-111	

Enthalpy changes depend on the number and type of bonds broken and formed.

a. Hydrogen gas can be formed industrially by the reaction of natural gas with steam. [3]



Determine the enthalpy change, ΔH , for the reaction, in kJ, using section 11 of the data booklet.

Bond enthalpy for $\text{C}\equiv\text{O}$: 1077 kJ mol^{-1}

b.i. Outline why no value is listed for $\text{H}_2(\text{g})$. [1]

b.ii. Determine the value of $\Delta H^\ominus$, in kJ, for the reaction using the values in the table. [1]

c. The table lists standard entropy, $S^\ominus$, values. [1]

	$\text{CH}_4(\text{g})$	$\text{H}_2\text{O}(\text{g})$	$\text{CO}(\text{g})$	$\text{H}_2(\text{g})$
$S^\ominus / \text{J K}^{-1} \text{mol}^{-1}$	+186	+189	+108	+131

Calculate the standard entropy change for the reaction, $\Delta S^\ominus$, in J K^{-1} .



d. Calculate the standard free energy change, $\Delta G^\ominus$, in kJ, for the reaction at 298 K using your answer to (b)(ii). [1]

e. Determine the temperature, in K, above which the reaction becomes spontaneous. [1]

Markscheme

a. bonds broken: $4(\text{C}-\text{H}) + 2(\text{H}-\text{O})/4(414) + 2(463)/2582 \text{ kJ}$

bonds made: $3(\text{H}-\text{H}) + \text{C}\equiv\text{O}/3(436) + 1077/2385 \text{ kJ}$

$$\Delta H = \text{IBE}_{\text{bonds broken}} - \text{IBE}_{\text{bonds made}} = 2582 - 2385 = -197 \text{ kJ}$$

Award [3] for correct final answer.

Award [2 max] for -197 kJ.

[3 marks]

M12 Ms Mathematic Hl Paper2 Tz1

AW Rasmussen



M12 Ms Mathematic HI Paper2 Tz1:

The book delves into M12 Ms Mathematic Hl Paper2 Tz1. M12 Ms Mathematic Hl Paper2 Tz1 is a vital topic that needs to be grasped by everyone, ranging from students and scholars to the general public. The book will furnish comprehensive and in-depth insights into M12 Ms Mathematic Hl Paper2 Tz1, encompassing both the fundamentals and more intricate discussions.

1. This book is structured into several chapters, namely:

- Chapter 1: Introduction to M12 Ms Mathematic Hl Paper2 Tz1
- Chapter 2: Essential Elements of M12 Ms Mathematic Hl Paper2 Tz1
- Chapter 3: M12 Ms Mathematic Hl Paper2 Tz1 in Everyday Life
- Chapter 4: M12 Ms Mathematic Hl Paper2 Tz1 in Specific Contexts
- Chapter 5: Conclusion

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5. In chapter 4, this book will scrutinize the relevance of M12 Ms Mathematic Hl Paper2 Tz1 in specific contexts. This chapter will explore how M12 Ms Mathematic Hl Paper2 Tz1 is applied in specialized fields, such as education, business, and technology.

6. In chapter 5, this book will draw a conclusion about M12 Ms Mathematic Hl Paper2 Tz1. This chapter will summarize the key points that have been discussed throughout the book.

The book is crafted in an easy-to-understand language and is complemented by engaging illustrations. It is highly recommended for anyone seeking to gain a comprehensive understanding of M12 Ms Mathematic Hl Paper2 Tz1.

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