

15.2 Entropy & Spontaneity

Question Paper

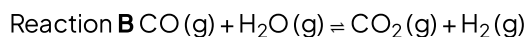
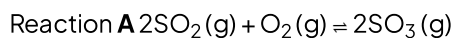
Course	DPIB Chemistry
Section	15. Energetics/Thermochemistry (HL only)
Topic	15.2 Entropy & Spontaneity
Difficulty	Hard

Time allowed: 50
Score: /41
Percentage: /100

Question 1a

a)

The equations for two separate reversible reactions are as follows:

Use the information in the following table to determine the enthalpy change, ΔH_r , for reaction **A**.

	SO_2	O_2	SO_3	H_2
$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	-296.8	0	-395.7	0
$S^\ominus / \text{JK}^{-1} \text{mol}^{-1}$	248.2	205.1	256.8	130.6

[2]

[2 marks]

Question 1b

b)

Using the information from the table in part a), calculate the standard entropy change, ΔS , of reaction **A**.

[2]

[2 marks]

Question 1c

c)

Use your answer to parts a) and b) to determine the temperature at which reaction **A** becomes feasible.

[2 marks]

Question 1d

d)

By using the data from part a) and section 12 of the data booklet, deduce if reaction **B** is feasible at a low temperature.

[4]

[4 marks]

Question 2a

a)

Magnesium carbonate decomposes at a relatively high temperature.

	MgCO ₃	MgO
$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	-1095.8	-601.7
$\Delta S^\ominus / \text{J mol}^{-1}$	65.7	26.9

i)

Write an equation for the decomposition and use section 12 of the data booklet and the information given to determine the enthalpy change for the decomposition of magnesium carbonate.

[3]

ii)

Use section 12 of the data booklet and the information given to determine the standard entropy change for the decomposition of magnesium carbonate.

[2]

[5 marks]

Question 2b

b)
Using your answer to part a) to determine if the decomposition of magnesium carbonate is feasible at 280 °C.

[1]

[1 mark]

Question 2c

c)
Using your answer to part b) to determine the temperature, in °C, at which the decomposition of magnesium carbonate becomes feasible.

[3]

[3 marks]

Question 3a

a)

Used in the production of polymers, methanol is manufactured in large quantities.

i)

State the equation for the combustion of methanol.

[1]

ii)

Comment on the entropy change of the reaction.

[2]

[3 marks]

Question 3b

b)

Use section 12 of the data booklet to determine the enthalpy change, ΔH_r , for the production of methanol from carbon monoxide and hydrogen.

[3]

[3 marks]

Question 3c

c)

Use your answer to part b) and section 12 of the data booklet to calculate the free energy change, ΔG , for the formation of methanol from carbon monoxide and hydrogen at 300 K.

[3]

[3 marks]

Question 3d

d)

A student states that if the temperature is lowered for the formation of methanol, the reaction will become non-spontaneous. Comment on the student's statement.

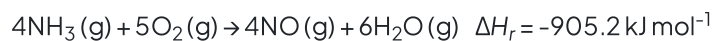
[4]

[4 marks]

Question 4a

a)

The Ostwald process to produce nitric acid involves the oxidation of ammonia. The equation is shown below:



	$\text{NH}_3(\text{g})$	$\text{O}_2(\text{g})$
$S^\ominus(\text{J K}^{-1} \text{ mol}^{-1})$	192.5	205

The free energy change, ΔG^\ominus , for the oxidation of ammonia at 298 K is -959 kJ mol^{-1} .

Use section 12 of the data booklet, to calculate the entropy change for the oxidation of ammonia in $\text{J K}^{-1} \text{ mol}^{-1}$.

[3]

[3 marks]

Question 4b

b)
Use your answer to part a) and section 12 of the data booklet to determine the standard entropy of nitric oxide gas.

[3]

[3 marks]

Question 4c

c)
A 1.00 mol sample of NOCl was placed in reactor and heated to 227°C until the system reached equilibrium. The value for the equilibrium constant at this temperature is K_c is $4.5 \times 10^{-4} \text{ mol dm}^{-3}$.



Write an expression for K_c .

[1]

[1 mark]

Question 4d

d)
Using section 1 and 2 in the data booklet determine the value for the free energy change, ΔG^\ominus , in kJ mol^{-1} for the reaction in part c).

[2]

[2 marks]



Head to [savemyexams.co.uk](https://www.savemyexams.co.uk) for more awesome resources