

APOLLO

Entropy and spontaneity (Additional higher level)

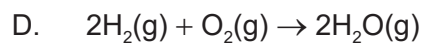
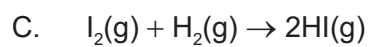
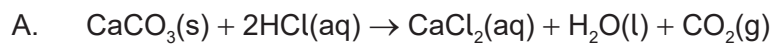
HL

Chemistry

First assessment 2025

9 questions | questions

25. Which of the following reactions will have the largest positive change in entropy?



— 15 —

2225-0201

21. Which change results in a decrease in entropy?

- A. $\text{N}_2\text{H}_4(\text{l}) \rightarrow \text{N}_2(\text{g}) + 2\text{H}_2(\text{g})$
- B. $\text{K}_2\text{Cr}_2\text{O}_7(\text{s}) \rightarrow \text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$
- C. $\text{MgCO}_3(\text{s}) \rightarrow \text{MgO}(\text{s}) + \text{CO}_2(\text{g})$
- D. $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g})$

22. Which value indicates an equilibrium reaction?

A. $\Delta S = 0 \text{ J K}^{-1} \text{ mol}^{-1}$

B. $\Delta G = 0 \text{ kJ mol}^{-1}$

C. $\Delta H = 0 \text{ kJ mol}^{-1}$

D. $\Delta T = 0 \text{ K}$

23. In which reaction does entropy decrease?

- A. $\text{KBr(s)} \rightarrow \text{KBr(aq)}$
- B. $\text{NH}_3\text{(g)} + \text{HCl(g)} \rightarrow \text{NH}_4\text{Cl(s)}$
- C. $\text{Mg(s)} + \text{H}_2\text{SO}_4\text{(aq)} \rightarrow \text{MgSO}_4\text{(aq)} + \text{H}_2\text{(g)}$
- D. $\text{CaCO}_3\text{(s)} \rightarrow \text{CaO(s)} + \text{CO}_2\text{(g)}$

24. What are the signs of ΔH and ΔS for a reaction that is non-spontaneous at low temperatures but spontaneous at high temperatures?

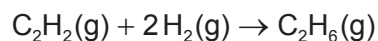
	ΔH	ΔS
A.	+	–
B.	–	–
C.	+	+
D.	–	+

– 10 –

Turn over
2225-0213

5. Ethyne, C_2H_2 , is a useful raw material in the synthesis of organic compounds.

- (a) (i) Calculate the standard enthalpy change, in kJ mol^{-1} , of the complete hydrogenation of ethyne to produce ethane. Use section 14 of the data booklet. [2]



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- (ii) Calculate the temperature at which this reaction is no longer spontaneous. [2]

Use your answer to part (a)(i) and section 1 of the data booklet.

The standard entropy change of this reaction is $\Delta S^\ominus = -233 \text{ JK}^{-1} \text{ mol}^{-1}$.

If you did not obtain an answer to part (a)(i) then use the value $-80.0 \text{ kJ mol}^{-1}$, although this is not the correct answer.

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(This question continues on the following page)



(Question 5 continued)

- (b) 140.0 cm^3 of ethyne are reacted with 160.0 cm^3 of hydrogen in a container at 420 K and $1.00 \times 10^5\text{ Pa}$. Ethane is the only product.

Determine the maximum possible volume of ethane formed under these conditions of temperature and pressure.

[2]

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- (c) (i) Draw the Lewis formula of C_2H_2 .

[1]

- (ii) State the hybridization of the carbon atom in C_2H_2 .

[1]

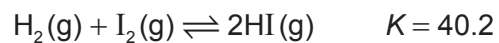
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**Turn over**

24. Which reaction is predicted to occur with the largest decrease in entropy?

- A. $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$
- B. $\text{N}_2(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow 2\text{NO}_2(\text{g})$
- C. $6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{g}) \rightarrow \text{C}_6\text{H}_{12}\text{O}_6(\text{s}) + 6\text{O}_2(\text{g})$
- D. $\text{CO}(\text{g}) + 2\text{H}_2(\text{g}) \rightarrow \text{CH}_3\text{OH}(\text{l})$

28. What is the value of the Gibbs energy change, ΔG , in kJ mol^{-1} , for the reaction between hydrogen and iodine gases at 30°C ?



$$\Delta G = -RT \ln K \quad R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$$

- A. -9300
- B. -921
- C. -9.30
- D. -0.921

— 14 —

Turn over

0020-0213

24. What is correct as a system approaches equilibrium?

- A. Q remains constant.
- B. K_c increases.
- C. $\Delta G^\ominus$ becomes more negative.
- D. ΔG approaches zero.