

1 The value of  $E_{\text{cell}}$  indicates whether the cell reaction is thermodynamically feasible. Which of the following is a correct statement about  $E_{\text{cell}}$ ?

- A  $E_{\text{cell}}$  is directly proportional to the equilibrium constant.
- B  $E_{\text{cell}}$  is directly proportional to the entropy change of the system,  $\Delta S_{\text{system}}$ .
- C  $E_{\text{cell}}$  is directly proportional to the total entropy change,  $\Delta S_{\text{total}}$ .
- D The value of  $\ln E_{\text{cell}}$  is directly proportional to the total entropy change,  $\Delta S_{\text{total}}$ .

**(Total for Question = 1 mark)**

2 The enthalpy changes of the reactions below are similar. The equilibrium constants for the two reactions are  $K_1$  and  $K_2$  respectively.

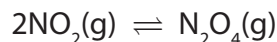


The value of  $K_1$  is greater than  $K_2$  because

- A  $\Delta S_{\text{system}}$  is much more positive in Reaction 1.
- B  $\Delta S_{\text{surroundings}}$  is much more positive in Reaction 1.
- C the  $\text{EDTA}^{4-}$  is more highly charged than  $\text{Cl}^{-}$ .
- D a lower concentration of  $\text{EDTA}^{4-}$  is needed than  $\text{Cl}^{-}$ .

**(Total for Question = 1 mark)**

3 For the reaction



at 450 K the total entropy change,  $\Delta S_{\text{total}}$ , is negative. Hence the equilibrium constant,  $K_p$ , for this reaction at 450 K is

- A zero.
- B positive and greater than 1.
- C positive and less than 1.
- D negative.

**(Total for Question = 1 mark)**

4 The overall equation for a reaction between two chemicals, M and N, is



(a) This reaction occurs spontaneously at room temperature. Which of the following **must** be true?

(1)

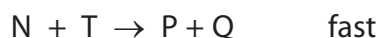
**A**  $\Delta H_{\text{reaction}}^{\ominus}$  is positive.

**B**  $\Delta H_{\text{reaction}}^{\ominus}$  is negative.

**C**  $\Delta S_{\text{total}}^{\ominus}$  is positive.

**D**  $\Delta S_{\text{total}}^{\ominus}$  is negative.

(b) The reaction above occurs in two stages via an intermediate, T.



From this it can be deduced that the rate equation for the reaction between M and N is

(1)

**A** rate =  $k[M][N]$

**B** rate =  $k[M][N]^2$

**C** rate =  $k[M][T]$

**D** rate =  $k[N][T]$

**(Total for Question = 2 marks)**

- 5 Calcium carbonate decomposes at high temperature to form calcium oxide and carbon dioxide:



Calcium carbonate is **thermodynamically** stable at room temperature because for this reaction

- A the activation energy is high.
- B the enthalpy change,  $\Delta H$ , is positive.
- C entropy change of the system ( $\Delta S_{\text{system}}$ ) is positive.
- D entropy change of the system ( $\Delta S_{\text{system}}$ ) is negative.

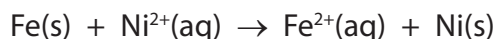
**(Total for Question = 1 mark)**

- 6 2-methylpropane has a smaller standard molar entropy at 298 K than butane. The best explanation for this is that 2-methylpropane has

- A a lower boiling temperature.
- B a higher standard molar enthalpy change of formation.
- C fewer ways of distributing energy quanta.
- D more ways of distributing energy quanta.

**(Total for Question = 1 mark)**

- 7 The equation for the reaction of iron and nickel(II) ions in aqueous solution is

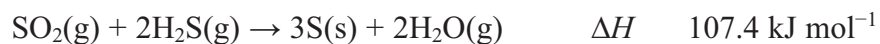


Under standard conditions the value of the equilibrium constant,  $K_c$ , for this reaction is greater than 1. Hence, for this reaction,

- A  $\Delta S_{\text{total}}^{\ominus}$  and  $E_{\text{reaction}}^{\ominus}$  are both positive.
- B  $\Delta S_{\text{total}}^{\ominus}$  is positive and  $E_{\text{reaction}}^{\ominus}$  is negative.
- C  $\Delta S_{\text{total}}^{\ominus}$  is negative and  $E_{\text{reaction}}^{\ominus}$  is positive.
- D  $\Delta S_{\text{total}}^{\ominus}$  and  $E_{\text{reaction}}^{\ominus}$  are both negative.

**(Total for Question = 1 mark)**

- 8 The reaction below is carried out at 25 °C. Use the equation and the data to answer the questions that follow.



Substance	Standard molar entropy, $S^\ominus$ / $\text{J mol}^{-1} \text{K}^{-1}$
$\text{SO}_2(\text{g})$	248
$\text{H}_2\text{S}(\text{g})$	206
$\text{H}_2\text{O}(\text{g})$	189
$\text{S}(\text{s})$	32

- (a) The standard entropy change of the system, in  $\text{J mol}^{-1} \text{K}^{-1}$ , is (1)

- A 186  
 B +186  
 C 233  
 D +233

- (b) The standard entropy change of the surroundings, in  $\text{J mol}^{-1} \text{K}^{-1}$ , is (1)

- A  $107.4 \times 1000 / 25$   
 B  $107.4 \times 1000 / 25$   
 C  $107.4 \times 1000 / 298$   
 D  $107.4 \times 1000 / 298$

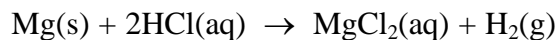
**(Total for Question 2 marks)**

9 A decrease in the entropy of the system,  $\Delta S_{\text{system}}$ , occurs when

- A water freezes.
- B water boils.
- C water reacts with sodium.
- D water reacts with ethanoyl chloride.

(Total for Question 1 mark)

10 Which of the following is true for the exothermic reaction shown below?



- A  $\Delta H$  positive
- B  $\Delta S_{\text{surroundings}}$  positive
- C  $\Delta S_{\text{system}}$  negative
- D  $\Delta S_{\text{total}}$  negative

(Total for Question = 1 mark)

11 Which of these solid substances is likely to have the greatest standard entropy? Use of the data booklet is not required.

- A SnO
- B SnO<sub>2</sub>
- C SnBr<sub>2</sub>
- D SnBr<sub>4</sub>

(Total for Question 1 mark)

12 Which reaction has the most positive entropy change for the system,  $\Delta S_{\text{system}}$ ?

- A  $\text{NaOH(aq)} + \text{HCl(aq)} \rightarrow \text{NaCl(aq)} + \text{H}_2\text{O(l)}$
- B  $\text{AgNO}_3\text{(aq)} + \text{NaCl(aq)} \rightarrow \text{AgCl(s)} + \text{NaNO}_3\text{(aq)}$
- C  $\text{C}_2\text{H}_4\text{(g)} + \text{HCl(g)} \rightarrow \text{C}_2\text{H}_5\text{Cl(l)}$
- D  $\text{C}_4\text{H}_{10}\text{(g)} \rightarrow \text{C}_2\text{H}_4\text{(g)} + \text{C}_2\text{H}_6\text{(g)}$

(Total for Question 1 mark)

13 Barium carbonate decomposes in an endothermic reaction when heated to 1500 K.



What are the signs of the entropy changes at 1500 K?

		$\Delta S_{\text{system}}$	$\Delta S_{\text{surroundings}}$
<input type="checkbox"/>	<b>A</b>	+	+
<input type="checkbox"/>	<b>B</b>	+	
<input type="checkbox"/>	<b>C</b>		+
<input type="checkbox"/>	<b>D</b>		

(Total for Question 1 mark)

14 When ammonium nitrate crystals dissolve in water, the entropy of the system

- A remains the same.
- B falls, because the hydrated ions are more ordered than the solid.
- C rises, because the ions in the crystal become hydrated in the solution.
- D rises, because the ions are arranged more randomly in the solution than in the crystal.

(Total for Question = 1 mark)