23.3 ENTROPY CHANGE

https://subarnam.com.np/

1. Define entropy.

……

…… [1]

2. Explain what is meant by entropy, *S*.

……

…… [1]

3. The three physical states of H_2O have different standard entropies, $\Delta S^{\ominus}$, associated with them.
Table 2.1 shows these $\Delta S^{\ominus}$ values.

state of H_2O standard entropy,	$\Delta S^{\ominus}$ / J K^{-1} mol^{-1}
solid	+48.0
liquid	+70.1
gas	+188.7

(i) Explain the difference in the $\Delta S^{\ominus}$ values of $H_2O(s)$ and $H_2O(l)$.

……

…… [1]

(ii) Explain why the increase in $\Delta S^{\ominus}$ is much greater when H_2O boils than when it melts.

……

…… [1]

4. Fig. 3.1 shows how the entropy, S, of a pure substance changes with temperature, T.

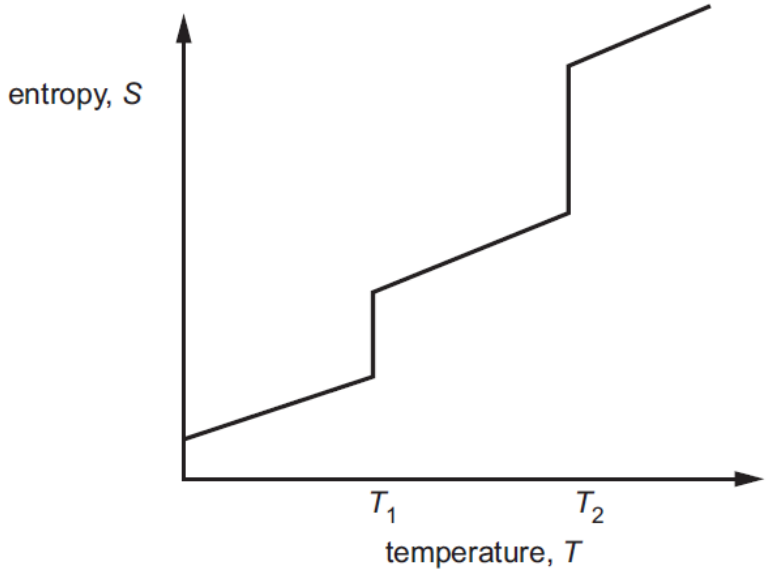

Fig. 3.1

Identify the process occurring at each of the temperatures T1 and T2.

T1 ..... T2 ..... [1]

(ii) Explain why the entropy change, ΔS, at T2 is bigger than the entropy change at T1.

…….....

…….....

……..... [1]

Signs of Entropy changes

5. Silicon is the second most abundant element by mass in the Earth's crust.
In industry, silicon is extracted from SiO_2 by reaction with carbon at over 2000 ° C.
reaction 1 $SiO_2(s) + 2C(s) \rightarrow Si(l) + 2CO(g)$
Explain why the entropy change, Δ S, of reaction 1 is positive.

…….....

……..... [1]

6. Hydrogen peroxide is a liquid at 298 K. It is moderately stable under room conditions but will decompose quickly if a catalyst is added.
reaction 1 $2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$
Predict the sign of the standard entropy change of reaction 1.
Explain your answer.

sign .....

explanation .....

…….....[1]

7. The feasibility of a chemical reaction depends on the standard Gibbs free energy change, $\Delta G^{\ominus}$.
This is dependent on the standard enthalpy and entropy changes, and the temperature.
State and explain whether the following processes will lead to an increase or decrease in entropy.
(i) the reaction of magnesium with hydrochloric acid

entropy change .....

explanation ..... [1]

(ii) the dissolving of solid potassium chloride in water

entropy change .....

explanation ..... [1]

(iii) the condensing of water from steam

entropy change .....

explanation ..... [1]

8. Calcium fluoride, $CaF_2(s)$, can be synthesised directly from its elements.
The value of $\Delta H_f^{\ominus}$ ($CaF_2(s)$) is –1214 kJ mol^{-1}.
Predict the sign of the entropy change, Δ S o, for this synthesis. Explain your answer.

The sign of the entropy change is ..... .

explanation .....

.....[1]

9. State and explain whether the entropy change of each of the following processes is positive or negative. Do not consider the entropy change of the surroundings.

●● l iquid water at 80 ° C is cooled to 60 ° C

The entropy change is ..... because .....

…….....

●● solid calcium chloride is added to water, and the mixture is stirred

The entropy change is ……..... because .....

…….....

●● the change corresponding to the lattice energy of calcium chloride, ΔH_{latt} $CaCl_2(s)$, takes place

The entropy change is ..... because .....

..... [3]

Calculating entropy changes

10. Some bond energy data are shown in Table 3.1.

type of bond	bond energy / kJ mol^{-1}
O–O	150
O–H	460
O=O	496

Use the data in Table 3.1 to show that the enthalpy change of the following reaction is –196 kJ mol^{-1}.

$2H_2O_2(g) \rightarrow 2H_2O(g) + O_2(g)$ [1]

11. The standard entropies, ΔS, of three species are given in the table.

species	$\Delta S^{\ominus}$ = / J K^{-1} mol^{-1}
HCl (g)	+187
$H_2(g)$	+131
$Cl_2(g)$	+223

(i) Calculate $\Delta S^{\ominus}$ for the reaction $2HCl\ (g) \rightarrow H_2(g) + Cl_2(g)$.

$\Delta S^{\ominus}$ = ... (ans = -20) ..... J K–1 mol^{-1} [1]

12. KI slowly oxidises in air, forming I_2.
reaction 1 $4KI(s) + 2CO_2(g) + O_2(g) \rightarrow 2K_2CO_3(s) + 2I_2(s)$ $\Delta H^{\ominus} = -203.4$ kJ mol^{-1}
Table 1.2 shows some data relevant to this question.

substance	standard entropy, $\Delta S^{\ominus}$ / J K^{-1} mol^{-1}
$CO_2(g)$	213.6
$I_2(s)$	116.1
$K_2CO_3(s)$	155.5
KI(s)	106.3
O2(g)	205.2

(i) Calculate the standard entropy change, $\Delta S^{\ominus}$, of reaction 1.

$\Delta S^{\ominus}$ = ...(ans= -514.4)..... J K–1 mol^{-1} [2]

13. Zinc metal can be obtained in a two-step process as shown.
step 1 $2ZnS(s) + 3O_2(g) \rightleftharpoons 2ZnO(s) + 2SO_2(g)$
step 2 $ZnO(s) + C(s) \rightleftharpoons Zn(l) + CO(g)$
The reactions are carried out at 800 °C.
(i) Predict the sign of the entropy change, ΔS^{o} , of the reaction in step 1.
Explain your answer.

…….....

……..... [1]

(ii) Use the data in Table 1.1 to calculate ΔS^{o} of the reaction shown in step 2.

chemical	ZnO(s)	C(s)	Zn(l)	CO(g)
$S^{\ominus}$ / J K^{-1} mol^{-1}	43.7	5.7	50.8	197.7

ΔS^{o} = ... (ans =199.1)..... J K^{-1} mol^{-1} [1]

*****This is not a complete note. It is just to guide you. It is recommended to study the prescribed textbooks along with this material. *****