Essential Pre-Uni Chemistry G1.6

A Level

Use the following standard molar entropy values in $\mathrm{J\,K^{-1}\,mol^{-1}}$ to help answer the questions in this section.

$\mathrm{H_2O\,(l)}$	69.9	$\mathrm{HCl\,(g)}$	186.8	$\mathrm{NaCl\,(s)}$	72.1
$\mathrm{H_2O\,(g)}$	188.7	$\mathrm{Cl_2\,(g)}$	223.1	$\mathrm{ZnCl_2\,(s)}$	111.5
$\mathrm{H_2\,(g)}$	130.7	$\mathrm{H_2SO_4\,(l)}$	156.9	$\mathrm{Zn\,(s)}$	41.6
$\mathrm{Na\,(s)}$	51.2	$\mathrm{Zn\,(g)}$	150.0	$\mathrm{NaHSO_4\,(s)}$	113.0
$\mathrm{O_2\,(g)}$	205.2	$\mathrm{CO_2\,(g)}$	213.6	$\mathrm{C\,(s)}$ *graphite*	5.7

Calculate the entropy of $1.00\,\mathrm{kg}$ of solid zinc.

Essential Pre-Uni Chemistry G1.8

A Level

Use the following standard molar entropy values in $\mathrm{J\,K^{-1}\,mol^{-1}}$ to help answer the questions in this section.

$\mathrm{H_2O\,(l)}$	69.9	$\mathrm{HCl\,(g)}$	186.8	$\mathrm{NaCl\,(s)}$	72.1
$\mathrm{H_2O\,(g)}$	188.7	$\mathrm{Cl_2\,(g)}$	223.1	$\mathrm{ZnCl_2\,(s)}$	111.5
$\mathrm{H_2\,(g)}$	130.7	$\mathrm{H_2SO_4\,(l)}$	156.9	$\mathrm{Zn\,(s)}$	41.6
$\mathrm{Na\,(s)}$	51.2	$\mathrm{Zn\,(g)}$	150.0	$\mathrm{NaHSO_4\,(s)}$	113.0
$\mathrm{O_2\,(g)}$	205.2	$\mathrm{CO_2\,(g)}$	213.6	$\mathrm{C\,(s)}$ *graphite*	5.7

Calculate the mass of sodium chloride that has standard entropy of $100\,\mathrm{J\,K^{-1}}$.

Essential Pre-Uni Chemistry G1.10

A Level

Use the following standard molar entropy values in $\mathrm{J\,K^{-1}\,mol^{-1}}$ to help answer the questions in this section.

$\mathrm{H_2O\,(l)}$	69.9	$\mathrm{HCl\,(g)}$	186.8	$\mathrm{NaCl\,(s)}$	72.1
$\mathrm{H_2O\,(g)}$	188.7	$\mathrm{Cl_2\,(g)}$	223.1	$\mathrm{ZnCl_2\,(s)}$	111.5
$\mathrm{H_2\,(g)}$	130.7	$\mathrm{H_2SO_4\,(l)}$	156.9	$\mathrm{Zn\,(s)}$	41.6
$\mathrm{Na\,(s)}$	51.2	$\mathrm{Zn\,(g)}$	150.0	$\mathrm{NaHSO_4\,(s)}$	113.0
$\mathrm{O_2\,(g)}$	205.2	$\mathrm{CO_2\,(g)}$	213.6	$\mathrm{C\,(s)}$ *graphite*	5.7

Calculate the total entropy of $250\,\mathrm{cm^3}$ of hydrogen and $500\,\mathrm{cm^3}$ of chlorine held separately at room temperature and pressure.

Essential Pre-Uni Chemistry G2.1

A Level

Use the following standard molar entropy values in $\mathrm{J\,K^{-1}\,mol^{-1}}$ to help answer the questions in this section.

$\mathrm{H_2O\,(l)}$	69.9	$\mathrm{HCl\,(g)}$	186.8	$\mathrm{NaCl\,(s)}$	72.1
$\mathrm{H_2O\,(g)}$	188.7	$\mathrm{Cl_2\,(g)}$	223.1	$\mathrm{ZnCl_2\,(s)}$	111.5
$\mathrm{H_2\,(g)}$	130.7	$\mathrm{H_2SO_4\,(l)}$	156.9	$\mathrm{Zn\,(s)}$	41.6
$\mathrm{Na\,(s)}$	51.2	$\mathrm{Zn\,(g)}$	150.0	$\mathrm{NaHSO_4\,(s)}$	113.0
$\mathrm{O_2\,(g)}$	205.2	$\mathrm{CO_2\,(g)}$	213.6	$\mathrm{C\,(s)}$ *graphite*	5.7

Calculate the standard entropy change per mole for the following reactions:

Part A **(a)**

$\mathrm{H_2O\,(l)} \longrightarrow \mathrm{H_2O\,(g)}$ Give your answer to 1 decimal place.

Part B **(b)**

$\mathrm{Zn\,(s)} + \mathrm{Cl_2\,(g)} \longrightarrow \mathrm{ZnCl_2\,(s)}$ Give your answer to 1 decimal place.

Part C **(c)**

$\mathrm{H_2\,(g) + Cl_2\,(g) \longrightarrow 2\,HCl\,(g)}$ Give your answer to 1 decimal place.

Part D **(d)**

$\mathrm{NaCl\,(s) + H_2SO_4\,(l) \longrightarrow NaHSO_4\,(s) + HCl\,(g)}$ Give your answer to 1 decimal place.

Part E **(e)**

$\mathrm{Zn\,(s) + 2\,HCl\,(g) \longrightarrow ZnCl_2\,(s) + H_2\,(g)}$ Give your answer to 1 decimal place.

Essential Pre-Uni Chemistry G2.2

A Level

Use the following standard molar entropy values in $\mathrm{J\,K^{-1}\,mol^{-1}}$ to help answer the questions in this section.

$\mathrm{H_2O\,(l)}$	69.9	$\mathrm{HCl\,(g)}$	186.8	$\mathrm{NaCl\,(s)}$	72.1
$\mathrm{H_2O\,(g)}$	188.7	$\mathrm{Cl_2\,(g)}$	223.1	$\mathrm{ZnCl_2\,(s)}$	111.5
$\mathrm{H_2\,(g)}$	130.7	$\mathrm{H_2SO_4\,(l)}$	156.9	$\mathrm{Zn\,(s)}$	41.6
$\mathrm{Na\,(s)}$	51.2	$\mathrm{Zn\,(g)}$	150.0	$\mathrm{NaHSO_4\,(s)}$	113.0
$\mathrm{O_2\,(g)}$	205.2	$\mathrm{CO_2\,(g)}$	213.6	$\mathrm{C\,(s)}$ *graphite*	5.7

Calculate the standard entropy change when...

Part A **(a)**

$2.50\,\mathrm{mol}$ of solid zinc chloride decomposes into its gaseous elements.

Part B **(b)**

$2.0\,\mathrm{g}$ of sodium reacts fully with chlorine gas.

Part C **(c)**

$10.0\,\mathrm{mg}$ of zinc vapour deposits onto a surface.

Part D **(d)**

$40.0\,\mathrm{m}^3$ (at RTP) of steam condenses. Give your answer to 3 significant figures.

Part E **(e)**

$200\,\mathrm{cm}^3$ of water $(1.00\,\mathrm{g\,cm}^{-3})$ is electrolysed.

Essential Pre-Uni Chemistry G2.3

A Level

Use the following standard molar entropy values in $\mathrm{J\,K^{-1}\,mol^{-1}}$ to help answer the questions in this section.

$\mathrm{H_2O\,(l)}$	69.9	$\mathrm{HCl\,(g)}$	186.8	$\mathrm{NaCl\,(s)}$	72.1
$\mathrm{H_2O\,(g)}$	188.7	$\mathrm{Cl_2\,(g)}$	223.1	$\mathrm{ZnCl_2\,(s)}$	111.5
$\mathrm{H_2\,(g)}$	130.7	$\mathrm{H_2SO_4\,(l)}$	156.9	$\mathrm{Zn\,(s)}$	41.6
$\mathrm{Na\,(s)}$	51.2	$\mathrm{Zn\,(g)}$	150.0	$\mathrm{NaHSO_4\,(s)}$	113.0
$\mathrm{O_2\,(g)}$	205.2	$\mathrm{CO_2\,(g)}$	213.6	$\mathrm{C\,(s)}$ *graphite*	5.7

The decomposition of hydrogen peroxide has a standard entropy change of $62.9\,\mathrm{J\,K^{-1}\,mol^{-1}}$. Find the standard molar entropy of hydrogen peroxide. Give your answer to 1 decimal place.

Essential Pre-Uni Chemistry G2.4

A Level

Use the following standard molar entropy values in $\mathrm{J\,K^{-1}\,mol^{-1}}$ to help answer the questions in this section.

$\mathrm{H_2O\,(l)}$	69.9	$\mathrm{HCl\,(g)}$	186.8	$\mathrm{NaCl\,(s)}$	72.1
$\mathrm{H_2O\,(g)}$	188.7	$\mathrm{Cl_2\,(g)}$	223.1	$\mathrm{ZnCl_2\,(s)}$	111.5
$\mathrm{H_2\,(g)}$	130.7	$\mathrm{H_2SO_4\,(l)}$	156.9	$\mathrm{Zn\,(s)}$	41.6
$\mathrm{Na\,(s)}$	51.2	$\mathrm{Zn\,(g)}$	150.0	$\mathrm{NaHSO_4\,(s)}$	113.0
$\mathrm{O_2\,(g)}$	205.2	$\mathrm{CO_2\,(g)}$	213.6	$\mathrm{C\,(s)}$ *graphite*	5.7

The combustion of methane has a standard molar entropy change of $-243.2\,\mathrm{J\,K^{-1}\,mol^{-1}}$. Calculate the standard molar entropy of methane. Give your answer to one decimal place.

Reaction Feasibility

A Level

A process is described as being thermodynamically feasible when it results in an increase in the entropy of the universe. For a chemical reaction to be feasible, the sum of the entropy changes of the reaction system and the surroundings needs to be positive. The entropy change of the surroundings arises as a result of heat flow between the surroundings and the reaction system.

Part A Universe entropy change

The entropy change of the surroundings is calculated by dividing the heat flowing into the surroundings by the temperature.

For a reaction with an entropy change (of the system) of x and an enthalpy change of y, write down an inequality that needs to hold for the reaction to be spontaneous at a temperature T.

The following symbols may be useful: `>, T, x, y`

Part B Gibbs Free Energy

Alternatively, chemists often phrase the requirement in terms of Gibbs free energy (G) of the reaction, a function of temperature (T), enthalpy (H) and entropy (S):

$$G = H - TS$$

If the change in Gibbs free energy of the reaction at a given temperature is z, write down an inequality that needs to hold for this reaction to be feasible.

The following symbols may be useful: `<, z`

Essential Pre-Uni Chemistry H2.3

A Level

The standard enthalpy change on decomposition of magnesium carbonate is $100.6\,\mathrm{kJ\,mol^{-1}}$, and the standard entropy change is $174.8\,\mathrm{J\,K^{-1}\,mol^{-1}}$. Find the temperature at which its decomposition becomes spontaneous under standard conditions.

Essential Pre-Uni Chemistry H2.4

A Level

The standard enthalpy of formation of copper(II) oxide at $290\,^{\circ}\mathrm{C}$ is $-157\,\mathrm{kJ\,mol^{-1}}$. The standard entropy change for the same process is $-41.9\,\mathrm{J\,K^{-1}\,mol^{-1}}$. Find the standard Gibbs free energy change of formation of copper(II) oxide at this temperature.