

Thermodynamics

Question 1.

Choose the correct answer. A thermodynamic state function is a quantity

- (a) used to determine heat changes
- (b) whose value is independent of path
- (c) used to determine pressure volume work
- (d) whose value depends on temperature only.

Question 2.

For the process to occur under adiabatic conditions, the correct condition is

- (a) $\Delta T = 0$
- (b) $\Delta p = 0$
- (c) $q = 0$
- (d) $w=0$

Question 3.

The enthalpies of all elements in their standard states are

- (a) unity
- (b) zero
- (c) <0
- (d) different for each element.

Question 4.

ΔU° of combustion of methane is $-X \text{ kJ mol}^{-1}$. The value of ΔH° is

- (a) $= \Delta U^\circ$
- (b) $> \Delta U^\circ$
- (c) $< \Delta U^\circ$
- (d) $=0$

Question 5.

The enthalpy of combustion of methane, graphite and dihydrogen at 298 K are, $-890.3 \text{ kJ mol}^{-1}$, $-393.5 \text{ kJ mol}^{-1}$ and $-285.8 \text{ kJ mol}^{-1}$ respectively. Enthalpy of formation of $\text{CH}_{4(g)}$ will be

- (a) $-74.8 \text{ kJ mol}^{-1}$
- (b) $-52.27 \text{ kJ mol}^{-1}$
- (c) $+74.8 \text{ kJ mol}^{-1}$
- (d) $+52.26 \text{ kJ mol}^{-1}$

Question 6.

A reaction, $A + B \rightarrow C + D + q$ is found to have a positive entropy change. The reaction will be

- (a) possible at high temperature
- (b) possible only at low temperature
- (c) not possible at any temperature
- (d) possible at any temperature

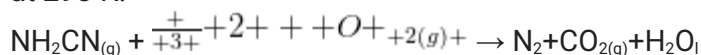
Question 7.

In a process, 701 J of heat is absorbed by a system and 394 J of work is done by the system. What is the change in internal energy for the process?

Question 8.

The reaction of cyanamide, $\text{NH}_2\text{CN}_{(g)}$, with dioxygen was carried out in a bomb calorimeter, and ΔU was found to be $-742.7 \text{ kJ mol}^{-1}$ at 298 K. Calculate enthalpy change for the reaction

at 298 K.



Question 9.

- * Calculate the number of kJ of heat necessary to raise the temperature of 60.0 g of aluminium from 35°C to 55°C. Molar heat capacity of Al is 24 J mol⁻¹ K⁻¹.

Question 10.

Calculate the enthalpy change on freezing of 1.0 mol of water at 10.0°C to ice at -10.0°C.

$\Delta_{\text{fus}}H = 6.03 \text{ kJ mol}^{-1}$ at 0°C.

$C_p[\text{H}_2\text{O}_{(l)}] = 75.3 \text{ J mol}^{-1} \text{ K}^{-1}$,

$C_p[\text{H}_2\text{O}_{(s)}] = 36.8 \text{ J mol}^{-1} \text{ K}^{-1}$

Question 11.

- * Enthalpy of combustion of carbon to CO₂ is -393.5 kJ mol⁻¹. Calculate the heat released upon formation of 35.2 g of CO₂ from carbon and dioxygen gas.

Question 12.

Enthalpies of formation of CO_(g), CO_{2(g)}, N_{2O(g)} and N_{2O_{4(g)}} are -110, -393, 81 and 9.7 kJ mol⁻¹ respectively. Find the value of $\Delta_r H^\circ$ for the reaction

- ** $\text{N}_2\text{O}_{4(g)} + 3\text{CO}_{(g)} \rightarrow \text{N}_2\text{O}_{(g)} + 3\text{CO}_{2(g)}$

Question 13.

Given: $\text{N}_{2(g)} + 3\text{H}_{2(g)} \rightarrow 2\text{NH}_{3(g)}$; $\Delta_r H^\circ = -92.4 \text{ kJ mol}^{-1}$ What is the standard enthalpy of formation of NH₃ gas?

Question 14.

- ** Calculate the standard enthalpy of formation of CH₃OH_l from the following data :

Question 15.

- * Calculate the enthalpy change for the process
 $\text{CCl}_{4(g)} \rightarrow \text{C}_{(g)} + 4\text{Cl}_{(g)}$
 and calculate bond enthalpy of C – Cl in CCl_{4(g)}.
 $\Delta_{\text{vap}}H^\circ(\text{CCl}_4) = 30.5 \text{ kJ mol}^{-1}$,
 $\Delta_f H^\circ(\text{CCl}_4) = -135.5 \text{ kJ mol}^{-1}$,
 $\Delta_a H^\circ(\text{C}) = 715.0 \text{ kJ mol}^{-1}$, where $\Delta_a H^\circ$ is enthalpy of atomisation $\Delta_a H^\circ(\text{Cl}_2) = 242 \text{ kJ mol}^{-1}$

Question 16.

For an isolated system, $\Delta U = 0$, what will be ΔS ?

Question 17.

For the reaction at 298 K, $2A + B \rightarrow C$,

- * $\Delta H = 400 \text{ kJ mol}^{-1}$ and $\Delta S = 0.2 \text{ kJ K}^{-1} \text{ mol}^{-1}$ At what temperature will the reaction become spontaneous considering ΔH and ΔS to be constant over the temperature range.

Question 18.

For the reaction, $2\text{Cl}_{(g)} \rightarrow \text{Cl}_{2(g)}$, what are the signs of ΔH and ΔS ?

- * **Question 19.**

For the reaction



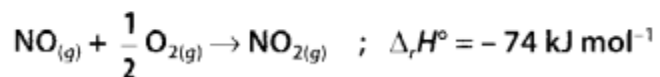
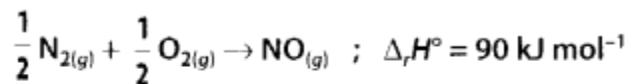
Calculate ΔG° for the reaction, and predict whether the reaction may occur spontaneously.

Question 20.

- ✱ The equilibrium constant for a reaction is 10. What will be the value of ΔG° ?
 $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$, $T = 300 \text{ K}$.

Question 21.

Comment on the thermodynamic stability of $\text{NO}_{(g)}$, given

**Question 22.**

Calculate the entropy change in surroundings when 1.00 mol of H_2O_l is formed under standard conditions.

$$\Delta_f H^\circ = -286 \text{ kJ mol}^{-1}.$$