

# 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.**

$\Delta U^\circ$  of combustion of methane is  $-X \text{ kJ mol}^{-1}$ . The value of  $\Delta H^\circ$  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  $\text{CH}_4(\text{g})$  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

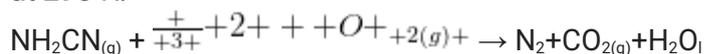
**Question 7.**

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

**Question 8.**

The reaction of cyanamide,  $\text{NH}_2\text{CN}(\text{g})$ , with dioxygen was carried out in a bomb calorimeter, and  $\Delta U$  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<sup>-1</sup> K<sup>-1</sup>.

**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.

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

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

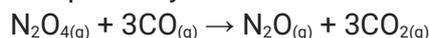
**Question 11.**

- \* Enthalpy of combustion of carbon to CO<sub>2</sub> is -393.5 kJ mol<sup>-1</sup>. Calculate the heat released upon formation of 35.2 g of CO<sub>2</sub> from carbon and dioxygen gas.

**Question 12.**

Enthalpies of formation of CO<sub>(g)</sub>, CO<sub>2(g)</sub>, N<sub>2O(g)</sub> and N<sub>2O<sub>4(g)</sub></sub> are -110, -393, 81 and 9.7 kJ mol<sup>-1</sup>

- \*\* 1 respectively. Find the value of  $\Delta_r H^\circ$  for the reaction



**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 NH<sub>3</sub> gas?

**Question 14.**

- \*\* Calculate the standard enthalpy of formation of CH<sub>3</sub>OH<sub>l</sub> from the following data :

**Question 15.**

- \* Calculate the enthalpy change for the process



and calculate bond enthalpy of C – Cl in CCl<sub>4(g)</sub>.

$\Delta_{\text{vap}}H^\circ(\text{CCl}_4) = 30.5 \text{ kJ mol}^{-1}$ ,

$\Delta_f H^\circ(\text{CCl}_4) = -135.5 \text{ kJ mol}^{-1}$ ,

$\Delta_a H^\circ(\text{C}) = 715.0 \text{ kJ mol}^{-1}$ , 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  $\Delta S$ ?

**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  $\Delta H$  and  $\Delta S$  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  $\Delta H$  and  $\Delta S$ ?

- \* **Question 19.**

For the reaction



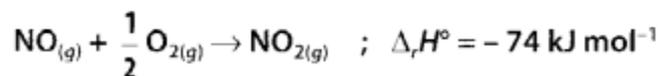
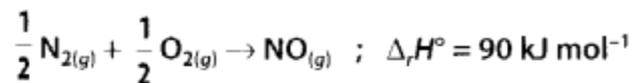
Calculate  $\Delta G^\circ$  for the reaction, and predict whether the reaction may occur spontaneously.

**Question 20.**

- \* The equilibrium constant for a reaction is 10. What will be the value of  $\Delta G^\circ$  ?  
R = 8.314 J K<sup>-1</sup> mol<sup>-1</sup>, T = 300 K.

**Question 21.**

Comment on the thermodynamic stability of NO<sub>(g)</sub>, given

**Question 22.**

Calculate the entropy change in surroundings when 1.00 mol of H<sub>2</sub>O<sub>l</sub> is formed under standard conditions.

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

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