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) g = 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.
$\Delta U°$ of combustion of methane is − X kJ mol^{-1}. The value of $\Delta H°$ is
(a) = $\Delta U°$
(b) >$\Delta U°$
(c) <$\Delta U°$
(d) =0

Question 5.
The enthalpy of combustion of methane, graphite and dihydrogen at 298 K are, -890.3 kJ mol^{-1},-393.5 kJ mol^{-1} and-285.8 kJ mol^{-1} respectively. Enthalpy of formation of $CH_{4(g)}$ will be
(a) -74.8 kJ mol^{-1}
(b) -52.27 kJ mol^{-1}
(c) +74.8 kJ mol^{-1}
(d) +52.26 kJ mol^{-1}

Question 6.
A reaction, A + B → 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, $NH_2CN_{(g)}$, with dioxygen was carried out in a bomb calorimeter, and AU was found to be -742.7 kJ mol 1 at 298 K. Calculate enthalpy change for the reaction

at 298 K.

$NH_2CN_{(g)} + \frac{+}{+3+}+2+ + +O+_{+2(g)+} \rightarrow N_2+CO_{2(g)}+H_2O_l$

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.
$\Delta_{fus}H$ = 6.03 kJ mol^{-1} at 0°C.
$C_p[H_2O_{(l)}]$ = 75.3 J mol^{-1} K^{-1},
$C_p[H_2O_{(s)}]$ = 36.8 J mol^{-1} K^{-1}

Question 11.

* Enthalpy of combustion of carbon to CO_2 is -393.5 kJ mol^{-1}. Calculate the heat released upon formation of 35.2 g of CO_2 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 $\Delta_r f$ for the reaction
$N_2O_{4(g)} + 3CO_{(g)} \rightarrow N_2O_{(g)} + 3CO_{2(g)}$

Question 13.

Given: $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$; $\Delta_rH°$ = -92.4 kJ mol^{-1} What is the standard enthalpy of formation of NH_3 gas?

Question 14.

** Calculate the standard enthalpy of formation of CH_3OH_l from the following data :

Question 15.

* Calculate the enthalpy change for the process
$CCl_{4(g)} \rightarrow C_{(g)} + 4Cl_{(g)}$
and calculate bond enthalpy of C – Cl in $CCl_{4(g)}$.
$\Delta_{vap}H°(CCl_4)$ = 30.5 kJ mol^{-1},
$\Delta_fH°(CCl_4)$ = -135.5 kJ mol^{-1},
$\Delta_aH°(C)$ = 715.0 kJ mol^{-1}, where $\Delta_aH°$ is enthalpy of atomisation $\Delta_aH°(Cl_2)$ = 242 kJ mol^{-1}

Question 16.

For an isolated system, ΔU = 0, what will be ΔS?

Question 17.

For the reaction at 298 K, 2A + B → C,
* ΔH = 400 kJ mol^{-1} and ΔS = 0.2 kJ K^{-1} 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, $2Cl_{(g)} \rightarrow Cl_{2(g)}$, what are the signs of ΔH and ΔS?

* **Question 19.**

For the reaction
$2A_{(g)} + B_{(g)} \rightarrow 2D_{(g)}$, ΔU° = -10.5 kJ and ΔS° = – 44.1 JK^{-1}.
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° ?
$R = 8.314 J\ K^{-1}\ mol^{-1}$, T= 300 K.

Question 21.

Comment on the thermodynamic stability of $NO_{(g)}$, given

$$\frac{1}{2}N_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow NO_{(g)} \quad ; \quad \Delta_r H^\circ = 90\ kJ\ mol^{-1}$$

$$NO_{(g)} + \frac{1}{2}O_{2(g)} \rightarrow NO_{2(g)} \quad ; \quad \Delta_r H^\circ = -74\ kJ\ mol^{-1}$$

Question 22.

Calculate the entropy change in surroundings when 1.00 mol of H_2O_l is formed under standard conditions.
$\Delta_{(f)}H^\circ = -286\ kJ\ mol^{-1}$.