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TEXTBOOK QUESTIONS SOLVED

Question 1. Choose the correct answer:
A thermodynamic state junction is a quantity
(i) used to determine heat changes
(ii) whose value is independent of path
(iii) used to determine pressure volume work
(iv) whose value depends on temperature only.
Answer: (ii) whose value is independent of path

Question 2. For the process to occur under adiabatic conditions, the correct condition is:
(i) $\Delta T = 0$
(ii) $\Delta p = 0$
(iii) $q = 0$
(iv) $w = 0$
Answer: (iii) $q = 0$

Question 3. The enthalpies of all elements in their standard states are:
(i) unity
(ii) zero
(iii) < 0
(iv) different for each element
Answer: (ii) zero

Question 4.
$\Delta U^\ominus$ of combustion of methane is $-X$ kJ mol^{-1}. The value of $\Delta H^\ominus$ is
(i) $= \Delta U^\ominus$ (ii) $> \Delta U^\ominus$
(iii) $< \Delta U^\ominus$ (iv) 0
Answer:
The balanced chemical equation for the combustion reaction is :

$$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$$
$$\Delta_{ng} = 1 - 3 = -2$$
$$\Delta H^\ominus = \Delta U^\ominus + \Delta_{ng} RT = \Delta U^\ominus - 2RT$$

$\therefore$ $\Delta H^\ominus < \Delta U^\ominus$ or (*iii*) is the correct answer.

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 CHJg) will be
(i) - 74.8 KJ mol^{-1}
(ii) - 52.27 KJ mol^{-1}
(iii) + 74.8 KJ mol^{-1}
(iv) + 52.26 KJ mol^{-1}
Answer: As per the available data :

(*i*) $CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$; $\Delta_C H^\ominus = -890.3$ kJ mol^{-1}
(*ii*) $C(s) + O_2(g) \longrightarrow CO_2(g)$; $\Delta_c H^\ominus = -393.5$ kJ mol^{-1}
(*iii*) $H_2(g) + 1/2O_2(g) \longrightarrow H_2O(l)$; $\Delta_c H^\ominus = -285.8$ kJ mol^{-1}

The equation we aim at:

$$C(s) + 2H_2(g) \longrightarrow CH_4(g);\quad \Delta_f H^\ominus = ?$$

Eqn. (*ii*) + 2 × Eqn. (*iii*) – Eqn. (*i*) and the correct $\Delta_f H^\ominus$ value is:

$$= (-393.5) + 2 \times (-285.8) - (-890.3) = -74.8 \text{ kJ mol}^{-1}$$

$\therefore$ (*i*) is the correct answer.

Question 6. A reaction, A + B → C + D + q is found to have a positive entropy change. The reaction will be
(i) possible at high temperature
(ii) possible only at low temperature
(iii) not possible at any temperature (iv) possible at any temperature
Answer: (iv) possible at any temperature

Question 7. In a process, 701] 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?
Answer: Heat absorbed by the system, q = 701 J Work done by the system = - 394 J Change in internal energy (ΔU) = q + w = 701 - 394 = 307 J.

Question 8. The reaction of cyanamide, $NH_2CN(s)$ with dioxygen was carried out in a bomb calorimeter and ΔU was found to be - 742, 7 KJ^{-1} mol^{-1} at 298 K. Calculate the enthalpy change for the reaction at 298 K.
NH_2CN (S) + 3/202(g) → N_2(g) + CO_2(g) + H_2O(Z)
Answer:
ΔU = - 742.7 KJ^{-1} mol^{-1} ; Δ^{ng} = 2 - 3/2 = + 1/2 mol.
R = 8.314 x 10-3KJ^{-1} mol^{-1} ; T = 298 K
According to the relation, ΔH = ΔU + Δ^{ng}RT
ΔH = (- 742.7 kj) + (1/2 mol) x (8.314 x10^{-3} KJ^{-1} mol^{-1}) x (298 K)
= - 742.7 kj + 1.239 kj = - 741.5 kj.

Question 9. Calculate the number of kj of heat necessary to raise the temperature of 60 g of aluminium from 35°C to 55°C. Molar heat capacity of Al is 24 J mol^{-1} K^{-1}.
Answer:
No. of moles of Al (m) = (60g)/(27 g $mol^{-1)}$ = 2.22 mol
Molar heat capacity (C) = 24 J mol^{-1} K^{-1}.
Rise in temperature (ΔT) = 55 - 35 = 20°C = 20 K
Heat evolved (q) = C x m x T = (24 J mol^{-1} K^{-1}) x (2.22 mol) x (20 K)
= 1065.6 J = 1.067 kj

Question 10. Calculate the enthalpy change on freezing of 1.0 mol of water at 10.0°C to ice at - 10.0°C. A, H = 6.03 KJ mot1 at 0°C. Cp [H_2O(l)J = 75.3 J mol^{-1} K^{-1}; Cp [H_2O(s)J = 36.8 J mol^{-1} K^{-1}.
Answer: The change may be represented as:

$$\begin{tikzcd}
H_2O\,(l)\,(10°C) \arrow[r, "\Delta H"] \arrow[d, "\Delta H_1"] & H_2O(s)\,(-10°C) \\
H_2O\,(l)\,(0°C) \arrow[r, "\Delta H_2"] & H_2O(s)\,(0°C) \arrow[u, "\Delta H_3"']
\end{tikzcd}$$

According to Hess's Law;

$$\Delta H = \Delta H_1 + \Delta H_2 + \Delta H_3$$
$$\Delta H_1 = 75.3\ J\ mol^{-1}\ K^{-1}\ (10\ K) = 753\ J\ mol^{-1}$$
$$\Delta H_2\ (\text{solidification}) = -6.03\ kJ\ mol^{-1} = -6030\ J\ mol^{-1}$$

(sign changed)

$$\Delta H_3 = 36.8\ J\ mol^{-1}\ K^{-1}\ (-10\ K) = -368\ J\ mol^{-1}$$
$$\Delta H = (753 - 6030 - 368)\ J\ mol^{-1} = -5645\ J\ mol^{-1}$$
$$\therefore\ = \mathbf{-5.645\ kJ\ mol^{-1}}.$$

*********** END **********