



TEXTBOOK QUESTIONS SOLVED

Question 1. Choose the correct answer:

A thermodynamic state function 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

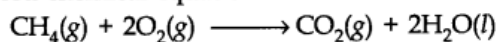
Question 4.

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



$$\Delta_{\text{ng}} = 1 - 3 = -2$$

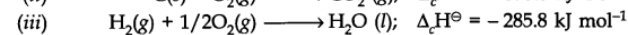
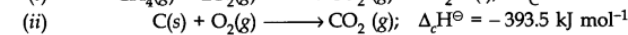
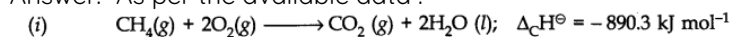
$$\Delta H^\ominus = \Delta U^\ominus + \Delta_{\text{ng}} RT = \Delta U^\ominus - 2RT$$

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

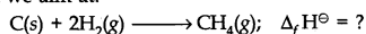
Question 5. The enthalpy of combustion of methane, graphite and dihydrogen at 298 K are $-890.3 \text{ kJ mol}^{-1}$, $-393.5 \text{ kJ mol}^{-1}$ and $-285.8 \text{ kJ mol}^{-1}$ respectively. Enthalpy of formation of $\text{CH}_4(\text{g})$ will be

- (i) $-74.8 \text{ kJ mol}^{-1}$
- (ii) $-52.27 \text{ kJ mol}^{-1}$
- (iii) $+74.8 \text{ kJ mol}^{-1}$
- (iv) $+52.26 \text{ kJ mol}^{-1}$

Answer: As per the available data :



The equation we aim at:



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

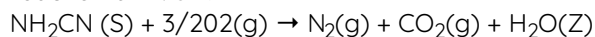
- (i) possible at high temperature
- (ii) possible only at low temperature
- (iii) not possible at any temperature
- (iv) possible at any temperature

Answer: (iv) possible at any temperature

Question 7. In a process, 701 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?

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



Answer:

$$\Delta U = - 742.7 \text{ kJ mol}^{-1}; \Delta n_g = 2 - 3/2 = + 1/2 \text{ mol.}$$

$$R = 8.314 \times 10^{-3} \text{ kJ mol}^{-1} \text{ K}^{-1}; T = 298 \text{ K}$$

According to the relation, $\Delta H = \Delta U + \Delta n_g RT$

$$\Delta H = (- 742.7 \text{ kJ}) + (1/2 \text{ mol}) \times (8.314 \times 10^{-3} \text{ kJ mol}^{-1} \text{ K}^{-1}) \times (298 \text{ K})$$

$$= - 742.7 \text{ kJ} + 1.239 \text{ kJ} = - 741.5 \text{ kJ.}$$

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 $\text{J mol}^{-1} \text{ K}^{-1}$.

Answer:

$$\text{No. of moles of Al (m)} = (60\text{g}) / (27 \text{ g mol}^{-1}) = 2.22 \text{ mol}$$

$$\text{Molar heat capacity (C)} = 24 \text{ J mol}^{-1} \text{ K}^{-1}.$$

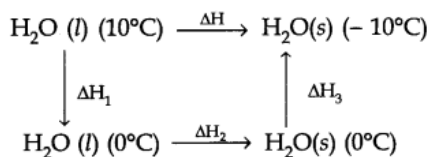
$$\text{Rise in temperature } (\Delta T) = 55 - 35 = 20^\circ\text{C} = 20 \text{ K}$$

$$\text{Heat evolved (q)} = C \times m \times T = (24 \text{ J mol}^{-1} \text{ K}^{-1}) \times (2.22 \text{ mol}) \times (20 \text{ K})$$

$$= 1065.6 \text{ J} = 1.067 \text{ kJ}$$

Question 10. Calculate the enthalpy change on freezing of 1.0 mol of water at 10.0°C to ice at - 10.0°C. $\Delta H_f = 6.03 \text{ kJ mol}^{-1}$ at 0°C. $C_p [\text{H}_2\text{O}(\text{l})] = 75.3 \text{ J mol}^{-1} \text{ K}^{-1}$; $C_p [\text{H}_2\text{O}(\text{s})] = 36.8 \text{ J mol}^{-1} \text{ K}^{-1}$.

Answer: The change may be represented as:



According to Hess's Law;

$$\Delta H = \Delta H_1 + \Delta H_2 + \Delta H_3$$

$$\Delta H_1 = 75.3 \text{ J mol}^{-1} \text{ K}^{-1} (10 \text{ K}) = 753 \text{ J mol}^{-1}$$

$$\Delta H_2 (\text{solidification}) = - 6.03 \text{ kJ mol}^{-1} = - 6030 \text{ J mol}^{-1}$$

(sign changed)

$$\Delta H_3 = 36.8 \text{ J mol}^{-1} \text{ K}^{-1} (-10 \text{ K}) = - 368 \text{ J mol}^{-1}$$

$$\Delta H = (753 - 6030 - 368) \text{ J mol}^{-1} = - 5645 \text{ J mol}^{-1}$$

$$\therefore \Delta H = - 5.645 \text{ kJ mol}^{-1}.$$

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