CBSE TEST PAPER 01

CLASS XI CHEMISTRY (Thermodynamics)

General Instructions:

- All questions are compulsory.
- Marks are given alongwith the questions.

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1. Define a system. [1]

2. Define surroundings. [1]

3. State the first law of thermodynamics. [1]

4. What kind of system is the coffee held in a cup? [1]

5. Give an example of an isolated system. [1]

6. Name the different types of the system. [1]

7. What will happen to internal energy if work is done by the system? [1]

8. From thermodynamic point of view, to which system the animals and plants belong? [1]

9. How may the state of thermodynamic system be defined? [1]

10. Change in internal energy is a state function while work is not, why? [2]

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CLASS XI CHEMISTRY (Thermodynamics)
[ANSWERS]

Ans 1. A system in thermodynamics refers to that part of the universe in which observations like temperature , pressure, volume ,etc. are made.

Ans 2. The rest of the universe excluding system which might be in a position to exchange energy and matter with the system is called its surroundings.

Ans 3. The first law of thermodynamics states that ‘the energy of an isolated system is constant’. *or*

Energy can neither be created nor be destroyed although it may be converted from one form to another.

Ans 4. Coffee held in a cup is an open system because it can exchange matter (water vapors) and energy (heat) with the surroundings.

Ans 5. Coffee held in a thermos flask is an example of an isolated system because it can neither exchange energy nor matter with the surroundings.

Ans 6. There are three types of system –

(i) Open system (ii) Closed system (iii) Isolated system

Ans 7. The internal energy of the system will decrease if work is done by the system.

Ans 8. Open system.

Ans 9. The state of thermodynamic system may be defined by specifying conditions of the system in terms of certain observable properties i.e.state variables like temperature, pressure, volume etc.

Ans 10. The change in internal energy during a process depends only upon the initial and final state of the system. Therefore it is a state function. But the work is related to the path followed. Therefore, it is not a state function rather it is a path function.

CBSE TEST PAPER 02

CLASS XI CHEMISTRY (Thermodynamics)

General Instruction:

- All questions are compulsory.
- Marks are given alongwith their questions.

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1. Define enthalpy. [1]

2. Give the mathematical expression of enthalpy. [1]

3. With the help of first law of thermodynamics and H = U + PV, prove that: $\Delta H = q_p$ [2]

4. When is enthalpy change (ΔH) -

(i) positive (ii) negative. [1]

5. Why is the value of ΔH and ΔU not significant for solids or liquids? [1]

6. Give the relationship between $\Delta U \text{ and } \Delta\mathrm{H}$ for gases. [2]

7. What is an extensive and intensive property? Give example of each . [2]

8. Give an expression for

(i) isothermal irreversible change

(ii) isothermal reversible change. [2]

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CLASS XI CHEMISTRY (Thermodynamics)
[ANSWERS]

Ans 1. Enthalpy is defined as total heat content of the system.

Ans 2. Mathematically,

$H = U + PV$ where U is internal energy ,PV is pressure-volume work

Ans 3. The enthalpy is defined as

$H = U + PV$

So, the change in enthalpy

$\Delta H = \Delta U + \Delta(PV)$

$\Delta H = \Delta U + P\Delta V + V\Delta P$ ....(i)

The first law of thermodynamics states that –

$\Delta H = q + W$

or $\Delta U = q - P\Delta V$.........................(ii)

From (i) and (ii),

$\Delta H = q - P\Delta V + P\Delta V + V\Delta P$

$\Delta H = q + V\Delta P$

When the pressure is constant,

$\Delta P = 0$, then $V\Delta P = 0$

Hence, $\Delta H = q_P$ (at constant pressure)

Ans 4. (i) ΔH is positive for endothermic reaction which absorbs heat from the surroundings.

(ii) ΔH is negative for exothermic reactions which evolve heat to the surroundings.

Ans 5. The value of ΔH and ΔU is not usually significant for systems consisting of only solids and / or liquids because they do not undergo any significant volume changes upon heating.

Ans 6. For gases the volume change is appreciable.

let V_A be the total volume of gaseous reactants, and

V_B be the total volume of gaseous product.

n_A be the number of moles of the reactant and

n_B be the number of moles of the product,

Then at constant pressure and temperature,
$PV_A = n_A RT$……………….(i)

$PV_B = n_B RT$……………….(ii)

Subtracting eq(i) from eq(ii) ,we get , $P(V_B - V_A) = (n_B - n_A) RT$

or $P\Delta V = \Delta n_g RT$

where $\Delta n_g = n_B - n_A$ and is equal to the difference between the number of moles of gaseous products and gaseous reactants.
Substituting the value of $P\Delta V$ we get.

$$\Delta H = \Delta U + (\Delta n)_g RT$$

$\Delta H = q_p$(heat change at constant pressure)

$\Delta U = q_V$(heat change at constant volume)

$\therefore$ for gaseous system.

$q_p = q_V + \Delta n_g RT$

Ans 7. Extensive property is a property whose value depends on the quantity of matter present in the system. eg. internal energy,mass,volume,etc.
Intensive property is a property which do not depend upon the quantity of matter present but depend only upon the nature of the substance present in the system.eg boiling point,density,etc.
Ans 8. (i) For isothermal irreversible change : $q = -W = P_{exp}(v_f - v_i)$

(ii) For isothermal reversible change: $q = -W = -nRT \ln \frac{v_f}{v_i}$

$= -2.303\, nRT \log \frac{v_f}{v_i}$

CBSE TEST PAPER 03
CLASS XI CHEMISTRY (Thermodynamics)

General Instructions:

- All questions are compulsory.
- Marks are given alongwith their questions.

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1. Define Heat capacity. [1]

2. Define specific heat. [1]

3. Give the mathematical expression of heat capacity. [1]

4. It has been found that 221.4J is needed to heat 30g of ethanol from 15^0C to 18^0C. calculate (a) specific heat capacity, and (b) molar heat capacity of ethanol. [3]

5. Show that for an ideal gas Cp- Cv = R [2]

6. Show that for an ideal gas, the molar heat capacity at constant volume is equal to 3/2 R. [2]

7. A 1.25g sample of octane (C_{18} H_{18}) is burnt in excess of oxygen in a bomb calorimeter. The temperature of the calorimeter rises from 294.05 K to 300.78 K. If heat capacity of the calorimeter is 8.93 KJ/K. find the heat transferred to calorimeter. [2]

CBSE TEST PAPER 03
CLASS XI CHEMISTRY (Thermodynamics)
[ANSWERS]

Ans 1. The molar heat capacity of the substance is defined as the amount of heat required to raise the temperature of one mole through one degree Celsius / Kelvin.
Ans 2. Specific heat /specific heat capacity is defined as the amount of heat required to raise the temperature of one unit mass of a substance through one degree Celsius (or one Kelvin).
Ans 3. The mathematical expression of heat capacity (C)
C = q / ΔT where q = heat supplied to the system

ΔT = temperature change.

Ans 4. (a) Specific heat capacity

$$\frac{Heat \text{ absorbed by the substance}}{Mass \text{ of the substance x Rise in temp.}}$$

C = $\frac{221.4j}{30g\ \left(18^0c-15^0c\right)} = \frac{221.4}{30 \text{ x } 3}\ Jg^{-1}\ {}^0c^{-1}$

= $\underline{\underline{2.46J}}\ g^{-1}\ {}^0c^{-1}$

Since 1^0C is equal to 1k, the specific heat capacity of ethanol = $2.46Jg^{-1}\ {}^0C^{-1}$.

(b) Molar heat capacity, C_m = specific heat x molar mass.

Therefore, C_m (ethanol) = $2.46J\ g^{-1}\ {}^0C^{-1}$ x $46g\ mol^{-1}$

= $113.2\ Jmol^{-1}\ {}^0C^{-1}$

The molar heat capacity of ethanol is $113.2\ J\ mol^{-1}\ {}^0\ C^{-1}$.

Ans 5. When a gas is heated under constant pressure, the heat is required for raising the temperature of the gas and also for doing mechanical work against the external pressure during expansion.

At constant volume, the heat capacity, C is written as Cv and at constant pressure this is denoted by C_p.

we write heat q

at constant volume as $q_v = C_v \Delta T = \Delta U$

at constant pressure as $q_p = Cp\Delta T = \Delta H$

The difference between Cp and Cv can be derived for an ideal gas as :

For a mole of an ideal gas, $\Delta H = \Delta U + \Delta\left(pv\right)$ ....(a)

For a mole of an ideal gas, PV= RT ; hence equation (a) becomes

$\Delta H = \Delta U + \Delta\left(RT\right)$

$\Delta H = \Delta U + R\Delta T$

$\therefore\ \Delta H = \Delta U + R\Delta T$..... (i)

On putting the values of ΔH and ΔU, we have;

$Cp\Delta T = Cv\Delta T + R\Delta T$

Cp = Cv +R

$Cp - Cv = R$

Ans 6. For an ideal gas, from kinetic theory of gases, the average kinetic energy per mole for monoatomic gases (E_k) at any temperature T K is given by $Ek = \frac{3}{2}RT$

At (T+1)k, the kinetic energy per mole (Ek^1) is E_{k^1} = $\frac{3}{2}R(T+1)$

Therefore increase in the average kinetic energy of the gas for 1^0C (or 1K) rise in temperature is $\Delta\overline{E}_k = \frac{3}{2}R(T+1) - \frac{3}{2}RT = \frac{3}{2}R$

Also by definition $\overline{E}_k$ is equal to the molar heat capacity of a gas at constant volume, C_v.

$\therefore Cv = \frac{3}{2}R$

Ans 7. Mass of octane,M = 1.250 g.

Heat capacity of calorimeter, c = 8.93 kJ/k

Rise in temp, $\Delta T = 300.78 - 294.05$

= 6.73 K

Heat transferred to calorimeter = heat capacity of calorimeter X Rise in temperature

= 8.93 kJ mol^{-1} x 6.73 K

= 60.1 kJ