

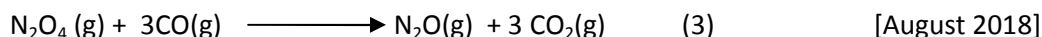
Previous HSE Questions from the chapter "THERMODYNAMICS"

- Differentiate state functions from path functions and give one example for each. (2)
- First law of thermodynamics can be stated as $\Delta U = q + w$. How can this equation be expressed for :
 - An isothermal reversible change?
 - A process carried out at constant volume? (2)

- Enthalpies of formation of some compounds are given below :

Compound	CO	CO ₂	N ₂ O	N ₂ O ₄
Enthalpy of formation (kJ/mol)	-110.0	-393.0	81.0	9.7

Using these data, calculate the enthalpy of reaction for



- What is meant by entropy of a system? What happens to the entropy during the following changes?

- A gas condenses into liquid.

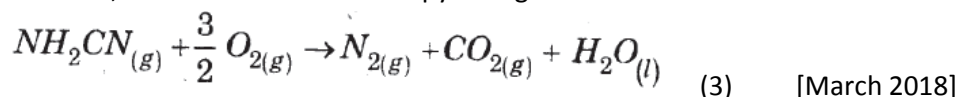
- $\text{CaCO}_3(\text{s}) \longrightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g}) \quad (2)$



- Write the thermochemical equation corresponding to the standard enthalpy of formation of benzene.

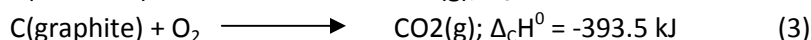
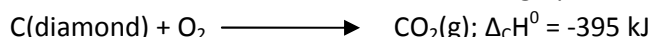
[Hint; $\Delta_f H^\circ$ of benzene = + 49.0 kJ mol⁻¹] (2)

- The reaction of cyanamide (NH₂CN) with dioxygen was carried out in a bomb calorimeter and ΔU was found to be -742.7 kJ mol⁻¹, at 298K. Calculate enthalpy change for the reaction at 298 K.



- State Hess's law.

- Calculate $\Delta_f H^\circ$ when diamond is formed from graphite.



- An extensive property is.....

- density
- pressure
- temperature
- mass

(1) [July 2017]

- Some macroscopic properties are given below. Help Reena to classify them into two groups under suitable titles.

[Heat capacity, Entropy, Refractive index, Surface tension] (2)

- For the reaction $2\text{A}(\text{g}) + \text{B}(\text{g}) \longrightarrow 2\text{D}(\text{g})$, $\Delta U^\circ = -10.5 \text{ kJ/mol}$, $\Delta S^\circ = -44.1 \text{ J/K/mol}$ at 298K. Calculate ΔG° for the reaction. (2) [March 2017]

- Which of the following is a process taking place with increase in entropy?

- Freezing of water
- Condensation of steam
- Cooling of a liquid
- Dissolution of a solute

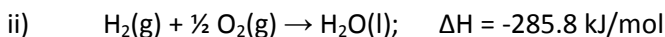
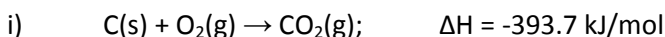
(1)

- State and illustrate Hess's law. (3) [September 2016]

- The enthalpy change in a process is the same, whether the process is carried out in a single step or in several steps.

- Identify the law stated here. (1)

- Calculate the enthalpy of formation of CH₄ from the following data:



- Expansion of a gas in vacuum is called free expansion.

- Which one of the following represents free expansion of an ideal gas under adiabatic conditions?

i) $q = 0, \Delta T \neq 0, w = 0$ ii) $q \neq 0, \Delta T = 0, w = 0$ iii) $q = 0, \Delta T = 0, w = 0$ iv) $q = 0, \Delta T < 0, w \neq 0$ (1)

b) The enthalpy change for the reaction $N_2(g) + 3 H_2(g) \rightarrow 2 NH_3(g)$ is -91.8 kJ at 298 K . Calculate the value of internal energy change. ($R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$) (3) [Oct. 2015]

12. a) Classify the following into intensive and extensive properties.

i) Internal energy ii) Density iii) Heat capacity iv) Temperature (2)

b) Calculate the standard free energy (ΔG^0) for the conversion of oxygen to ozone $3/2 O_2(g) \rightarrow O_3(g)$ at 298 K , if the equilibrium constant for the conversion is 2.47×10^{-29} . (Given $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$). (2) [March 2015]

13. a) ΔG gives a criterion for spontaneity of reactions at a constant pressure and temperature. How is ΔG helpful in predicting the spontaneity of the reaction? (2)

b) State and explain Hess's law of constant heat summation. (2) [August 2014]

14. a) For the oxidation of iron $4 Fe_{(s)} + 3 O_{2(g)} \rightarrow 2 Fe_2O_{3(s)}$, entropy change ΔS is -549.4 J/K/mol at 298 K . In spite of the negative entropy change of this reaction, why is the reaction spontaneous? ($\Delta_r H^0$ for the reaction is $-1648 \times 10^3 \text{ J/mol}^{-1}$). (2)

b) Write the differences between extensive and intensive properties. Give one example of each. (2) [March 2014]

15. a) The enthalpy of combustion of $CH_{4(g)}$, $C(\text{graphite})$ and $H_{2(g)}$ at 298 K are $-890.3 \text{ kJ mol}^{-1}$, $-393.5 \text{ kJ mol}^{-1}$ and $-285.8 \text{ kJ mol}^{-1}$ respectively. Calculate the enthalpy of formation of $CH_{4(g)}$. (2)

b) Match the following:



1. $W = -\Delta U$	a) Enthalpy change
2. $\Delta U = 0$	b) Universal gas constant
3. $C_p - C_v$	c) Adiabatic process
4. q_p	d) Isothermal process
	e) Cyclic process

(2) [September 2013]

16. Most of the naturally occurring processes are spontaneous.

a) Give the criteria for spontaneity of a process in terms of free energy change (ΔG). (1)

b) Exothermic reactions associated with a decrease in entropy are spontaneous at lower temperatures. Justify on the basis of Gibbs equation. (1)

c) Find the temperature above which the reaction $MgO_{(s)} + C_{(s)} \rightarrow Mg_{(s)} + CO_{(g)}$ becomes spontaneous. (Given $\Delta_r H^0 = 490 \text{ kJ mol}^{-1}$ and $\Delta_r S^0 = 198 \text{ JK mol}^{-1}$). (2) [March 2013]

17. a) Construct an enthalpy diagram for the determination of lattice enthalpy of sodium chloride. (2)

b) Enthalpy and entropy changes of a reaction are 40.63 kJ/mol and 108.8 J/K/mol . Predict the feasibility of the reaction at 27°C . (2) [September 2012]

18. a) Explain the Hess's law of constant heat summation, with an example. (2)

b) Draw the enthalpy diagram for exothermic and endothermic reactions. (2) [September 2012]

19. Thermodynamics deals with energy changes of macroscopic systems.

a) Consider a chemical reaction taking place in a closed insulated vessel. To which type of thermodynamic system does it belong? (1)

b) State the first law of thermodynamics. (1)

- c) 3 mol of an ideal gas at 1.5 atm and 25°C expands isothermally in a reversible manner to twice its original volume against an external pressure of 1 atm. Calculate the work done. ($R = 8.314 \text{ JK}^{-1}\text{mol}^{-1}$) (2) [March 2012]
20. A spontaneous process is an irreversible process and may only be reversed by some external agency.
- Decrease in entropy is the only criterion for spontaneity. Do you agree? Why? (2)
 - Calculate the work done for the reversible isothermal expansion of 1 mole of an ideal gas at 27°C, from a volume of 10 dm³ to a volume of 20 dm³. (2) [October 2011]
21. The spontaneity of a process is expressed in terms of a change in Gibbs energy.
- What is meant by change in Gibbs energy of a system? (1)
 - How is it related to the enthalpy and entropy of a system? (1)
 - How is it useful in predicting the feasibility of a process? (2) [March 2011]
22. Lattice enthalpy of an ionic salt is a factor that determines its stability.
- Define the lattice enthalpy. (1)
 - Draw the Born-Haber cycle for the calculation of lattice enthalpy of the ionic crystal NaCl. (3) [September 2010]
23. A system in thermodynamics refers to that part of the universe in which observations are made.
- What do you mean by an isolated system? Give an example. (1)
 - Distinguish between intensive and extensive properties. Give two examples for each. (3) [March 2010]
24. a) State Hess's law of constant heat summation. (2)
- The equilibrium constant for a reaction is 5. What will be the value of ΔG° ? Given that $R = 8.314 \text{ J/K/mol}$, $T = 300\text{K}$. (2) [March 2009]
25. Some properties are "state functions".
- q and w are not state functions, but $(q+w)$ is a state function. Why? (1)
 - What do you mean by saying that pressure is an intensive property? (1)
 - What is the difference in internal energy of a system, if 100 kJ of energy is radiated out without doing any work? (1) [February 2008]

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