

Answer key

1/10

1

Q.P. code - 576900

- Q1 (A) (i) (a) negative
(ii) (c) Isolated System
(iii) (a) negative
(iv) (a) $(\Delta H_2 - \Delta H_1) = \Delta C_p (T_2 - T_1)$
(v) ^aOne
(vi) a) 17
(vii) c) M
(viii) a) 2
(ix) b) One .
(X) b) atomic number
(xi) (a) Metals
(xii) b) Increases
(xiii) a) $-CH_3$
(xiv) b) $-CH_2Cl$
(xv) a) $-BF_3$.
(xvi) b) sp^2
(xvii) c) Three
(xviii) c) Polar .

2

(B)

(i) False

(ii) True

(iii) False.

(iv) True

(v) True

(vi) False

(C) (i) Temperature

(ii) (f) has more solvent than solute.


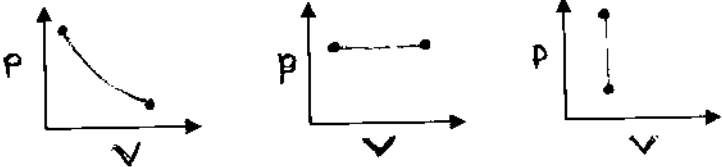
(iii) (a) Positive Centre of atom.

(iv) (g) 3.0

(v) (b) R-CN

(vi) (h) NH₃.

Set - I

Q2	A	With suitable example, explain the concept of state function and path function.	
		<p>State function:</p> <p>A thermodynamic property is said to be state function, if the change in its value during the process depends only upon initial and final state of the system and does not depend upon the path by which this change has been brought about. E.g. internal energy 'U', enthalpy 'H', entropy 'S', etc.</p> <p>As internal energy is state function its value depends upon the initial and final state of system and is expressed in terms of change in internal energy i.e.</p> $\Delta U = U_2 - U_1$ <p>In the language of calculus, state function gives exact differentials.</p> 	2.5
		<p>Path function:</p> <p>If the change in value of any function depends upon the path followed by the system from initial to final state, then that function is called path function. The heat absorbed 'q' and the work done 'w' by the system are not the state functions but are path functions, because their values depends upon the path by which process is carried out.</p> <p>The differential equations for heat 'δq' or work 'δw' are inexact differential and they depend on the path followed by the system.</p>  <p style="text-align: center;"> Isothermal expansion Isobaric expansion Isochoric expansion a) expansion b) expansion c) expansion </p>	2.5
	B	<p>State the first law of thermodynamics in any three forms and derive the mathematical expression for it.</p>	
		<p>Statements of first law of thermodynamics:</p> <ol style="list-style-type: none"> 1) Energy can neither be created nor destroyed but can be converted from one form to another. 2) The energy of isolated system remains constant. 3) Whenever one kind of energy is produced, an exactly equivalent amount of another kind of energy must disappear. 4) Energy of the universe is constant. 5) It is impossible to construct a perpetual motion machine which could produce work without consuming energy. 	03
			02

4.

	<p>Mathematical expression: Let, U_1 is the energy of the system in its initial state. When the system absorb 'q' amount of heat, then the internal energy is given by, $U_1 + q$. If 'w' is the work done on the system, the internal energy U_2 in the final state of the system will be given by, $U_2 = U_1 + q + w$ $U_2 - U_1 = q + w$ $\Delta U = q + w$ $q = \Delta U - w$ however if work is done by the system, work is taken as negative, so that, $\Delta U = q - w$</p>	
<p>C</p>	<p>1.5 mole of an ideal gas at 2 atmospheres and 27°C is compressed isothermally to one half its volume by an external pressure of 4 atmospheres. Calculate the work done. ($R = 0.082 \text{ atm dm}^3 \text{ K}^{-1} \text{ mol}^{-1}$, $1 \text{ atm dm}^3 = 101.32 \text{ J}$) Given: $n = 1.5$, $P = 2 \text{ atm}$, $T = 27 + 273 = 300 \text{ K}$, $P_{\text{ext}} = 4 \text{ atm}$, $w = ?$ Work done, $W = -P_{\text{ext}} (V_2 - V_1)$ ----- ① $\therefore V_1 = \frac{nRT}{P} = \frac{1.5 \times 0.082 \times 300}{2}$ $= 18.45 \text{ dm}^3$ $V_2 = \frac{V_1}{2} = \frac{18.45}{2}$ $V_2 = 9.225 \text{ dm}^3$ Substituting in equation ① $W = -4 (9.225 - 18.45)$ $= -4 \times -9.225$ $= 36.9 \text{ atm. dm}^3$ $w = 36.9 \times 101.32$ $= 3738.708 \text{ J}$ $w = 3.738 \text{ kJ}$</p>	<p>01 01 01 01 01</p>

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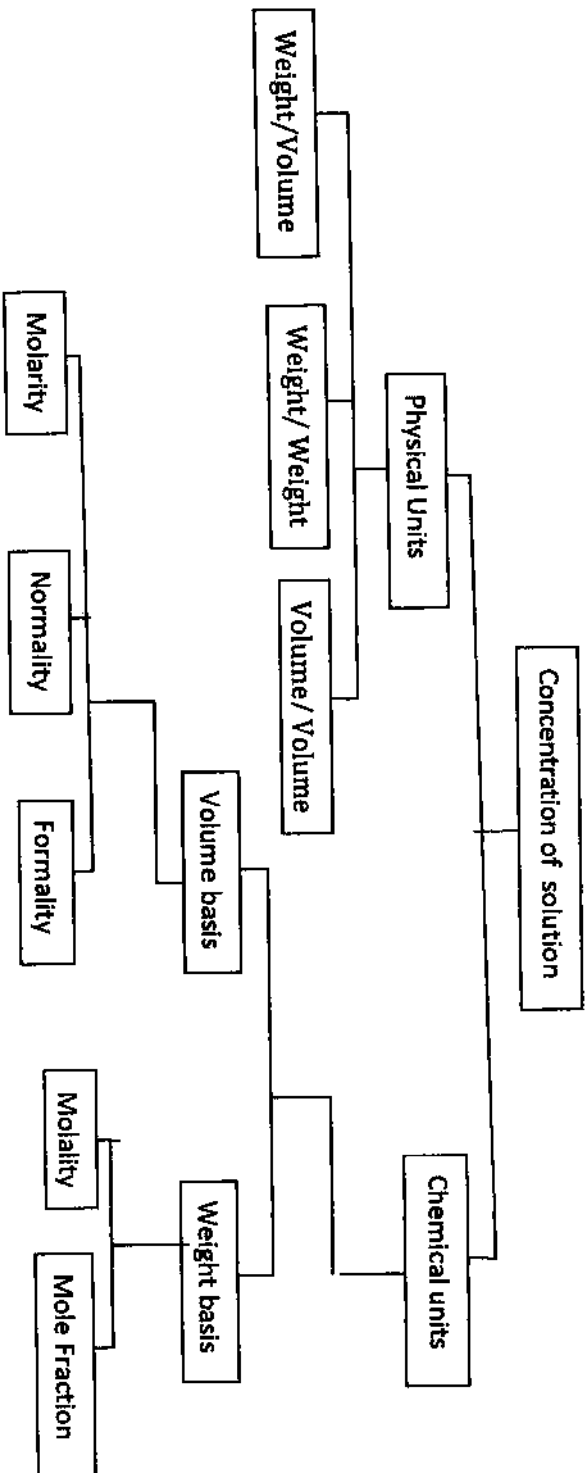
D	Define enthalpy of formation of molecule and explain it with suitable example.	01
	<p>The standard enthalpy of formation is defined as, the enthalpy change accompanying the formation of one mole of compound from the constituent elements in standard state. It is represented as ΔH°. Since, molar enthalpy is a state function.</p>	04
	<p>Following conventions are used to calculate the standard molar enthalpies of various substances.</p>	
	<p>The standard molar enthalpy of every element in its most stable or natural state is taken as zero. E.g. H° of H_2</p>	
	<p>For example consider the formation of 1 mole of HBr from reaction between H_2 and Br_2.</p>	
	$\frac{1}{2} H_{2(g)} + \frac{1}{2} Br_{2(g)} \rightarrow HBr_{(g)}$	
	<p>The enthalpy change for this reaction will be the enthalpy of formation of HBr or from its elements H_2 and Br_2 in their stable state.</p>	
	$\Delta H^\circ_{(reaction)} = \Delta H^\circ_{f(products)} - \Delta H^\circ_{f(reactants)}$	
	$\Delta H^\circ_f = \Delta H^\circ_f(HBr) - \frac{1}{2} \Delta H^\circ_f(H_2) - \frac{1}{2} \Delta H^\circ_f(Br_2)$	
	<p>By convention, the standard molar enthalpies are taken as zero for $H_{2(g)}$ and $Br_{2(l)}$.</p>	
	<p>Therefore,</p>	
	$\Delta H^\circ_{reaction} = \Delta H^\circ_f(HBr)$	
	<p>It is observed that, the standard enthalpy of formation of a compound is equal to its standard molar enthalpy of reaction, provided it is formed from its elements in their natural stable state.</p>	

Q 2 e Classification :

5 marks

Concentration of solution can be expressed using Physical and chemical units. Those concentration terms which doesnot require the nature of solute and solvent present in solution is called Physical units whereas Chemical units needs information about the nature of solute and solvent present.

The different ways in which they can be classified is as follows:



Q2 f. $M = \frac{\text{wt.of solute in g} \times 1000}{\text{Mol.wt} \times \text{vol.}}$

2 Marks

Wt of solute in g = $\frac{0.15 \times 106 \times 100}{1000}$

2 Marks

= 1.59 g

1 Mark

Questions should be —
WRITTEN IN LEGIBLE HANDWRITING IN BLACK INK.
SIGNS, SKETCHES OR FIGURES IF ANY BE DRAWN IN NEAT BLACK INK,
so as to avoid mistakes in the printed question papers.

Duration Hours.

Total Marks assigned to the paper

Q. No.

Marks

N.B. :

Q.3
A)

Calculate effective Nuclear charge (Z_{eff}) for 2p electron in oxygen. ($Z = 8$)

electronic configuration
 oxygen $1s^2 2s^2 2p^4$

$$Z_{eff} = Z - S$$

$$(1s^2) (2s^2 2p^4)$$

$$5 \times 0.35 =$$

$$2 \times 0.85 =$$

$$S = (2 \times 0.85) + (5 \times 0.35)$$

$$\therefore Z_{eff} = 8 - 3.45$$

$$= 4.55$$

01

01

01

01

01

8

Q. No.

Marks

B] Rutherford's Atomic Model
 - α -particle scattering experiment

01

Diagram

parallel beam of α -particle from Radium were passed through a thin sheet of gold metal majority of alpha particles continued straight paths. some were scattered through larger angles. few thrown back.

01

conclusion.

- 1) entire mass and positive charge is concentrated at nucleus
- 2) Magnitude is different for different atom
- 3) electron balance the charge of nucleus revolving around nucleus
- 4) space inside an atom is empty
- 5)

01

0 1/2

01.

0 1/2

9

Q. No.

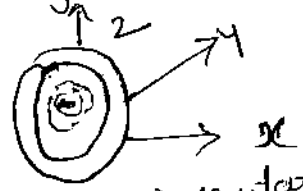
Marks

c)

Angular shape of s and p orbital gives the probability of finding an electron in any given direction from the nucleus.

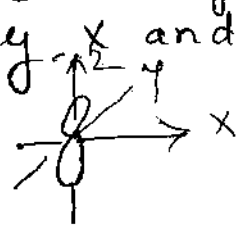
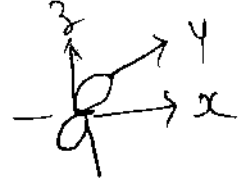
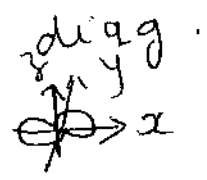
i) s-orbital diagram spherical boundary surface. Not dependent on either of angles θ or ϕ . In other words, spherically symmetrical probability of finding the electron is equal in all directions.

Three dimensional $l=0$ has no node. 2s orbital $n=2$, surface at which the probability of finding electron goes to zero called as nodes.



Dot representation of electron density in 2s orbital.

ii) p-orbital. $l=1$ $\therefore m=0 \pm 1$ Three values of m representing three orientations p_x , p_y , p_z . $l=1$ $m=0$ is labeled as p_z and expression $(3/4\pi)^{1/2} \cos \theta$ gives two tangent dumb-bells symmetrical about z-axis. Similarly p_x and p_y have dumb-bell shapes about x and y-axis.



0/1 m

0/1

1/2

1/2

0/1

Q. No.

Marks

- 10
- 3 D) Properties of elements - governed by principle or law. Many scientist like Lavoisier, Berzelius, Julius Meyer etc attempted to classify elements on the basis of similar properties. Mendeleev is one of the several persons to study well. His work is significant & recognised to classify elements in the periodic table. 1M
- Earlier classification of elements on the basis of empiricism - which explain hypothesis - but fails to explain, as new facts come in to light. 1M
- Mendeleev realized & made principle in the form of table - called periodic ^{law} table, in 1869. His properties of elements useful in predicting properties of elements. 1M
- periodic law - The properties of elements are a periodic function of their atomic weights. Elements - same properties - arranged in vertical groups - according to increasing at. wts. 1M
- 3 E) Classification of elements
three types
- I) Main group i.e. s & p block elements - i.e. Group 1 & 2, Group 13 to 18 - They are metals & s block elements. Gr. 13 to 18 are non metals i.e. p block elements. Gr. 1 & 2, ^{13 to 18} are also called as representative elements. Gr. 18 elements - noble gases. 1M
- II) Transition elements - d block elements - they have (n-1) shell - metals - horizontal & vertical relationship. 1M

Q. No.

III) Inner Transition elements — Last three shells are incomplete with electrons. — f subshell — last two shells (n-2) incomplete — 14 elements — Lanthanides & actinides. — Some properties.

Marks

1M

3 F)

Pauling's method — electronegativity — It is based on empirical relation between bond energy & electronegativities of atoms

1M

Covalent bond formed between atoms — 100%. Covalent. Dissociation energy $D_{A-B} = D_{cov}$

1M

$$D_{A-B} = D_{cov} = \frac{1}{2} [D_{A-A} + D_{B-B}]$$

But if bond is not 100% covalent & A & B — have different electronegativity then $D_{A-B} > D_{cov}$ by an amt. Δ_{A-B} — called ionic covalent resonance energy or resonance energy.

1M

$$D_{A-B} = \frac{1}{2} [D_{A-A} + D_{B-B}] + \Delta_{A-B}$$

$$\text{ie } \Delta_{A-B} = D_{A-B} - \frac{1}{2} [D_{A-A} + D_{B-B}]$$

Diff in A & B more, greater is the value of Δ_{A-B}

1M.

R.E Δ = Actual bond energy — Energy for 100%.

According to Pauling it is = $0.088\sqrt{\Delta}$

1M

eg. $\Delta_{H-Cl} = 92.1 \text{ kJ mol}^{-1}$

12

Synoptic Answer key, Organic section.

Q.4 A] ~~XIII~~ $-CH_3$ ~~XIV~~ CH_3-Cl ~~XV~~ BF_3 ~~XVI~~ sp^2 ~~XVII~~ Three
~~XVIII~~ Polar.

B] ~~Nitrile~~ ~~$R-CN$~~
 i) True ii) false.

C] Nitrile - $R-C\equiv N$
 Lewis Base - $\bullet-NH_2$

Q.4] A] i) Methyl cyclohexane carboxylate ii) Nitrocyclohexane. iii) 2-methyl butanoic acid.
 iv) N-methyl butanamine. v) ~~Hexanoic~~ Hexanoic acid.

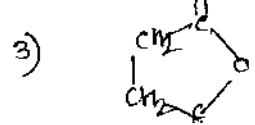
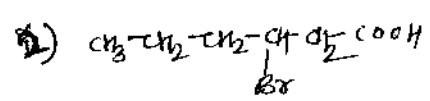
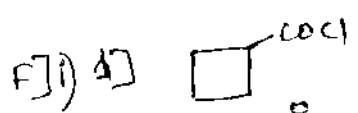
B] sp^3 hybridisation of carbon: Example - 1 mark
 Structure - 1 mark
 Explanation - 1 mark.
 Orbital picture of methane - 2 mark.

C] Structure of free radicals:
 hybridisation - sp^2 & sp^3 - 1 mark
 planar & pyramidal - 1 mark.
 structures - 1 mark.
 Explanation - 2 mark.

D] Stability of Carbocation:-
 Hyperconjugation - structure $1\frac{1}{2}$ mark
 Explanation $1\frac{1}{2}$ mark
 Resonance - structure with example $1\frac{1}{2}$ mark.
 Explanation 1 mark.

E] i) Nucleophile - definition - 1 mark
 example - 1 mark

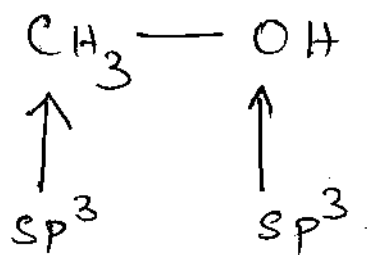
ii) sp -hybridization of Nitrogen - example - 1 mark
 structure - 1 mark.
 Explanation - 1 mark.



one mark each.

(13)

Q 4 F) (ii)



One mark each

(14)

Q5	A	1 Explain the term enthalpy of combustion and give its applications.	02
		<p>Enthalpy of combustion is defined as enthalpy change accompanying the complete combustion of one mole of substance in standard state. e.g. The combustion of ethane under standard conditions to form carbon dioxide and water is,</p> $\text{C}_2\text{H}_6(\text{g}) + 7/2 \text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\text{l}), \Delta\text{H}^\circ_{298} = -1560.1 \text{ kJ}$ <p>Enthalpy of combustion of most of the reaction is negative; this indicates that the reaction is exothermic except for some substances like N_2 and F_2.</p> <p>Applications:</p> <p>i) Calculations of enthalpy of formation: It is difficult to determine the enthalpy of formation of organic compound but easy to determine heat of combustion. Hence, heat of combustion is used to calculate the heat of formation in such cases.</p> <p>ii) Heat of formation of allotropic forms: Allotrope of carbon i.e. diamond and graphite has different values of heat of combustion. By knowing these values, the respective values of heat of formation can be calculated.</p> <p>iii) The calorific values of fuels: The efficiencies of fuel can be compared by determining their standard heats of combustion.</p>	03

15

15/18

Q5b.	Calculation of no of moles	2 marks
	$n_{\text{urea}} = \frac{10}{60} = 0.1666$	$n_{\text{water}} = \frac{297}{18} = 16.5$
	Calculation of mole fraction	
	$X_{\text{urea}} = \frac{n_{\text{urea}}}{n_{\text{urea}} + n_{\text{water}}}$	
	$X_{\text{water}} = \frac{n_{\text{water}}}{n_{\text{urea}} + n_{\text{water}}}$	1 mark
	$X_{\text{urea}} = \frac{0.1666}{0.1666 + 16.5}$	
	$= 0.0099$	1 mark
	$X_{\text{water}} = \frac{16.5}{0.1666 + 16.5}$	
	$= 0.999$	1 mark

18] E] i) structure of Ethane. - Hybridisation - 1 mark
structure - 1 mark
Explanation - 1 mark.

ii) Aniline is weakly basic than aliphatic amines
Resonating structure of Aniline - 1 mark
Explanation - 1 mark.

F] Inductive effect → definition - 1 mark
Example - 1 mark.
Types - 1 mark
Application - 1 mark
Explanation - 1 mark.

Q. No.

Aufbau Principle :-

Marks

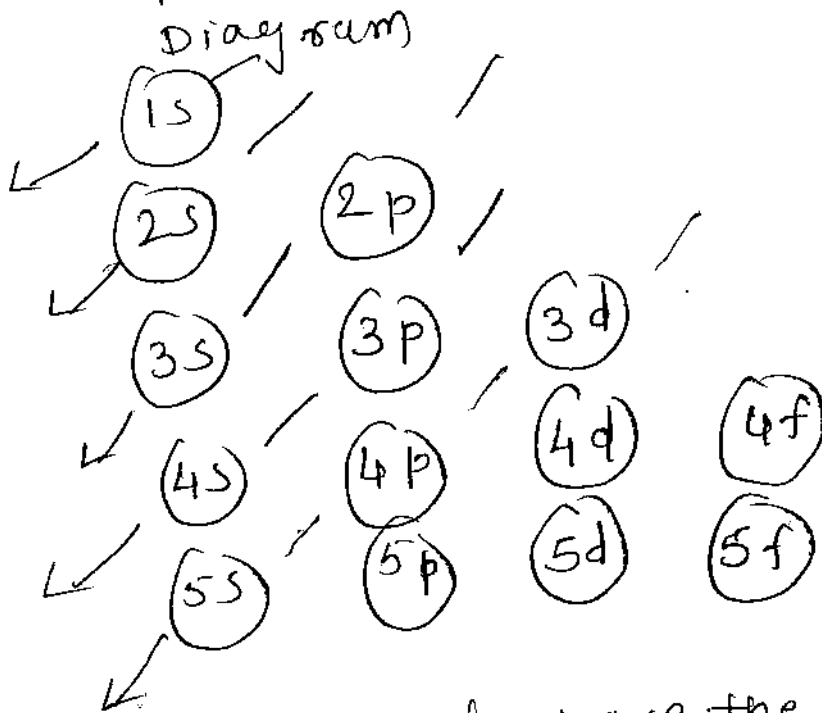
2.5-C

electrons occupy the orbital in order of their increases in energy .
 energy of orbital is determined by the quantum number n and l ,
 Rules

01

1) $n+l$ lowest A ($n+l$) are occupied first

01



$\frac{1}{2}$

2) Two orbitals have the same value A ($n+l$)

01

$1s$ is completely filled first, next electron is added in $2s$ in preference A

$\frac{1}{2}$

$2p$
 Thus $2p$ orbital have lower value A in n hence $2p$ orbitals are first filled.

Q. No.

Marks

- 17
- Q 5 D) Factors - Magnitude of enthalpy of ionisation
- i) size of atom
 - ii) Nuclear charge
 - iii) Nature of of electronic configuration — 3m
 - iv) Screening effect of inner electrons — 2m