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Combined Geo-Scientist (Preliminary) Examination, 2026

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**T.B.C. : BBSP-T-CMT**

**Test Booklet Series**

**Serial No.**

0004081

# TEST BOOKLET

## Paper II

## CHEMISTRY

**A**

***Time Allowed : Two Hours***

***Maximum Marks : 300***

**INSTRUCTIONS**

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2. **Please note that it is the candidate's responsibility to encode and fill in the Roll Number and Test Booklet Series Code A, B, C or D carefully and without any omission or discrepancy at the appropriate places in the *OMR* Answer Sheet. Any omission/discrepancy will render the Answer Sheet liable for rejection.**
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5. You have to mark your responses **ONLY** on the separate Answer Sheet provided. See directions in the Answer Sheet.
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9. Sheets for rough work are appended in the Test Booklet at the end.
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    THERE WILL BE PENALTY FOR WRONG ANSWERS MARKED BY A CANDIDATE.
    (i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, **one-third** of the marks assigned to that question will be deducted as penalty.
    (ii) If a candidate gives more than one answer, it will be treated as **wrong answer** even if one of the given answers happens to be correct and there will be same penalty as above to that question.
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1. Radial distribution function does **NOT** depend upon
   (a) Distance from the nucleus
   (b) Principal quantum number
   (c) Azimuthal quantum number
   (d) Orientation of orbital

2. Which one of the following statements regarding wave functions is **NOT** correct ?
   (a) Wave functions are three dimensional and contain three quantum numbers $n$, $l$ and $m$
   (b) Wave functions represent total movement of a particle over a period
   (c) Probability density is interpreted as the square of wave function
   (d) Wave functions should be differentiable

3. Which of the following statements regarding electron configuration of atoms is/are correct ?
   1. Principal quantum number = 1, K shell, example : He
   2. Principal quantum number = 3, M shell, example : Ne
   3. Principal quantum number = 2, L shell, example : F
   4. Principal quantum number = 3, K shell, example : Si

   Select the answer using the code given below :
   (a) 1 only
   (b) 1 and 3 only
   (c) 2 and 4
   (d) 1, 2 and 3

4. Which one of the following represents the correct order of boiling point among Li, Be, B and Zn ?
   (a) B > Li > Be > Zn
   (b) Zn > Be > B > Li
   (c) Li > Be > Zn > B
   (d) B > Be > Li > Zn

5. The correct group, period and block for element Hassium (Hs) is
   (Given : atomic number of Hs = 108)
   (a) $13^{th}$ group, $7^{th}$ period, $p$-block
   (b) $15^{th}$ group, $7^{th}$ period, $p$-block
   (c) $6^{th}$ group, $6^{th}$ period, $d$-block
   (d) $8^{th}$ group, $7^{th}$ period, $d$-block

6. Consider the following statements regarding the modern periodic table :
   1. Elements in group 16 are also known as chalcogens
   2. Elements in groups 3–12 are known as $p$-block elements
   3. The $f$-block elements are also known as inner transition elements
   4. Elements of groups 13–18 are known as transition elements
   5. Elements in group 2 are also known as alkaline earth metals

   Which of the statements given above are correct ?
   (a) 2 and 4
   (b) 1, 4 and 5
   (c) 1, 3 and 5
   (d) 3, 4 and 5

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7. Which one of the following statements regarding general properties of *s*, *p*, *d* and *f*-block elements is **NOT** correct ?

(a) The compounds of *s* and *p*-block elements are mostly white in color

(b) All *s*-block elements are metals

(c) Most stable oxidation state for all lanthanides is 3+

(d) The complexing ability of lanthanides is more in comparison with the *d*-block elements

8. Which of the following order(s) of ionic radii is/are correct ?

1. $O^{2-} < S^{2-} < Se^{2-} < Te^{2-}$
2. $Ti^{2+} < Ti^{3+} < Ti^{4+}$
3. $O^{2-} < F^{-} < Na^{+} < Mg^{2+}$

Select the answer using the code given below :

(a) 1 only

(b) 1 and 2 only

(c) 2 and 3 only

(d) 1, 2 and 3

9. Which one of the following is the correct value of the effective nuclear charge ($Z_{eff}$) for the 3*d* electron of chromium ?

(a) 4·95

(b) 11·0

(c) 4·60

(d) 11·35

10. Which one of the following represents the correct order of solubility of $Li_2CO_3$, $Na_2CO_3$, $K_2CO_3$, $Rb_2CO_3$ and $Cs_2CO_3$ in water ?

(a) $Li_2CO_3 > Na_2CO_3 > K_2CO_3 > Rb_2CO_3 > Cs_2CO_3$

(b) $Cs_2CO_3 > Rb_2CO_3 > K_2CO_3 > Na_2CO_3 > Li_2CO_3$

(c) $Na_2CO_3 > Li_2CO_3 > K_2CO_3 > Rb_2CO_3 > Cs_2CO_3$

(d) $Cs_2CO_3 > Li_2CO_3 > Rb_2CO_3 > K_2CO_3 > Na_2CO_3$

11. Which one of the following is expected to possess highest electronegativity ?

(a) Al

(b) Ga

(c) In

(d) Tl

12. Consider the following statements regarding catenation tendency of nitrogen :

1. Nitrogen has weaker catenation tendency than carbon due to repulsion between non-bonding lone pair electrons on nitrogen
2. Single bond energy of $CH_3–CH_3$ is much higher than $H_2N–NH_2$
3. Three or more nitrogen atoms can be joined through some multiple bonds

Which of the statement(s) given above is/are correct ?

(a) 1, 2 and 3

(b) 1 and 2 only

(c) 1 only

(d) 3 only

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13. Which one of the following is expected to exist in gaseous state ?

(a) $WF_6$

(b) $UF_4$

(c) $TiCl_4$

(d) $ScCl_3$

14. Which one of the following metal ions is diamagnetic ?

(a) $Ti^{3+}$

(b) $V^{3+}$

(c) $Cu^{+}$

(d) $Co^{2+}$

15. Which one of the following is the most unstable in nature ?

(a) $PF_5$

(b) $AsCl_5$

(c) $SbCl_5$

(d) $BiF_5$

16. The hydrolysis of $SiCl_4$ proceeds through

(a) $S_N1$ mechanism

(b) $S_N2$ mechanism

(c) Proton transfer

(d) Reductive elimination

17. Which one of the following combination of products, respectively are formed during the reaction of diborane with oxygen and water ?

(a) $B_2O_3$, $B(OH)_3$

(b) $B_2O_3$, $B_2H_5OH$

(c) $B(OH)_3$, $B_2O_2$

(d) $B_2O_2$, $B_2H_5OH$

18. The radius of $Na^+$ ion is 0·95 Å and that of $Cl^-$ ion is 1·81 Å. In which one of the following sites $Na^+$ ions will prefer to occupy in the crystal lattice of $Cl^-$ ions ?

(a) Plane trigonal

(b) Tetrahedral

(c) Octahedral

(d) Body-centred cubic

19. Consider the following information available for an ionic binary compound :

1. Madelung Constant
2. Interionic distance
3. Charges of the anions and cations
4. Ionic radii of anions and cations

Which of the information given above is/are required to estimate lattice energy using Born-Landé equation ?

(a) 3 only

(b) 1 and 2 only

(c) 1, 2 and 3 only

(d) 1, 2, 3 and 4

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**20.** Which of the following statement(s) regarding polarizability is/are correct ?

1. Small, highly charged cations have high polarizing power
2. Large, highly charged anions are easily polarized
3. Cations that do not have a noble-gas electron configuration are easily polarized

Select the answer using the code given below :

(a) 1, 2 and 3

(b) 1 only

(c) 3 only

(d) 1 and 2 only

**21.** Sodium chloride reacts with sodium vapour to give a non-stoichiometric compound $Na_{1+\delta}Cl$. This leads to

(a) Frenkel defect

(b) Schottky defect

(c) *F* center

(d) Wadsley effect

**22.** The number of type of bonds between two carbon atoms in calcium carbide is

(a) One $\sigma$ and one $\pi$

(b) One $\sigma$ and two $\pi$

(c) Two $\sigma$ and one $\pi$

(d) Two $\sigma$ and two $\pi$

**23.** Which one of the following is a correct combination of coordination number, geometry and hybridization ?

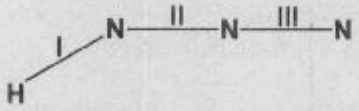
(a) 3, linear, $sp^3$

(b) 5, trigonal pyramidal, $sp^3d^2$

(c) 4, square planar, $sp^2d$

(d) 3, tetrahedral, $sp^3$

**24.**




The correct order of bond lengths in the above structure is

(a) II > I > III

(b) I > II > III

(c) III > I > II

(d) II > III > I

**25.** The spin only magnetic moment of $[Cr(CO)_6]$ is

(a) 2·84 BM

(b) 5·92 BM

(c) 4·90 BM

(d) 0 BM (diamagnetic)

**26.** Which of the following statement(s) regarding hydrazine is/are correct ?

1. It acts as an ambidentate ligand
2. It acts as a monodentate ligand
3. It acts as a bridging ligand
4. It does not bind with metal

Select the answer using the code given below :

(a) 4 only

(b) 2 only

(c) 1 and 3

(d) 2 and 3

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**27.** Which one of the following is the correct IUPAC name for the compound $K_2[Cr(CO)(NH_3)(CN)_4]$ ?

(a) Potassium amminetetracyano-carbonylchromate(III)

(b) Potassium amminecarbonyl-tetracyanochromate(II)

(c) Potassium amminecarbonyl-tetracyanochromate(0)

(d) Potassium amminetetracyano-carbonylchromate(I)

**28.** The meridional isomer of a coordination compound $[MA_3B_3]$ contains :

(where, M is the metal and A and B are ligands)

(a) All A and B ligands arranged at the vertices of a planar hexagon

(b) All A ligands in one plane and B ligands in a perpendicular plane in octahedral geometry

(c) A and B ligands randomly arranged at the vertices of an octahedron

(d) All A or B ligands are adjacent, occupying the vertices of a triangular face of octahedron

**29.** $[Co(NH_3)_3Cl_3]$ exhibits

(a) *Fac-* and *mer-* geometrical isomerism

(b) *Cis-* and *trans-* geometrical isomerism

(c) *R-* and *S-* optical isomerism

(d) Linkage isomerism

**30.** Consider the following reaction :

$$Nb_2S_5 + 5\,HgO \rightleftharpoons Nb_2O_5 + 5\,HgS$$

On the basis of the relative electro-negativity and charges on the various ions, hard and soft character of the acids and bases, which one of the following is correct ?

(a) The products are favoured

(b) The reactants are favoured

(c) $Nb_2O_5$ is favoured, however the reaction does not proceed due to HgS

(d) HgS formation is favoured, however the reaction does not proceed due to $Nb_2O_5$

**31.** Which one of the following is correct regarding addition of acetic acid to sulphuric acid, water and ammonia, respectively ?

(a) Acetic acid behaves as a base in sulphuric acid, weak acid in water and strong acid in ammonia

(b) Acetic acid behaves as a weak acid in sulphuric acid, water and ammonia

(c) Acetic acid behaves as a weak acid in water and strong acid in sulphuric acid and ammonia

(d) Acetic acid behaves as strong acid in sulphuric acid and ammonia and as weak acid in water

**32.** What will happen, if a 1·0 *M* solution of a weak acid is diluted to 0·01 *M* at constant temperature ?

(a) $K_a$ will increase

(b) Degree of ionization will increase

(c) pH will decrease by 2 units

(d) $[H^+]$ will decrease to 0·01 *M*

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**33.** Consider the following statements regarding the ionic product of water :

(where $C_{H^+}$ and $C_{OH^-}$ are the concentration of hydrogen and hydroxide ions of water, respectively and $K_W$ is the ionic product of water)

1. The value of $K_W$ at 25°C is $1 \times 10^{-14}$
2. $C_{H^+} = C_{OH^-}$ in pure water
3. $K_W$ increases with temperature
4. $C_{H^+} = K_W^{1/2}$ for pure water

Which of the statements given above are correct ?

(a) 1 and 2 only

(b) 1 and 3 only

(c) 2 and 4 only

(d) 1, 2, 3 and 4

**34.** An aqueous solution contains 0·3 mol/litre of $KHSO_4$ and 0·6 mol/litre of $K_2SO_4$. The pH of the solution will be

(The p*K*a value for $HSO_4^-$ is 2·0 and log 2·0 = 0·30)

(a) 2·3

(b) 0·3

(c) 2·0

(d) 4·3

**35.** Which one of the following does **NOT** act as Buffer in its aqueous solution ?

(a) Borax

(b) $NH_4HF_2$

(c) $CH_3COONa$

(d) $NH_3 + NH_4Cl$

**36.** Which one of the following is the correct form of Henderson's equation for calculating the pH of a weak acid solution containing its salt ?

(a) $pH = pK_a + \log \frac{[acid]}{[conjugate\ base]}$

(b) $pH = pK_a + \log \frac{[conjugate\ base]}{[acid]}$

(c) $pH = pK_a - \log \frac{[acid]}{[conjugate\ base]}$

(d) $pH = pK_a - \log \frac{[conjugate\ acid]}{[base]}$

**37.** Which one of the following equations is used to get molarity (*M*) of a standard solution ?

(a) $M = \frac{Weight\ of\ solute\ in\ gm}{Molecular\ weight\ of\ solute} \times \frac{1000}{Volume\ of\ solution\ (mL)}$

(b) $M = \frac{Weight\ of\ solute\ in\ gm}{Equivalent\ weight\ of\ solute} \times \frac{1000}{Volume\ of\ solution\ (mL)}$

(c) $M = \frac{Volume\ of\ solute\ (mL)}{Molecular\ weight\ of\ solute} \times \frac{1000}{Weight\ of\ solution\ (gm)}$

(d) $M = \frac{Volume\ of\ solute\ (mL)}{Equivalent\ weight\ of\ solute} \times \frac{1000}{Weight\ of\ solution\ (gm)}$

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**38.** Despite of being obtained in high purity, sodium thiosulphate is unsuitable as a primary standard. This is because :

1. $CO_2$ present in ordinary distilled water may decompose it
2. It can be decomposed by bacterial action
3. It decomposes upon exposure to light

Select the correct answer using the code given below :

(a) 1 and 2 only

(b) 1 and 3 only

(c) 2 and 3 only

(d) 1, 2 and 3

**39.** A sharp end point is **NOT** achieved during titration of boric acid against NaOH. The sharp end point can be observed

(a) By addition of suitable Lewis acid to the solution

(b) By using diphenylamine sulphonic acid as indicator

(c) By addition of suitable organic polyhydroxy compounds

(d) By using xylenol-orange as indicator

**40.** Which one of the following indicators is **NOT** used as acid-base indicator ?

(a) Methyl orange

(b) Phenolphthalein

(c) Murexide

(d) Methyl red

**41.** At a specific temperature, the ratio of the mean kinetic energy of hydrogen to oxygen gas is

(a) 1 : 16

(b) 1 : 8

(c) 1 : 4

(d) 1 : 1

**42.** The root mean square velocity of one mole of a monoatomic gas having molar mass $M$ is $u_{rms}$. Which one of the following correctly represents the relation between the average kinetic energy of the gas ($E$) and $u_{rms}$ ?

(a) $u_{rms} = \sqrt{\frac{3E}{2M}}$

(b) $u_{rms} = \sqrt{\frac{2E}{M}}$

(c) $u_{rms} = \sqrt{\frac{E}{2M}}$

(d) $u_{rms} = \sqrt{\frac{E}{3M}}$

**43.** Initially in a container having an ideal gas, all the molecules had the same translational energy of $6{\cdot}0 \times 10^{-21}$ J. After some time, due to random motion of the molecules, the energies of the molecules were distributed according to the Maxwell-Boltzmann distribution law. The final temperature of the system is

(Given : $k = 1{\cdot}38 \times 10^{-23}$ J K$^{-1}$)

(a) 289·72 K

(b) 0·481 K

(c) 481·1 K

(d) 2·898 K

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**44.** Which one of the following has the highest value of most probable speed ?

(a) $H_2(g)$ at –73°C

(b) $CH_4(g)$ at 27°C

(c) $N_2(g)$ at 1027°C

(d) $O_2(g)$ at 0°C

**45.** The root mean square velocity of gas A at 27°C was found to be equal to the root mean square velocity of gas B at 327°C. The ratio of molar mass of A to B is

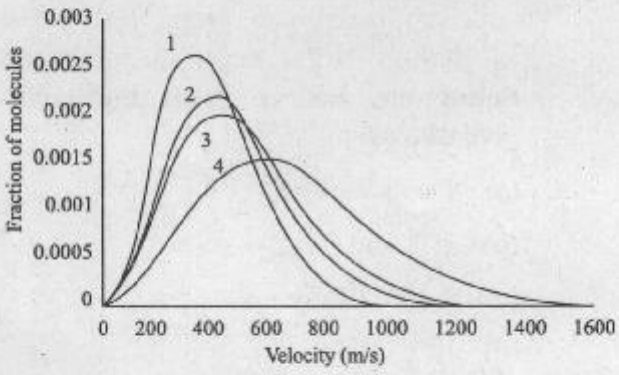
(a) 109 : 9

(b) 9 : 109

(c) 2 : 1

(d) 1 : 2

**46.** The Maxwell-Boltzmann distribution curves of oxygen, nitrogen, carbon dioxide and methane gases were plotted at 300 K and following graph was obtained




Identify the curves (1, 2, 3 and 4) with the appropriate gases and select the correct answer

(a) 1-$CO_2$, 2-$O_2$, 3-$N_2$, 4-$CH_4$

(b) 1-$CH_4$, 2-$N_2$, 3-$O_2$, 4-$CO_2$

(c) 1-$CH_4$, 2-$CO_2$, 3-$O_2$, 4-$N_2$

(d) 1-$CO_2$, 2-$N_2$, 3-$O_2$, 4-$CH_4$

**47.** A steel vessel contains a mixture of $H_2$ and $O_2$ in a 2 : 1 molar ratio at a constant temperature $T$ and pressure $p$. If the volume of $H_2$ gas collected in 10 min is 15 mL at the same $T$ and $p$, what will be the volume of $O_2$ gas collected in 20 min at the same $T$ and $p$ ?

(a) 3·8 mL

(b) 1·9 mL

(c) 3·2 mL

(d) 5·6 mL

**48.** The average velocity of a gas molecule of $O_2$ at 25°C and 1 bar is 400 m $s^{-1}$ and its collision frequency is $2{\cdot}0 \times 10^9$ $s^{-1}$. The mean free path and the average time between collisions are respectively

(a) 500 nm and $1{\cdot}25 \times 10^{-5}$ s

(b) 200 nm and $5{\cdot}0 \times 10^{-10}$ s

(c) 50 nm and $2{\cdot}0 \times 10^{10}$ s

(d) 200 nm and $5{\cdot}0 \times 10^{10}$ s

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**49.** Which of the following is/are correct when 131 g of zinc is allowed to react with hydrochloric acid at 27°C ?

(Given :
Molar mass of Zn is 65·4 g $mol^{-1}$ and $R = 8{\cdot}3\ J\ K^{-1}\ mol^{-1}$)

1. The reaction involved is $Zn + 2\ HCl \rightarrow ZnCl_2 + H_2$
2. When the reaction mixture is kept in a closed vessel of fixed volume, work done is zero
3. When the reaction mixture is kept in an open vessel, the reaction mixture does 4·98 kJ of work driving back the atmosphere

Select the answer using the code given below :

(a) 1 and 2 only

(b) 3 only

(c) 1 and 3 only

(d) 1, 2 and 3

**50.** A sample of an ideal gas changes its volume from 3·00 L to 6·00 L against an external pressure of 2·50 atm and simultaneously absorbs 1000 J of heat. The change in internal energy of the system is

(1 L atm = 101·325 J)

(a) –760 J

(b) 240 J

(c) –240 J

(d) 760 J

**51.** Match List I with List II and select the correct answer using the code given below the Lists :

| List I *(Property/ Variable)* | List II *(Intensive/ Extensive and SI unit)* |
|---|---|
| A. $U$ | 1. Intensive, $J\ mol^{-1}$ |
| B. $H_m$ | 2. Extensive, J |
| C. $C_{p,m}$ | 3. Extensive, $J\ K^{-1}$ |
| D. $C_p$ | 4. Intensive, $J\ mol^{-1}K^{-1}$ |

*Code :*

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 2 | 4 | 1 | 3 |
| (b) | 2 | 1 | 4 | 3 |
| (c) | 3 | 1 | 4 | 2 |
| (d) | 3 | 4 | 1 | 2 |

**52.** Consider the reversible isothermal expansion of 5·00 mol of an ideal gas from 0·500 $dm^3$ to 1·500 $dm^3$ at 300 K.

(Given : $R = 8{\cdot}314\ J\ K^{-1}\ mol^{-1}$ and $\log 3 = 0{\cdot}4771$)

Which of the following are true for the above system ?

1. $\Delta U = 0$
2. $\Delta H = 0$
3. $w = -13{\cdot}7$ kJ
4. $q = 13{\cdot}7$ kJ

Select the answer using the code given below :

(a) 1 and 2 only

(b) 1, 2 and 3 only

(c) 3 and 4 only

(d) 1, 2, 3 and 4

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**53.** Sphalerite (ZnS) is the sulphide ore of zinc.

Given : $\Delta_f H^\circ_{298}$ (in kJ mol$^{-1}$) for sphalerite, ZnO(s) and $SO_2$(g) are –206, –348 and –296, respectively, the $\Delta_r H^\circ_{298}$ (in kJ mol$^{-1}$) for the roasting of sphalerite ore will be

(a) –850

(b) 438

(c) –438

(d) –258

**54.** In a porcelain dish exposed to air at 27°C, 1·22 g of benzoic acid is burned, releasing 31,700 J of heat. The enthalpy change ($\Delta H$) and internal energy change ($\Delta U$) for the process are, respectively

(Given : Molar mass of benzoic acid is 122 g mol$^{-1}$)

(a) –31,688 J and –31,700 J

(b) –31,700 J and –30,453 J

(c) –31,700 J and –31,637 J

(d) –31,700 J and –31,688 J

**55.** Which of the following statements are correct ?

1. The rate of change of $\Delta H^\circ$ with respect to temperature is equal to $\Delta C^\circ_p$
2. For a reaction involving only ideal gases $\Delta C^\circ_p$ is independent of temperature
3. $\Delta_c H^\circ_{298} - \Delta_c U^\circ_{298} = 0$ for glucose
4. When a substance is in its thermodynamic standard state, the substance must be at 25°C

Select the answer using the code given below :

(a) 1 and 2

(b) 2 and 3

(c) 1 and 3

(d) 3 and 4

**56.** Which one of the following statements must be **true** for an endothermic reaction to be spontaneous under standard conditions at constant pressure and at a certain temperature $T$ ?

(a) $\Delta S^\circ$ must be positive and greater than $\frac{\Delta H^\circ}{T}$

(b) $\Delta S^\circ$ must be positive and less than $\frac{\Delta H^\circ}{T}$

(c) $\Delta S^\circ$ must be negative and greater than $-\frac{\Delta H^\circ}{T}$

(d) $\Delta S^\circ$ must be negative and less than $+\frac{\Delta H^\circ}{T}$

**57.** Suppose the coldest reservoir we have at hand is at 12°C. If we want a heat engine that is at least 90% efficient, the minimum temperature of the required hot reservoir should be

(a) 2577 K

(b) 2577°C

(c) 100°C

(d) 373 K

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**58.** Which of the following transformations will show positive entropy change ?

1. 1 mol of $H_2O$ (1, 273 K, 101·325 kPa) → 1 mol of $H_2O$ (s, 273 K, 101·325 kPa)
2. 1 mol of $H_2O$ (1, 273 K, 101·325 kPa) → 1 mol of $H_2O$ (1, 373 K, 101·325 kPa)
3. 1 mol of $H_2O$ (1, 373 K, 101·325 kPa) → 1 mol of $H_2O$ (g, 373 K, 101·325 kPa)
4. 1 mol of $H_2O$ (g, 373 K, 10·1325 kPa) → 1 mol of $H_2O$ (g, 373 K, 101·325 kPa)

Select the correct answer using the code given below :

(a) 1 and 2 only

(b) 2 and 3

(c) 1, 2 and 4

(d) 3 and 4

**59.** The correct value for the non-expansion work that can be obtained from the combustion of 2·00 mol of methane under standard conditions at 300 K is

Given that :

$\Delta_r S° = -243\ J\ K^{-1}\ mol^{-1}$,
$\Delta_f H°(CH_4, g) = -75\ kJ\ mol^{-1}$,
$\Delta_f H°(CO_2, g) = -393\ kJ\ mol^{-1}$,
$\Delta_f H°(H_2O, l) = -286\ kJ\ mol^{-1}$

(a) –1760 kJ

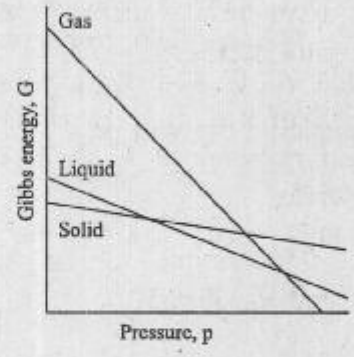
(b) –1634 kJ

(c) 144 kJ

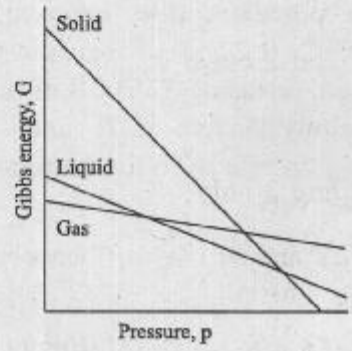
(d) –817 kJ

**60.** Which one of the following graphs correctly represents the variation of Gibbs energy with pressure ?

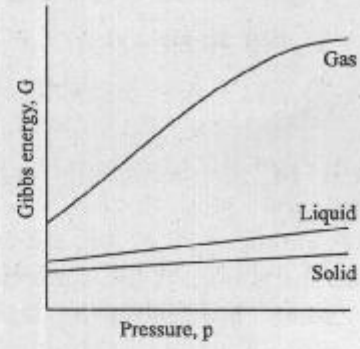
(a)



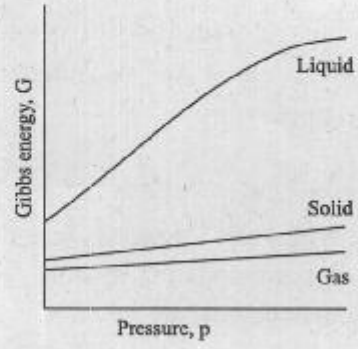

(b)




(c)




(d)

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**61.** Consider the following statements regarding the criteria for spontaneous processes in closed systems :

1. If a system is isolated, its entropy cannot decrease
2. If S of a closed system is fixed and no work is done, U cannot increase
3. $dA \leq 0$ (simple closed system, T and V constant)

Which of the statement(s) given above is/are correct ?

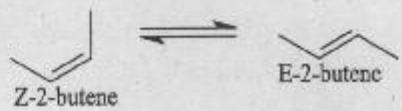
(a) 1 and 2 only

(b) 1 only

(c) 2 and 3 only

(d) 1, 2 and 3

**62.** At 300 K, Z-2-butene isomerises to E-2-butene with $\Delta G_r^o = -3{\cdot}44$ kJ mol$^{-1}$




A catalyst for isomerisation is added to a vessel that is kept at 300 K along with a small amount of Z-2-butene. The mole fraction of E-2-butene in the vessel when equilibrium is reached is :

(Given : R = 8·31 J K$^{-1}$ mol$^{-1}$ and ln 2 = 0·69)

(a) 0·23

(b) 0·34

(c) 0·56

(d) 0·80

**63.** The osmotic pressure of 0·01 mol dm$^{-3}$ solutions of the following substances was measured at 300 K :

1. Acetic acid in benzene
2. Acetic acid in water
3. NaCl in water
4. Glucose in water

Which one of the following is the correct order (increasing) of osmotic pressure of the above solutions ?

(a) Glucose in water, acetic acid in water, acetic acid in benzene, NaCl in water

(b) Glucose in water, acetic acid in benzene, acetic acid in water, NaCl in water

(c) Acetic acid in benzene, glucose in water, acetic acid in water, NaCl in water

(d) NaCl in water, acetic acid in water, acetic acid in benzene, glucose in water

**64.** 1 mol benzene ($p^o_{benzene}$ = 6·0 k Pa) and 2 mol toluene ($p^o_{toluene}$ = 4·8 k Pa) are mixed to form a solution.

Which one of the following statements regarding the above solution is **NOT** correct ?

(a) Total vapour pressure of the solution is 5·2 k Pa

(b) Mole fraction of vapours of benzene above the liquid mixture is 0·33

(c) The solution will follow Raoult's law

(d) The solution will not show any appreciable change in volume

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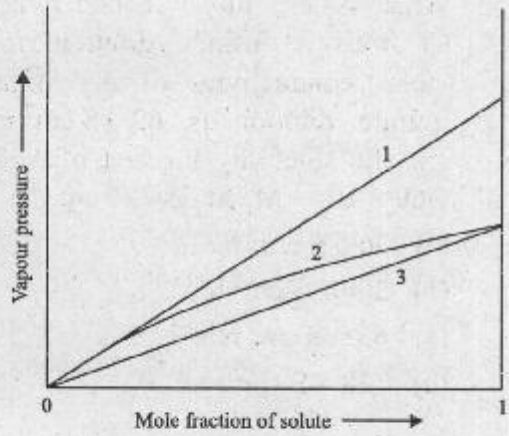
**65.** The correct labels for the given plots of vapour pressure against the mole fraction of solute is




(a) 1-Ideal solution (Raoult), 2-Ideal solution (Henry), 3-Real solution

(b) 1-Ideal solution (Henry), 2-Real solution, 3-Ideal solution (Raoult)

(c) 1-Ideal solution (Henry), 2-Ideal solution (Raoult), 3-Real solution

(d) 1-Real solution, 2-Ideal solution (Henry), 3-Ideal solution (Raoult)

**66.** A polymer $X$ is dissolved in a suitable solvent and the osmotic pressure ($\pi$) of solutions of various concentrations ($c$) is measured at 27°C. The intercept of a plot of $\frac{\pi/(N\,m^{-2})}{c/(g\,dm^{-3})}$ against $c/(g\,dm^{-3})$ is found to be 25. The molar mass of $X$ in kg mol$^{-1}$ is

(Given : R = 8·314 J K$^{-1}$ mol$^{-1}$)

(a) 100

(b) 997

(c) 9976

(d) 99768

**67.** Which of the following statements regarding the colligative properties of solutions containing a non-volatile electrolyte are correct ?

1. The vapour pressure of the pure solvent is higher than that of the solution
2. The vapour pressure of the pure solvent is less than that of the solution
3. Only solute molecules solidify at the freezing point
4. Only solvent molecules solidify at the freezing point

Select the answer using the code given below :

(a) 1 and 3

(b) 2 and 4

(c) 1 and 4

(d) 2 and 3

**68.** Which one among the following is NOT a factor affecting the boiling point elevation constant ?

(a) The molar mass of the solute

(b) The molar mass of the solvent

(c) The enthalpy of vaporization of the solvent

(d) The boiling point of the solvent

**69.** The Henry's Law constant (for the dissolution of gases in liquids) has the unit of

(a) Pa

(b) kg mol$^{-1}$

(c) mL

(d) K kg mol$^{-1}$

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**70.** When a conductivity cell is filled with a 0·001 mol $L^{-1}$ solution of $NaNO_3$, its resistance is found to be 6000 Ω. The molar conductance of the solution is given as 120 S $cm^2$ $mol^{-1}$. The cell constant of the given conductivity cell is

(a) 0·72 $cm^{-1}$

(b) 1·0 $cm^{-1}$

(c) 0·072 $cm^{-1}$

(d) 2·0 $cm^{-1}$

**71.** The $\Lambda_m^\infty$ values for calcium acetate, sodium acetate and sodium iodide solutions are 202, 91 and 127 S $cm^2$ $mol^{-1}$ respectively at 298 K. The $\Lambda_m^\infty$ for calcium iodide is

(a) 238 S $cm^2 mol^{-1}$

(b) 274 S $cm^2 mol^{-1}$

(c) 365 S $cm^2 mol^{-1}$

(d) 456 S $cm^2 mol^{-1}$

**72.** A potential difference of 4·5 V is applied across two electrodes placed 10·0 cm apart in a dilute solution of a salt of $X$ at 27°C. How far would the $X^-$ ion be expected to move in 2 hours ?

[Given : $\lambda(X^-) = 80$ S $cm^2$ $mol^{-1}$, F = 96,500 C $mol^{-1}$]

(a) 2·7 cm

(b) 5·9 cm

(c) 13·2 cm

(d) 4·5 cm

**73.** The conductivity of a saturated solution of AgCl was found to be $1{\cdot}8 \times 10^{-6}$ S $cm^{-1}$ at 25°C after correction for the conductivity of pure water. What is the molar conductivity of $Cl^-$ ions at infinite dilution, if the molar conductivity of $Ag^+$ ions at infinite dilution is 62·0 S $cm^2$ $mol^{-1}$ and the solubility product of AgCl is $1{\cdot}69 \times 10^{-10}$ $M^2$ at 25°C ?

(a) 76·5 S $cm^2$ $mol^{-1}$

(b) 200·4 S $cm^2$ $mol^{-1}$

(c) 63·4 S $cm^2$ $mol^{-1}$

(d) 138·4 S $cm^2$ $mol^{-1}$

**74.** Consider the following statements regarding two electrolytes 'X' and 'Y' whose molar conductivities increase by a factor of 20 and 1·5 respectively, on dilution :

**Statement – 1** : 'X' is a strong electrolyte and 'Y' is a weak electrolyte

**Statement – 2** : For weak electrolytes the increase in molar conductivity is due to the increase in degree of dissociation of the electrolyte on dilution

Which one of the following is correct in respect of above statements ?

(a) Both statement 1 and statement 2 are true and statement 2 is the correct explanation of statement 1

(b) Both statement 1 and statement 2 are true and statement 2 is not the correct explanation of statement 1

(c) Statement 1 is true but statement 2 is false

(d) Statement 1 is false but statement 2 is true

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**75.** Debye-Hückel theory explains the dependence of the conductance of strong electrolytes on their concentration. This theory also explains the other properties of ionic solutions. List I gives the conditions for conductance of aqueous electrolytic solutions, while List II provides the names of corresponding effects. Match List I with List II and select the correct answer using the code given below the lists :

| List I | List II |
|---|---|
| A. Ionic atmosphere | 1. Electrophoretic effect |
| B. Solvated ionic atmosphere | 2. Wien effect |
| C. Increased conductance under high potential | 3. Asymmetric effect |
| D. Increased conductance at high frequency | 4. Debye-Falkenhagen effect |

*Code :*

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 4 | 1 | 2 | 3 |
| (b) | 4 | 2 | 1 | 3 |
| (c) | 3 | 1 | 2 | 4 |
| (d) | 3 | 2 | 1 | 4 |

**76.** What molality of NaCl is needed so that it has the same ionic strength as 0·100 *m* $Ca_3(PO_4)_2$ ?

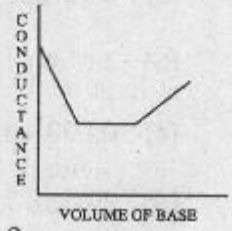
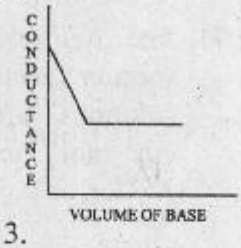
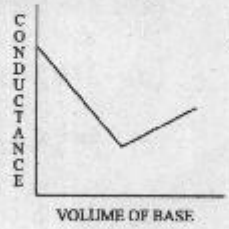
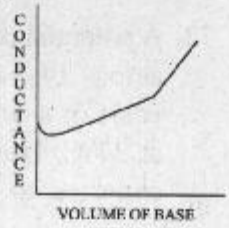
(a) 0·300 *m*

(b) 0·500 *m*

(c) 1·00 *m*

(d) 1·500 *m*

**77.** Match List-I with List-II and select the correct answer using the code given below the lists :

| List I *(conductometric titration)* | List II *(titration curve)* |
|---|---|
| A. HCl *vs* KOH | 1.  |
| B. HCl *vs* $NH_4OH$ | 2.  |
| C. $CH_3COOH$ *vs* NaOH | 3.  |
| D. Oxalic acid *vs* NaOH | 4.  |



*Code :*

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 3 | 2 | 4 | 1 |
| (b) | 3 | 4 | 2 | 1 |
| (c) | 1 | 2 | 4 | 3 |
| (d) | 1 | 4 | 2 | 3 |

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**78.** Consider the following statements regarding transport number :

**Statement – 1** : $Cd^{2+}$ shows negative transport number in highly concentrated solutions of $CdI_2$

**Statement – 2** : Transport numbers of ions are directly proportional to their speeds

Which of the statement(s) given above is/are correct ?

(a) Neither 1 nor 2
(b) Both 1 and 2
(c) 1 only
(d) 2 only

**79.** During the titration of 50·0 mL of a 0·10 mol $L^{-1}$ solution of acetic acid ($K_a = 1{\cdot}8\times10^{-5}$) with a 0·10 mol $L^{-1}$ solution of sodium hydroxide, the specific conductance after addition of 50·0 mL of sodium hydroxide will be :

(Given :

$\lambda^o_{CH_3COO^-} = 40{\cdot}9\times10^{-4}$ S $m^2mol^{-1}$,

$\lambda^o_{Na^+} = 50{\cdot}1\times10^{-4}$ S $m^2mol^{-1}$)

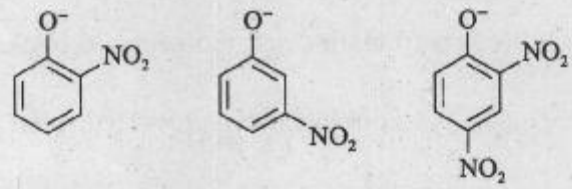
(a) 0·455 S $m^{-1}$
(b) 0·910 mS $m^{-1}$
(c) 0·455 mS $m^{-1}$
(d) 0·910 S $m^{-1}$

**80.** In the determination of the transport number of $Li^+$ ion by the moving boundary method, a 0·10 *M* solution of LiCl was taken in a cell having uniform area of cross section of 1·0 $cm^2$. At the end of the experiment the boundary moved by 2·0 cm and 0·09 g of silver was deposited on the cathode of a silver coulometer. The transference number of $Li^+$ ion is

(Given : Faraday = 96,500 C $mol^{-1}$;
Atomic mass of Ag = 108)

(a) 0·24
(b) 0·40
(c) 0·60
(d) 0·76

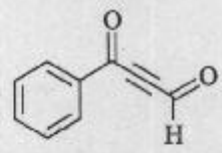
**81.** The correct decreasing order of basicity of the following anions is



I II III

(a) II > III > I
(b) I > III > II
(c) III > I > II
(d) II > I > III

**82.** The types of hybridization exhibited by the carbon atoms in the given compound are



(a) $sp^2$ and $sp^3$ only
(b) $sp^2$ and $sp$ only
(c) $sp$ and $sp^3$ only
(d) $sp$, $sp^2$ and $sp^3$

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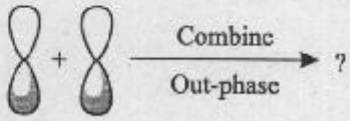
**83.** Which one of the following molecular orbitals will be formed by combination of the two $2p$ orbitals as shown below ?




(a) bonding $\pi$ molecular orbital

(b) bonding $\sigma$ molecular orbital

(c) antibonding $\pi^*$ molecular orbital

(d) antibonding $\sigma^*$ molecular orbital

**84.** Which one of the following compounds can be most readily converted into carbon free radical ?

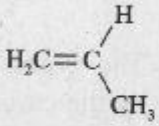
I

$HC \equiv CH$

II

$H_2C = CH_2$

III



IV

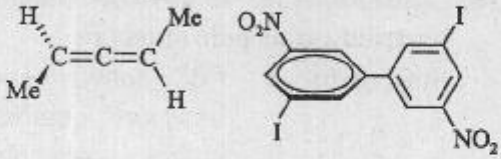
(a) I

(b) II

(c) III

(d) IV

**85.** Which one of the following is correct for the molecules given below ?



I II

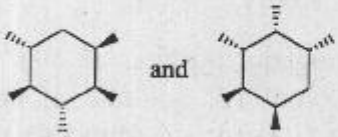
(a) Both I and II are chiral

(b) I is chiral and II is achiral

(c) I is achiral and II is chiral

(d) Both I and II are achiral

**86.** Predict the relationship between the pair of compounds given below :



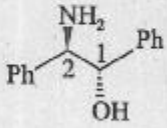

(a) Enantiomers

(b) Identical

(c) Diastereomers

(d) Constitutional isomers

**87.** The correct IUPAC name of the given compound is



(a) (1*S*, 2*R*)-2-Amino-1,2-diphenylethan-1-ol

(b) (1*R*, 2*S*)-2-Amino-1,2-diphenylethan-1-ol

(c) (1*S*, 2*S*)-2-Amino-1,2-diphenylethan-1-ol

(d) (1*R*, 2*R*)-2-Amino-1,2-diphenylethan-1-ol

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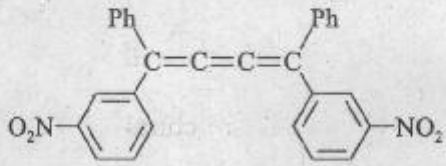
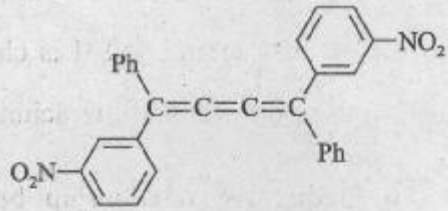
**88.** The relationship between the compounds given below is



and



(a) Optical isomers

(b) Constitutional isomers

(c) Geometrical isomers

(d) Regioisomers

**89.** Which one of the following compounds has the highest preference to exist as gauche conformer ?

1,2-Dichloroethane I — 1,2-Dibromoethane II

1,2-Difluoroethane III — n-Butane IV

(a) I

(b) II

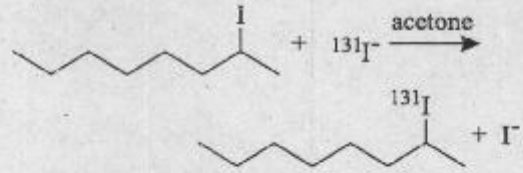
(c) III

(d) IV

**90.** Which one among the following pairs is **NOT** correctly matched ?

| | Statement | | Predominant pathway |
|---|---|---|---|
| (a) | Cyclohexyl bromide reacts with sodium ethoxide in ethanol | : | E2 |
| (b) | *tert*-Butyl bromide reacts with sodium ethoxide in ethanol | : | $S_N1$ |
| (c) | The strength of the nucleophile is important in determining rate | : | $S_N2$ |
| (d) | Rearrangements are possible in product formation | : | E1 |

**91.** In an experiment, the rate of racemization of 2-iodooctane by sodium iodide ($Na^{131}I$) in acetone was compared with the rate of incorporation of radioactive iodine into 2-iodooctane




If we assume that each incorporation proceeds stereospecifically with inversion of configuration then we can conclude that

(a) There will not be any observable racemization

(b) The rate of racemization will be equal to the rate of incorporation of radioactive iodine

(c) The rate of racemization will be twice the rate of incorporation of radioactive iodine

(d) The rate of incorporation of radioactive iodine will be twice the rate of racemization

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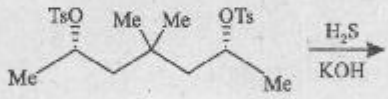
**92.** The number of methyl groups at the axial and equatorial positions, respectively in the most stable conformation of the major product formed in the following reaction are



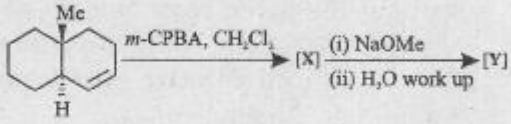

(a) Three and one

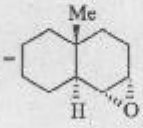
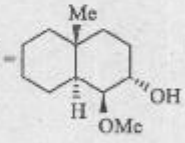
(b) Two and two

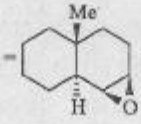
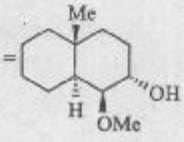
(c) One and three

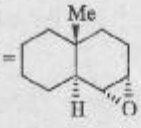
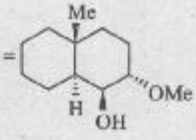
(d) Zero and four

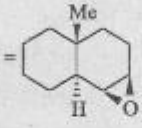
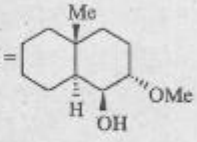
**93.** The major products [X] and [Y] formed in the following reaction sequence are



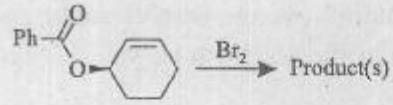

(a) [X] =  [Y] = 

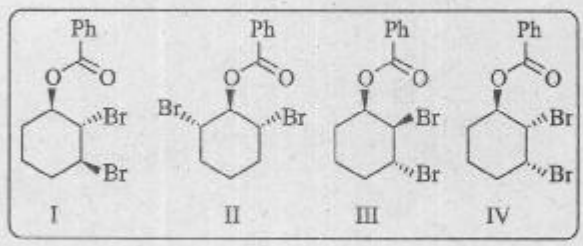
(b) [X] =  [Y] = 

(c) [X] =  [Y] = 

(d) [X] =  [Y] = 

**94.** The product(s) formed due to neighbouring group participation in the following reaction is/are



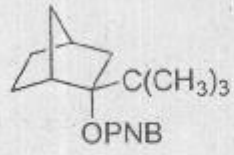

(a) I and III

(b) II and IV

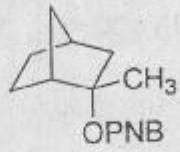
(c) Only II

(d) III and IV

**95.** Consider the following statements about the reactivity of compounds **I-IV** :




**I**




**II**

$PhSO_2CH_2CH_2Cl$

**III**

$PhSO_2CH_2Cl$

**IV**

where OPNB is *p*-nitrobenzoate

1. Compound **I** undergoes solvolysis in aqueous acetone slower than **II**
2. Compound **I** undergoes solvolysis in aqueous acetone faster than **II**
3. Compound **III** reacts with KI slower than **IV**
4. Compound **III** reacts with KI faster than **IV**

Which of the statements given above are correct ?

(a) 1 and 3

(b) 1 and 4

(c) 2 and 3

(d) 2 and 4

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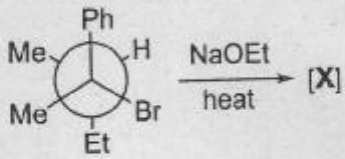
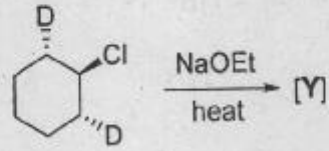
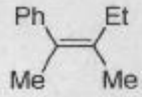
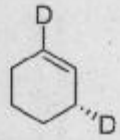
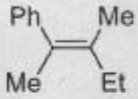
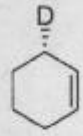
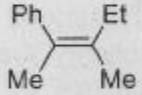
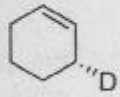
**96.** The major products [X] and [Y] formed in the following reactions are

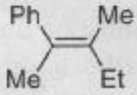
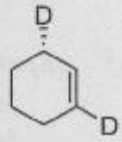


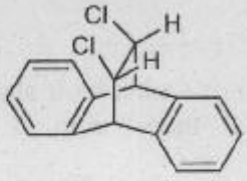

(a) [X] =  [Y] =  and its enantiomer

(b) [X] =  [Y] =  and its enantiomer

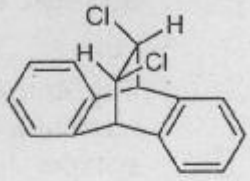
(c) [X] =  [Y] =  and its enantiomer

(d) [X] =  [Y] =  and its enantiomer

**97.** Consider the following statements with respect to compounds **A** and **B**




**A**




**B**

1. The dihedral angle between Cl and H on adjacent carbons in compound **A** is 180°
2. The dihedral angle between Cl and H on adjacent carbons in compound **B** is 0°
3. Compound **A** undergoes HCl elimination about 8 times faster than compound **B**

How many of the above statement(s) is/are correct ?

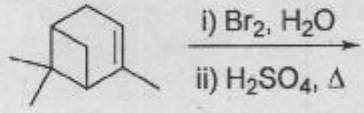
(a) Only one

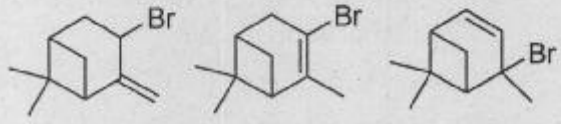
(b) Only two

(c) All three

(d) None

**98.** Which one of the following statements regarding the given reaction sequence is correct ?




**I** **II** **III**

(a) The major product of the reaction is **I** and is called Hofmann product

(b) The major product of the reaction is **II** and is called Zaitsev product

(c) The major product of the reaction is **III** and is called Hofmann product

(d) The major product of the reaction is **III** and is called Zaitsev product

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**99.** Which one of the following alkyl bromides will give exclusively one terminal mono-substituted alkene upon dehydrobromination by an E2 process ?

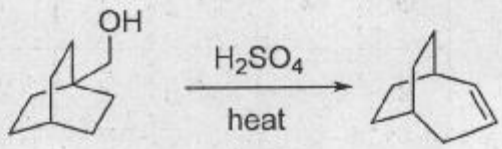
(a) 3-bromo-3-methylpentane

(b) 3-bromo-2-methylpentane

(c) 2-bromo-2,3-dimethylbutane

(d) 2-bromo-3,3-dimethylbutane

**100.** The mechanism of the following reaction involves the sequential conversion of



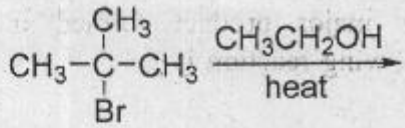

(a) 1° carbocation to 3° carbocation to 3° carbocation

(b) 1° carbocation to 2° carbocation to 2° carbocation

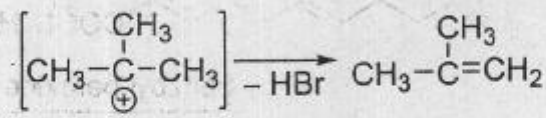
(c) 1° carbocation to 2° carbocation to 3° carbocation

(d) 1° carbocation to 3° carbocation to 2° carbocation

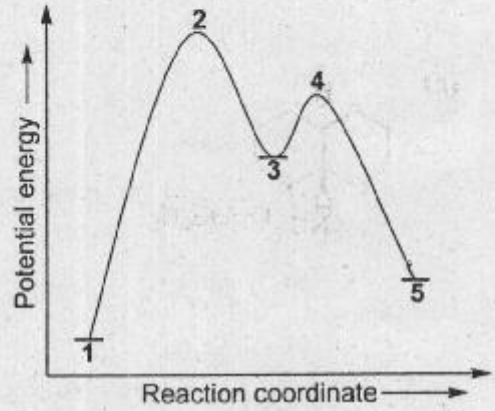
**101.** A potential energy diagram is shown below for the E1 mechanism of indicated reaction




1




3 5




By applying Hammond's postulate to the potential energy diagram for this reaction, which one of the following statements is correct ?

(a) The structure of transition state **2** is more carbocation-like than transition state **4**

(b) The structure of transition state **2** is less carbocation-like than transition state **4**

(c) The structure of transition state **2** resembles **1** more than it resembles **3**

(d) The structure of transition state **4** resembles **5** more than it resembles **3**

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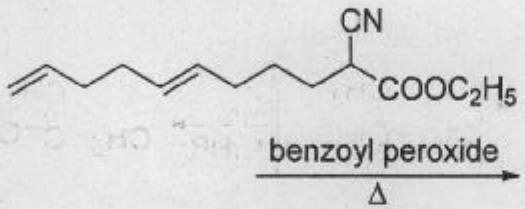
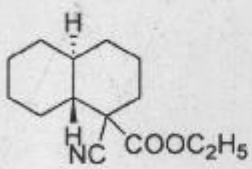
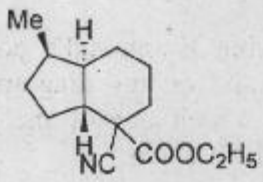
**102.** The major product formed in the following reaction is



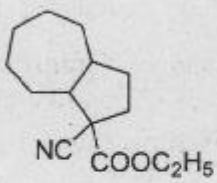

(a)



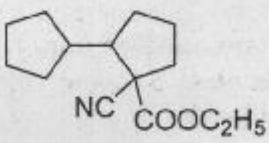

(b)




(c)




(d)




**103.** Consider the catalytic hydrogenation of compounds **P**, **Q** and **R** as indicated in the table. The number of carbocyclic rings and $\pi$-bonds present in compounds **P**, **Q** and **R** have been indicated. Complete the table by identifying the missing positions described by notations **W**, **X**, **Y** and **Z**

| Compound | Molecular formula before hydrogenation | Molecular formula after hydrogenation | Number of carbocyclic rings present | Number of $\pi$-bonds present |
|---|---|---|---|---|
| **P** | $C_{40}H_{56}$ | **W** | 2 | 11 |
| **Q** | **X** | $C_{10}H_{18}$ | 2 | 1 |
| **R** | $C_{15}H_{24}$ | $C_{15}H_{30}$ | **Y** | **Z** |

(a) **W** = $C_{40}H_{82}$, **X** = $C_{10}H_{22}$, **Y** = 3 and **Z** = 1

(b) **W** = $C_{40}H_{80}$, **X** = $C_{10}H_{20}$, **Y** = 2 and **Z** = 2

(c) **W** = $C_{40}H_{76}$, **X** = $C_{10}H_{22}$, **Y** = 0 and **Z** = 4

(d) **W** = $C_{40}H_{78}$, **X** = $C_{10}H_{16}$, **Y** = 1 and **Z** = 3

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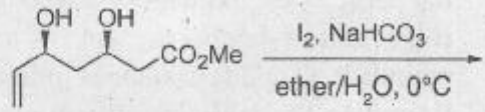
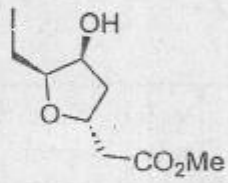
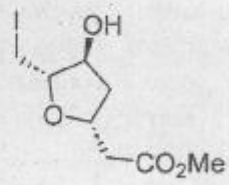
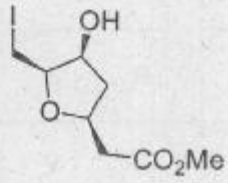
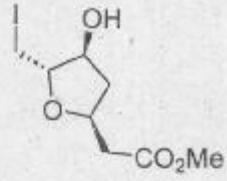
**104.** The major product formed in the following reaction is




(a)



(b)



(c)



(d)



**105.** Consider the following statements :

1. The *anti*-addition of a symmetric reagent to a symmetric *cis*-alkene gives racemic product
2. The *anti*-addition of a symmetric reagent to a symmetric *trans*-alkene gives racemic product
3. The *syn*-addition of a symmetric reagent to a symmetric *cis*-alkene gives racemic product
4. The *syn*-addition of a symmetric reagent to a symmetric *trans*-alkene gives meso product

How many of the above statement(s) is/are true ?

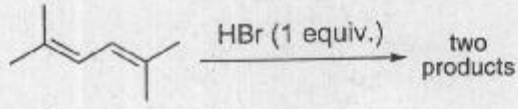
(a) Only one

(b) Only two

(c) Only three

(d) All of the above

**106.** Which one of the following statements is correct regarding the outcome of the indicated reaction ?




(a) At low and high temperature, 1,4-addition product is the major one

(b) At low and high temperature, 1,2-addition product is the major one

(c) At low temperature, 1,2-addition product is the major one while at high temperature, 1,4-addition product is the major one

(d) At low temperature, 1,4-addition product is the major one while at high temperature, 1,2-addition product is the major one

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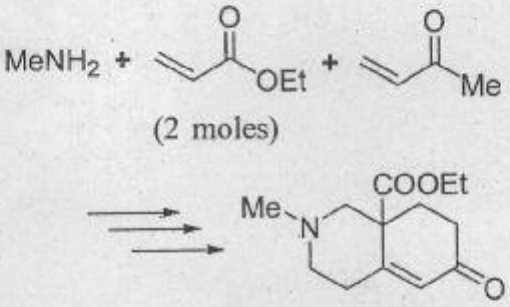
**107.** The total number of 1,4-addition reactions involved in the synthesis of target molecule [X] using the indicated starting material is/are




[X]

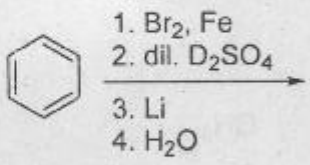
(a) One

(b) Two

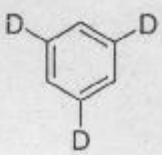
(c) Three

(d) Four

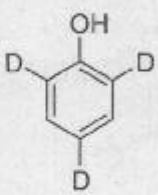
**108.** The major product formed in the following reaction sequence is




(a)




(b)

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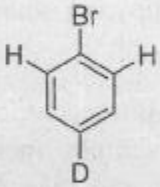


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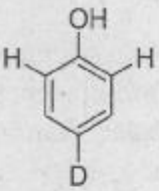
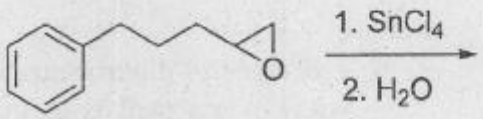
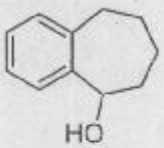


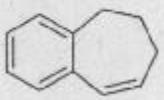

**109.** The major product formed in the following reaction is



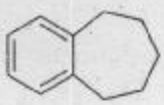

(a)



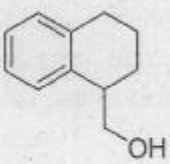

(b)



(c)



(d)

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**110.** Consider the following statements :

1. 4-Chloro-3-nitroacetophenone reacts with sodium methoxide in methanol slower than 4-chloro-3-nitrotoluene

2. 4-Chloro-3-nitroacetophenone reacts with sodium methoxide in methanol faster than 4-chloro-3-nitrotoluene

3. 1-Bromo-2,4-dinitrobenzene reacts with sodium methoxide in methanol faster than 1,4-dibromo-2-nitrobenzene

4. 1-Bromo-2,4-dinitrobenzene reacts with sodium methoxide in methanol slower than 1,4-dibromo-2-nitrobenzene

Which of the statements given above are correct ?

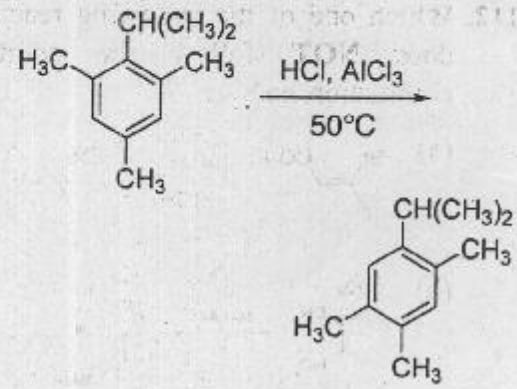
(a) 1 and 3

(b) 1 and 4

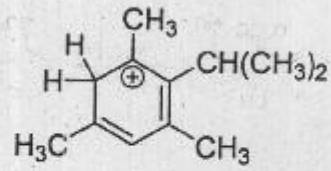
(c) 2 and 3

(d) 2 and 4

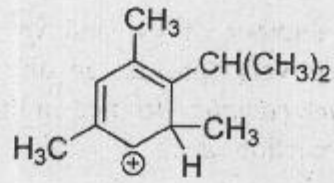
**111.** The most reasonable cyclohexadienyl cation intermediate involved in the mechanism of following isomerization reaction is



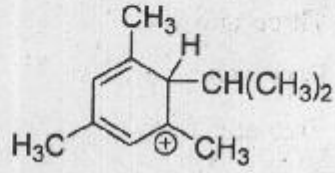

(a)



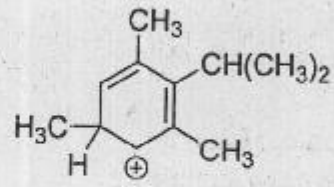

(b)




(c)




(d)

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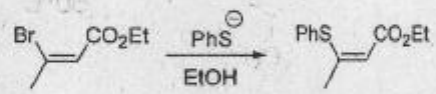
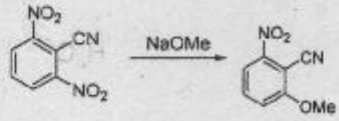
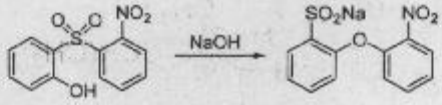
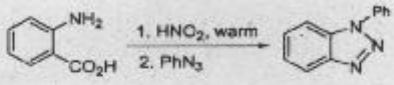
**112.** Which one of the following reactions does **NOT** follow the addition-elimination pathway ?

(a) 


(b) 


(c) 


(d) 


**113.** The number of $sp^3$ and $sp^2$ carbons, respectively, present in the *Meisenheimer complex*, formed in the following reaction are

2,4,6-Trinitroanisole $\xrightarrow{\text{NaOEt}}$ Meisenheimer complex ($NaC_9H_{10}N_3O_8$)

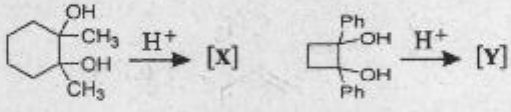
(a) Three and six

(b) Four and five

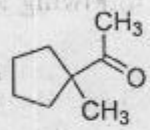
(c) Five and four

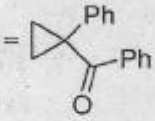
(d) Six and three

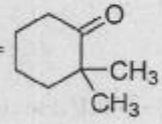
**114.** The major products [X] and [Y] formed in the following reactions are

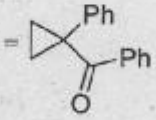


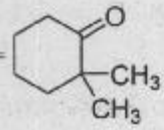

(mixture of *cis*- and *trans*-isomers)

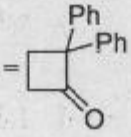
(a) [X] = 

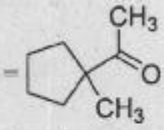
[Y] = 

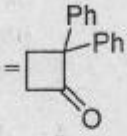

(b) [X] = 

[Y] = 

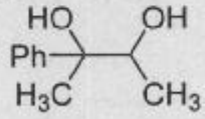

(c) [X] = 

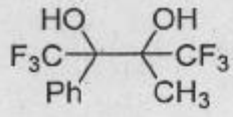
[Y] = 

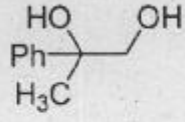

(d) [X] = 

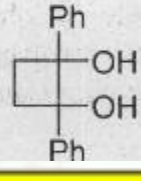
[Y] = 


**115.** Which one of the following 1,2-diols is the least reactive for acid catalyzed pinacol-pinacolone rearrangement ?

(a) 


(b) 


(c) 


(d) 

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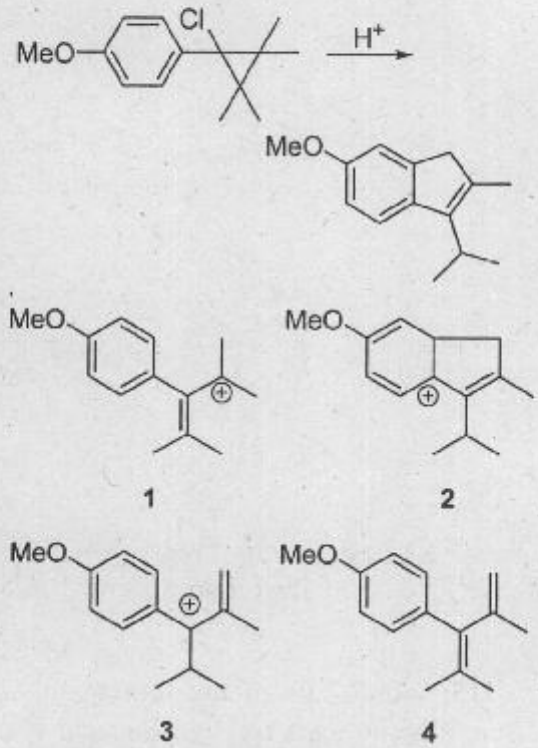
**116.** The reactive intermediates **1-4** that are likely to be formed in the given reaction are shown below :




What is the sequence of their formation in the mechanism of the above reaction ?

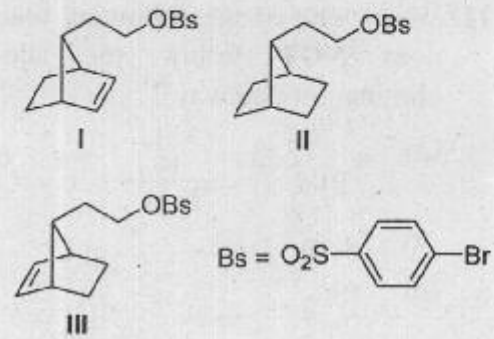
(a) 3→2→1→4

(b) 3→4→1→2

(c) 1→3→4→2

(d) 1→4→3→2

**117.** The relative order of reactivity for solvolysis of the following compounds in acetic acid is



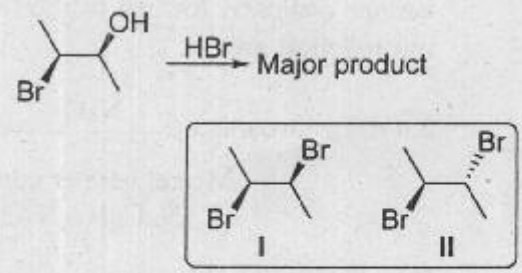

(a) **III < I < II**

(b) **I < III < II**

(c) **II < I < III**

(d) **II < III < I**

**118.** Which one of the following statements about the indicated reaction is correct ?




(a) The major product of the reaction is **I** and is achiral

(b) The major product of the reaction is **I** and is chiral

(c) The major product of the reaction is **II** and is chiral

(d) The major product of the reaction is **II** and is achiral

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**119.** The major product formed in **Reaction I** and **Reaction II** are

**Reaction I** :

(1*R*,2*R*)-2-bromocyclohexan-1-ol $\xrightarrow{H^+}$

**Reaction II** :

(1*S*,2*R*)-2-bromocyclohexan-1-ol $\xrightarrow{H^+}$

(a) **Reaction I** :
(1*S*,2*S*)-1,2-dibromocyclohexane

**Reaction II** :
(1*S*,2*S*)-1,2-dibromocyclohexane

(b) **Reaction I** :
(1*R*,2*S*)-1,2-dibromocyclohexane

**Reaction II** :
(1*R*,2*S*)-1,2-dibromocyclohexane

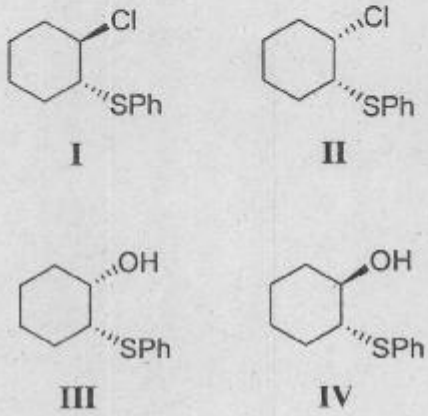
(c) **Reaction I** :
(1*R*,2*R*)-1,2-dibromocyclohexane

**Reaction II** :
(1*R*,2*S*)-1,2-dibromocyclohexane

(d) **Reaction I** :
(1*R*,2*R*)-1,2-dibromocyclohexane

**Reaction II** :
(1*R*,2*R*)-1,2-dibromocyclohexane

**120.** In the solvolysis reactions of **I** and **II** in aqueous ethanol, which one of the following statements is true ?




(a) **I** reacts faster than **II** and the major product formed is **III**

(b) **I** reacts faster than **II** and the major product formed is **IV**

(c) **II** reacts faster than **I** and the major product formed is **III**

(d) **II** reacts faster than **I** and the major product formed is **IV**

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