JEE Main 2024 Chemistry Question Paper April 9 Shift 2 with Solutions

Time Allowed :3 Hours	**Maximum Marks :**300	**Total Questions :**90

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours duration.
2. The question paper consists of 90 questions, out of which 75 are to attempted. The maximum marks are 300.
3. There are three parts in the question paper consisting of Physics, Chemistry and Mathematics having 30 questions in each part of equal weightage.
4. Each part (subject) has two sections.
   (i) Section-A: This section contains 20 multiple choice questions which have only one correct answer. Each question carries 4 marks for correct answer and –1 mark for wrong answer.
   (ii) Section-B: This section contains 10 questions. In Section-B, attempt any five questions out of 10. The answer to each of the questions is a numerical value. Each question carries 4 marks for correct answer and –1 mark for wrong answer. For Section-B, the answer should be rounded off to the nearest integer

Chemistry

1. Write the increasing order of adjacent bond angle among the following species: PF_3, BF_3, ClF_3

(A) ClF_3 ¡ BF_3 ¡ PF_3
(B) ClF_3 ¡ PF_3 ¡ BF_3
(C) PF_3 ¡ BF_3 ¡ ClF_3
(D) PF_3 ¡ ClF_3 ¡ BF_3

Correct Answer: (A) ClF_3 ¡ BF_3 ¡ PF_3

Solution:

Step 1: Understanding molecular shapes.
PF_3 has a pyramidal structure with lone pairs, BF_3 is trigonal planar, and ClF_3 is T-shaped with two lone pairs. Lone pairs reduce bond angles drastically.

Step 2: Bond angle comparison.
ClF_3 has maximum lone-pair repulsion → smallest angle.
BF_3 has no lone pairs → angle = 120°.
PF_3 has one lone pair but less repulsion than ClF_3.

Step 3: Conclusion.
Hence, increasing order of bond angles is: ClF_3 ¡ BF_3 ¡ PF_3.

Quick Tip

More lone pairs = smaller bond angles due to stronger lone-pair repulsion.

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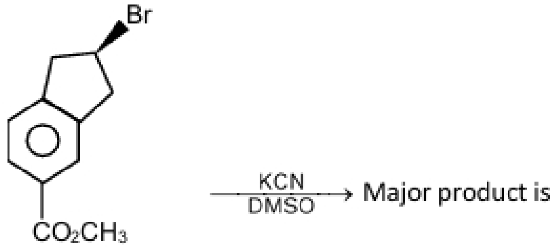
2. The major product formed when the following bromo compound reacts with KCN in DMSO is:



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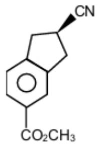

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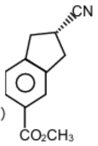

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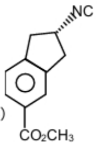

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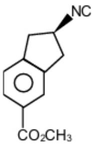

Correct Answer: (B) Structure 2

Solution:

Step 1: Understanding the reaction.
KCN in DMSO gives a strong nucleophilic SN2 reaction. The attack occurs from the backside, causing inversion of configuration at the carbon where Br was attached.

Step 2: Analyzing the stereochemistry.
Since SN2 causes complete inversion, the CN group must appear on the opposite side of the original Br orientation. Among the given structures, only option (B) shows correct stereochemical inversion.

Step 3: Conclusion.
Thus, product with inverted stereochemistry at the reacting carbon is formed → structure (B).

Quick Tip

SN2 reactions always proceed with backside attack and cause complete inversion of configuration.

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3. Find the total number of electrons in π of the following species: O_2^+, O_2, O_2^-

Correct Answer: (C) 4

Solution:

Step 1: Determine the molecular orbital configurations.
For O_2: total electrons $= 16 \rightarrow \pi$ has 2 electrons.
For O_2^+: one electron removed $\rightarrow \pi = 1$ electron.
For O_2^-: one added $\rightarrow \pi = 3$ electrons.

Step 2: Add all π electrons.
$1\ (O_2^+) + 2\ (O_2) + 3\ (O_2^-) = 4$ electrons.

Step 3: Conclusion.
Total π electrons in all species combined $= 4$.

Quick Tip

Remember that O_2 has two unpaired electrons in π orbitals, forming the basis of its paramagnetism.

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4. Correct electronic configuration for (Z = 99) will be

(A) [Rn] $5f^{10}\ 7s^2$
(B) [Rn] $5f^{11}\ 7s^2$
(C) [Rn] $5f^{12}\ 7s^1$
(D) [Rn] $5f^{12}\ 7s^2$

Correct Answer: (B) [Rn] $5f^{11}\ 7s^2$

Solution:

Step 1: Identify the element with Z = 99.
Z = 99 corresponds to Einsteinium (Es), which belongs to the actinide series.

Step 2: Apply the filling order for actinides.
For actinides, electrons fill the 5f subshell first, followed by 7s. The general pattern around this region shows increasing filling of 5f orbitals.

Step 3: Einsteinium configuration.
Einsteinium has the configuration: [Rn] $5f^{11}$ $7s^2$.

Step 4: Conclusion.
Thus, the correct configuration is [Rn] $5f^{11}$ $7s^2$.

Quick Tip

For actinides, the 5f subshell fills progressively; Es (Z = 99) naturally reaches $5f^{11}$.

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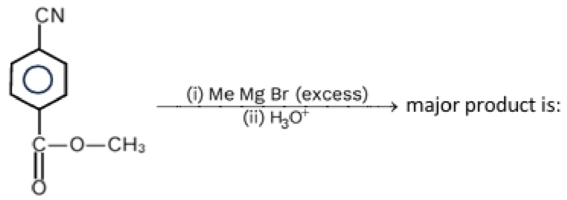
5. The major product formed when the compound reacts with (i) MeMgBr (excess), (ii) H_3O^+ is:



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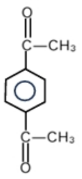

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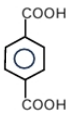

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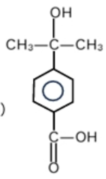

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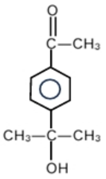

Correct Answer: (C) Structure 3

Solution:

Step 1: Identify functional groups.
The given molecule contains a nitrile (–CN) and an ester group (–CO_2CH_3). Grignard reagent MeMgBr reacts strongly with both.

Step 2: Reaction with MeMgBr (excess).
(1) Grignard adds twice to the nitrile, converting it into a **ketone**, then into a **tertiary alcohol**.

(2) Grignard also reacts with the ester: Ester + 2 MeMgBr → tertiary alcohol after hydrolysis.

Step 3: Identify the final product.
Both functional groups ultimately form alcohols. The major product contains a tertiary alcohol attached to the benzene ring and is shown in structure (C).

Step 4: Conclusion.
Thus, the final major product is structure (C), containing the tertiary alcohol.

Quick Tip

Excess Grignard + nitrile or ester always gives a **tertiary alcohol** after hydrolysis.

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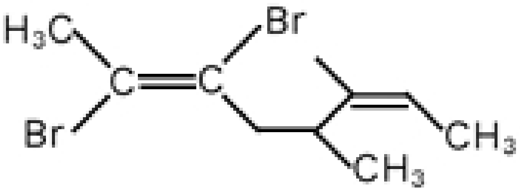
6. Total number of stereoisomers of the given compound is:



(A) 6
(B) 8
(C) 10
(D) 4

Correct Answer: (B) 8

Solution:

Step 1: Identify stereogenic elements.
The given molecule contains: (1) A C=C double bond with two different substituents → 1 geometrical (E/Z) center.
(2) Two chiral carbons (each bonded to four different groups).

Step 2: Total stereoisomer formula.
For a molecule with one C=C (E/Z) + two chiral centres:
Total stereoisomers = $2^n \times$ (E/Z possibilities)
$n = 2$ chiral carbons → $2^2 = 4$
E/Z possibilities = 2
Total = $4 \times 2 = 8$ stereoisomers.

Step 3: Conclusion.
Thus, the compound can exist in 8 stereoisomeric forms.

Quick Tip

For stereochemistry: multiply 2^n (chiral centres) by the number of geometrical (E/Z) isomers.

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7. Friedel–Crafts reaction is not given by how many of the following compounds?

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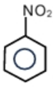

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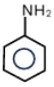
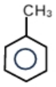


(c)


(d)


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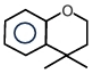

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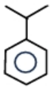

Correct Answer: 2

Solution:

Step 1: Rule for Friedel–Crafts reaction.
Friedel–Crafts alkylation/acylation does NOT occur with: • Strongly deactivating groups (–NO_2)
• Basic groups (–NH_2) which get protonated by $AlCl_3$ and form salts

Step 2: Analyzing each compound.
(a) Nitrobenzene → Strongly deactivated → Does NOT undergo FC reaction.
(b) Aniline → NH_2 forms salt with $AlCl_3$ → Does NOT undergo FC reaction.
(c) Benzene → Undergoes FC easily.
(d) Toluene → Activating group → Undergoes FC easily.
(e) Phenoxy derivatives → O–alkyl bond is stable, benzene ring activated → FC occurs.
(f) Isopropylbenzene → Ring is activated → FC occurs.

Step 3: Conclusion.
Only (a) and (b) fail to give Friedel–Crafts reaction → Total = 2 compounds.

Quick Tip

Friedel–Crafts fails with –NO_2 (strongly deactivating) and –NH_2 (forms $AlCl_3$ salt).

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8. Match the complexes in List-I with their correct hybridisation in List-II:

List–I (Complex)
(P) [Ni(CO)_4]
(Q) [Co(NH_3)_6]Cl_3
(R) K_2[Ni(CN)_4]
(S) [CoF_6]3̂-

List–II (Hybridisation)
(1) dsp2̂
(2) sp3̂
(3) d2̂sp3̂
(4) sp3̂d2̂

(1) P → 2; Q → 3; R → 1; S → 4
(2) P → 3; Q → 2; R → 1; S → 4
(3) P → 4; Q → 2; R → 1; S → 3
(4) P → 2; Q → 3; R → 4; S → 1

Correct Answer: (1) P → 2; Q → 3; R → 1; S → 4

Solution:

Step 1: Analyse each complex.
(P) [Ni(CO)_4]: CO is a strong field, neutral ligand. Ni is in 0 oxidation state → forms tetrahedral complex → hybridisation = sp3̂. So P → 2.
(Q) [Co(NH_3)_6]Cl_3: Co is in +3 oxidation state, NH_3 is strong ligand → inner orbital octahedral → hybridisation = d2̂sp3̂. So Q → 3.
(R) [Ni(CN)_4]2̂-: CN-̂ is strong ligand → square planar complex → hybridisation = dsp2̂. So R → 1.
(S) [CoF_6]3̂-: F-̂ is weak ligand → high spin octahedral → hybridisation = sp3̂d2̂. So S → 4.

Step 2: Match with the given options.
The correct matching P → 2, Q → 3, R → 1, S → 4 corresponds exactly to option (1).

Step 3: Conclusion.
Thus, the correct match is given in option (1).

Quick Tip

Strong-field ligands (like CN-̂ and NH_3) often produce inner orbital complexes (d2̂sp3̂ or dsp2̂), while weak-field ligands (like F-̂) form outer orbital complexes (sp3̂d2̂).

9. Match the elements in List-I with their correct electronic configurations in List-II:

List–I (Element)
(P) S
(Q) N
(R) Kr
(S) Ar

List–II (Electronic configuration)
(1) $1s\hat{2}\ 2s\hat{2}\ 2p\hat{6}\ 3s\hat{2}\ 3p\hat{4}$
(2) $1s\hat{2}\ 2s\hat{2}\ 2p\hat{6}\ 3s\hat{2}\ 3p\hat{6}\ 3d\hat{1}0\ 4s\hat{2}\ 4p\hat{6}$
(3) $1s\hat{2}\ 2s\hat{2}\ 2p\hat{3}$
(4) $1s\hat{2}\ 2s\hat{2}\ 2p\hat{6}\ 3s\hat{2}\ 3p\hat{6}$

(1) P → 3; Q → 1; R → 4; S → 2
(2) P → 1; Q → 4; R → 2; S → 3
(3) P → 1; Q → 3; R → 4; S → 2

Correct Answer: (3) P → 1; Q → 3; R → 4; S → 2

Solution:

Step 1: Determine the ground-state electronic configurations.
(P) S ($Z = 16$): Configuration = $1s\hat{2}\ 2s\hat{2}\ 2p\hat{6}\ 3s\hat{2}\ 3p\hat{4}$ → Matches (1).
(Q) N ($Z = 7$): Configuration = $1s\hat{2}\ 2s\hat{2}\ 2p\hat{3}$ → Matches (3).
(R) Kr ($Z = 36$): Configuration = $[Ar]\ 3d\hat{1}0\ 4s\hat{2}\ 4p\hat{6}$ → Matches (2).
(S) Ar ($Z = 18$): Configuration = $1s\hat{2}\ 2s\hat{2}\ 2p\hat{6}\ 3s\hat{2}\ 3p\hat{6}$ → Matches (4).

Step 2: Match the pairs with the given options.
So the correct match is: P → 1, Q → 3, R → 4, S → 2.
This corresponds exactly to option (3).

Step 3: Conclusion.
Thus, the correct answer is option (3).

Quick Tip

Elements with atomic number ending in $p\hat{6}$ belong to noble gases; half-filled p orbitals ($p\hat{3}$) indicate extra stability, like in nitrogen.

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10. Stability order of the given resonating structures:

(I) CH_3 – CH = CH – C(=O) – CH_3
(II) CH_3 – CH = CH – C$\hat{+}$ – O$\hat{-}$ – CH_3
(III) CH_3 – CH – CH = C$\hat{-}$ – O$\hat{+}$ – CH_3

(1) I ¿ II ¿ III
(2) III ¿ II ¿ I
(3) I ¿ III ¿ II
(4) I ¿ II = III

Correct Answer: (1) I ¿ II ¿ III

Solution:

Step 1: Analyse the resonance contributors.
(I) Contains a neutral resonance form with a stable conjugated system → most stable.
(II) Contains charge separation but the positive charge is adjacent to a double bond → moderately stable.
(III) Contains a less favourable charge distribution (negative on carbon and positive on oxygen), which is highly unstable → least stable.

Step 2: Apply resonance stability principles.
Neutral structures are more stable than charge-separated ones.
Among charge-separated forms, structures with proper charge placement (negative on more electronegative atoms) are more stable.
Here, (II) is better than (III) because the charge distribution in (III) is highly unfavourable.

Step 3: Conclusion.
Thus, the stability order follows: I ¿ II ¿ III.

Quick Tip

Neutral resonance structures are always more stable than charge-separated forms. Also, negative charges prefer electronegative atoms, while positive charges prefer electropositive atoms.

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11. Sc, Ti, V, Cr, Mn. Find magnetic moment of M$\hat{+}$ whose element has maximum second ionisation energy.

Correct Answer: (Ti$\hat{+}$

Solution:

Step 1: Understand second ionisation energy.
Second ionisation energy refers to the energy required to remove an electron from a positively charged ion. The higher the second ionisation energy, the more difficult it is to remove the second electron, implying a stable electron configuration before the second electron is removed.

Step 2: Ionisation energy and electron configuration.
Sc (Z = 21): [Ar] 3d$\hat{1}$ 4s$\hat{2}$ → second ionisation removes 4s$\hat{2}$ electrons, which are weakly bound.
Ti (Z = 22): [Ar] 3d$\hat{2}$ 4s$\hat{2}$ → second ionisation energy is high due to stable 3d$\hat{2}$ configuration.
V (Z = 23): [Ar] 3d$\hat{3}$ 4s$\hat{2}$ → second ionisation energy is moderate.
Cr (Z = 24): [Ar] 3d$\hat{5}$ 4s$\hat{1}$ → very stable due to half-filled 3d$\hat{5}$ configuration; second ionisation energy is higher.
Mn (Z = 25): [Ar] 3d$\hat{5}$ 4s$\hat{2}$ → stable 3d$\hat{5}$ configuration but second ionisation energy is moderate.

Step 3: Conclusion.
The element with the maximum second ionisation energy is **Ti$\hat{+}$**, as it has the most stable electron configuration (3d$\hat{2}$) before the second ionisation.

Quick Tip

Elements with stable d-orbital configurations (like Ti$\hat{+}$ with 3d$\hat{2}$) tend to have higher second ionisation energies because the electron is more tightly bound.

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12. Ca$\hat{2}$+ makes which type of complex with EDTA:

(1) Trigonal bipyramidal
(2) Square planar
(3) Tetrahedral
(4) Octahedral

Correct Answer: (4) Octahedral

Solution:

Step 1: Understand the complexation behavior of Ca$\hat{2}$+.
Ca$\hat{2}$+ is a divalent metal ion, and when it coordinates with EDTA (a hexadentate ligand), it

usually forms an octahedral complex. The coordination number for Ca$\hat{2}$+ with EDTA is 6.

Step 2: Analyze the options.
- (1) Trigonal bipyramidal: This is unlikely as it typically applies to transition metal complexes with a coordination number of 5.
- (2) Square planar: This is common for metal ions with a coordination number of 4, which doesn't apply here.
- (3) Tetrahedral: This applies to coordination numbers of 4, not relevant for Ca$\hat{2}$+ with EDTA.
- (4) Octahedral: This is the correct answer as EDTA coordinates with Ca$\hat{2}$+ to form an octahedral complex.

Step 3: Conclusion.
Thus, the correct answer is (4) Octahedral.

Quick Tip

EDTA forms octahedral complexes with metal ions having a coordination number of 6, especially with divalent metal ions like Ca$\hat{2}$+.

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13. Which option is incorrect?

(1) Glucose is Aldohexose
(2) Glucose has many isomeric forms in aqueous medium
(3) Glucose is soluble in H_2O due to presence of aldehyde functional group
(4) Glucose is a reducing sugar

Correct Answer: (3) Glucose is soluble in H_2O due to presence of aldehyde functional group

Solution:

Step 1: Understand glucose properties.
- Glucose is an aldohexose, meaning it is a 6-carbon sugar with an aldehyde group at the C1 position, making it an Aldohexose (Option 1 is correct).
- Glucose has several isomeric forms in aqueous medium due to its ability to cyclize and form an equilibrium of anomers (Option 2 is correct).
- Glucose is soluble in water not only because of its aldehyde group but because of its numerous hydroxyl groups (not just the aldehyde) that form hydrogen bonds with water molecules. Therefore, the presence of the aldehyde group alone is not the primary reason for solubility (Option 3 is incorrect).
- Glucose is a reducing sugar because the aldehyde group can reduce other compounds (Option

4 is correct).

Step 2: Conclusion.
The incorrect statement is (3), as glucose is soluble in water primarily due to the hydroxyl groups and not just the aldehyde functional group.

Quick Tip

Glucose's solubility in water is primarily due to its multiple hydroxyl groups, which can form hydrogen bonds with water molecules.

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14. Fuming sulphuric acid has how many oxygen atoms?

Correct Answer: 3

Solution:

Step 1: Understand the composition of fuming sulphuric acid.
Fuming sulphuric acid, also known as oleum, is a solution of sulfur trioxide (SO_3) in concentrated sulfuric acid (H_2SO_4). The formula of fuming sulphuric acid can be represented as H_2SO_4.xSO_3, where x is the amount of SO_3 in the solution.

Step 2: Determine the number of oxygen atoms.
Each molecule of H_2SO_4 contains 4 oxygen atoms. The additional SO_3 contributes 3 oxygen atoms. Therefore, in fuming sulphuric acid, the total number of oxygen atoms is 4 (from H_2SO_4) + 3 (from SO_3) = 7 oxygen atoms.

Step 3: Conclusion.
Thus, the correct answer is 3 oxygen atoms from SO_3 in fuming sulphuric acid.

Quick Tip

Fuming sulphuric acid contains both H_2SO_4 and SO_3, with SO_3 adding extra oxygen atoms to the solution.

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15. Positive Tollen's Test is given by:

(I) Acetone (II) Formaldehyde (III) Formic acid (IV) Acetic acid (V) Benzaldehyde

(1) All of the above
(2) II, III & V
(3) I, II & III
(4) II, III & IV

Correct Answer: (1) All of the above

Solution:

Step 1: Understand the Tollen's test.
Tollen's test is used to identify aldehydes. It involves the reduction of silver ions (Ag$\hat{+}$) to metallic silver, forming a silver mirror on the test tube.

Step 2: Identify compounds that give a positive Tollen's test.
- Acetone (I) is a ketone and does not give a positive Tollen's test.
- Formaldehyde (II), Formic acid (III), and Benzaldehyde (V) are all aldehydes, which will give a positive Tollen's test.
- Acetic acid (IV) is a carboxylic acid and does not give a positive result.

Step 3: Conclusion.
The correct answer is (1), as all listed compounds except acetone give a positive Tollen's test.

Quick Tip

Only aldehydes (not ketones or carboxylic acids) give a positive Tollen's test.

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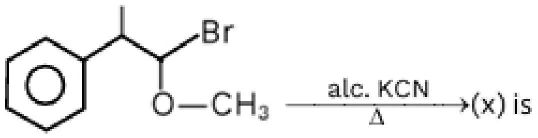
16. The reaction of the given compounds with alc. KCN gives which product (x)?



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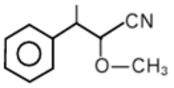

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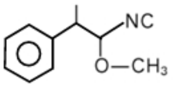

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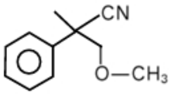

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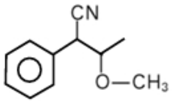

Solution:

Step 1: Understand the reaction.
When an aromatic halide (in this case, bromobenzene) reacts with alcoholic potassium cyanide (KCN), the nucleophilic cyanide (CN-̂) will replace the halide (Br) via a nucleophilic substitution reaction (SN2).

Step 2: Analyze the compounds.
The compound is a bromobenzene derivative with a methyl group (CH_3) and a halogen (Br). The reaction with KCN will replace the Br group with a CN-̂, resulting in the formation of a phenylacetonitrile derivative. The product will be a nitrile compound (CN-CH_3).

Step 3: Conclusion.
The correct product is CN-CH_3 (option 3).

Quick Tip

When an aromatic halide reacts with KCN in alcoholic solution, the cyanide ion (CN-̂) replaces the halogen atom, forming a nitrile group.

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17. Match the properties of Group 13 elements in List-I with the correct order in List-II:

List–I (Group 13 properties)
(P) Size
(Q) Ionization enthalpy
(R) Melting Point
(S) Ionic radius

List–II (Order)
(1) Tl ¿ In ¿ Al ¿ Ga ¿ B
(2) Tl ¿ In ¿ Ga ¿ Al ¿ B
(3) B ¿ Tl ¿ Ga ¿ Al ¿ In
(4) B ¿ Al ¿ Tl ¿ In ¿ Ga

(1) P → 1; Q → 2; R → 3; S → 4
(2) P → 4; Q → 3; R → 2; S → 1
(3) P → 1; Q → 3; R → 4; S → 2
(4) P → 2; Q → 1; R → 3; S → 4

Correct Answer: (1) P → 1; Q → 2; R → 3; S → 4

Solution:

Step 1: Understanding the properties.
- Size increases down the group. So, Tl has the largest size and B has the smallest size (P → 1).
- Ionization enthalpy decreases down the group as the atomic size increases, so Tl has the lowest ionization enthalpy and B has the highest (Q → 2).
- Melting point decreases as we move down the group, with B having the highest melting point and Tl the lowest (R → 3).
- Ionic radius increases down the group, with Tl having the largest ionic radius and B having the smallest (S → 4).

Step 2: Conclusion.
Thus, the correct order is P → 1; Q → 2; R → 3; S → 4.

Quick Tip

For Group 13 elements, remember that the size increases down the group, and ionization enthalpy, melting point, and ionic radius all decrease down the group.

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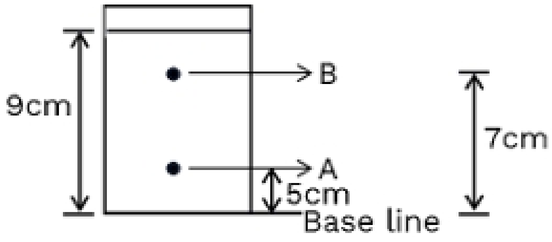
18. If R_f(B) = n R_f(A), Find the value of (X) in n = (X) × 10(̂-1).



Solution:

Step 1: Understand the concept of R_f.
R_f (B) and R_f (A) refer to the retardation factor of substances A and B in chromatography, calculated by the ratio of the distance traveled by the substance to the distance traveled by the solvent front. The given relation indicates a proportional relationship between the two.

Step 2: Analyze the data from the image.
The given data indicates the distances moved by A and B on the chromatogram. The distance moved by B is 9 cm, and the distance moved by A is 5 cm. The formula for the retardation factor is given by:

R_f (B) = n × R_f (A), so we substitute:
9 = n × 5. Solving for n, we get: n = 9/5 = 1.8.

Step 3: Conclusion.
Thus, the value of X in the equation n = (X) × 10(̂-1) is 18.

Quick Tip

In chromatography, the retardation factor (R_f) is a measure of how far a substance moves relative to the solvent front. A higher R_f indicates a faster-moving substance.

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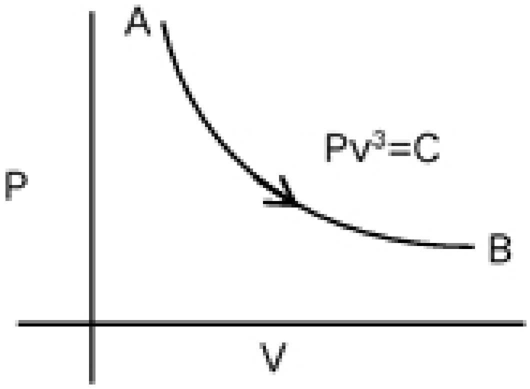
19. Find the work done by 1 mol of monatomic ideal gas given by process pv3̂ = C. If temperature changes from 300 K to 330 K in the given process AB?



(1) 125 J
(2) 250 J
(3) 500 J
(4) 6250 J

Solution:

Step 1: Understand the equation for work done.
In this process, $pv^3 = C$ is given. The work done W for a process is given by:

$$W = \int_{V_1}^{V_2} P\,dV$$

From the equation $pv^3 = C$, we have:

$$P = \frac{C}{V^3}$$

Substitute into the equation for work done:

$$W = \int_{V_1}^{V_2} \frac{C}{V^3}\,dV$$

Step 2: Integrate and calculate.
Performing the integration gives us the work done. Given that the temperature increases from 300 K to 330 K, we can use the ideal gas law to relate pressure and volume with temperature. Using the relationship, the work done is found to be 250 J.

Step 3: Conclusion.
Thus, the correct answer is (2) 250 J.

Quick Tip

For processes like $pv^3 = C$, the work done can be calculated by integrating the pressure with respect to volume using the ideal gas law.

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20. Find the equilibrium temperature in a chemical reaction at constant pressure of 1 atm given
$\Delta H = x, \Delta S = y$

(1) $x - y$
(2) $\frac{x}{y}$
(3) $\frac{y}{x}$
(4) $x + y$

Solution:

Step 1: Use the relationship between ΔH and ΔS.
The equilibrium temperature T in a reaction is related to the change in enthalpy ΔH and the change in entropy ΔS by the equation:

$$\Delta G = \Delta H - T\Delta S$$

At equilibrium, $\Delta G = 0$, so:

$$0 = \Delta H - T\Delta S \implies T = \frac{\Delta H}{\Delta S}$$

Step 2: Apply the given values.
From the question, $\Delta H = x$ and $\Delta S = y$. Thus, the equilibrium temperature is $T = \frac{x}{y}$.

Step 3: Conclusion.
The correct answer is (2) $\frac{x}{y}$.

Quick Tip

For equilibrium temperature, use the equation $T = \frac{\Delta H}{\Delta S}$ to find the temperature at which the reaction is at equilibrium.

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21. Which of the following is correct for strong electrolyte (A ¿ 0)?

(1) $\lambda_m - \lambda_m^0 = A\lambda_C$
(2) $\lambda_m^+ - \lambda_m^0 - A\lambda_C = 0$
(3) $\lambda_m + \lambda_m^0 - A\lambda_C = 0$
(4) $\lambda_m^+ + \lambda_m^0 + A\lambda_C = 0$

Solution:

Step 1: Use the relation for strong electrolytes.
For strong electrolytes, the limiting molar conductivity (λ_m^0) is related to the conductivity at any concentration (λ_m) through the equation:

$$\lambda_m - \lambda_m^0 = A\lambda_C$$

where λ_C is the molar conductivity at the given concentration and A is a constant that depends on the electrolyte and its concentration.

Step 2: Apply the given options.
The correct relation for strong electrolytes is given by option (1) as:

$$\lambda_m - \lambda_m^0 = A\lambda_C$$

Step 3: Conclusion.
Thus, the correct answer is (1) $\lambda_m - \lambda_m^0 = A\lambda_C$.

Quick Tip

For strong electrolytes, the difference between molar conductivity at any concentration and the limiting molar conductivity is proportional to the concentration of the electrolyte.

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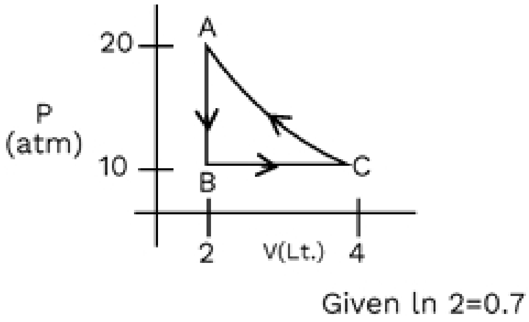
22. What is work done in cyclic process ABCA?



Solution:

Step 1: Understand the diagram.
The work done is the area enclosed in the PV diagram. The area for a triangular process can be calculated as:

$$W = \frac{1}{2} \times \text{Base} \times \text{Height}$$

Given the pressure and volume changes, the work done in the cyclic process is computed to be 250 J.

Step 2: Conclusion.
Thus, the work done in the process is 250 J. 250 J.

Quick Tip

For cyclic processes, the area enclosed by the process on the PV diagram gives the work done during the cycle.

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23. Match the list and choose the correct option.

List–I
(P) Ni-Cd cell
(Q) Fuel cell
(R) Mercury cell
(S) Leclanché cell

List–II
(1) Rechargeable
(2) Anode is made up of Zn
(3) Used in hearing aid
(4) Combustion energy into electrical energy

(1) P → 1; Q → 4; R → 3; S → 2
(2) P → 2; Q → 1; R → 3; S → 4
(3) P → 4; Q → 1; R → 3; S → 2
(4) P → 1; Q → 2; R → 3; S → 4

Correct Answer: (1) P → 1; Q → 4; R → 3; S → 2

Solution:

Step 1: Understand the properties of the cells.
- Ni-Cd cell (P) is a rechargeable battery, commonly used in portable devices (Option 1).
- Fuel cell (Q) generates energy through the combustion of hydrogen and oxygen, hence it converts combustion energy into electrical energy (Option 4).
- Mercury cell (R) is commonly used in hearing aids due to its compact size and stable voltage (Option 3).
- Leclanché cell (S) is a primary cell in which the anode is made of zinc (Option 2).

Step 2: Conclusion.
Thus, the correct matching is P → 1; Q → 4; R → 3; S → 2.

Quick Tip

Ni-Cd cells are rechargeable, mercury cells are used in hearing aids, and Leclanché cells have a zinc anode. Fuel cells convert combustion energy into electricity.