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Previous Year Paper

IIT JEE 2009

Paper- I

(with solutions)

IIT – JEE - 2009

(PAPER – 1, CODE – 1)

Time: 3 Hours **Maximum Marks: 240**

A. Question paper format:

1. The question paper consists of 3 parts (Chemistry, Mathematics and Physics). Each part has 4 sections.
2. **Section I** contains **8** multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **only one is correct.**
3. **Section II** contains **4** multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **one or more is/are correct.**
4. **Section III** contains **2** groups of questions. Each group has 3 questions based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **only one is correct.**
5. **Section IV** contains **2** questions. Each question has four statements (A, B, C and D) given in column I and five statements (p, q, r, s and t) in Column II. Any given statement in column I can have correct matching with **one or more** statements(s) given in column II. For example, if for a given question, statement B matches with the statements given in q and r, then for that particular question, against statement B, darken the bubbles corresponding to q and r in the ORS.

B. Marking scheme:

6. For each question in **Section I** you will be **awarded 3 marks** if you darken the bubble corresponding to the correct answer and **zero mark** if no bubble is darkened. In case of bubbling of incorrect answer, **minus one (-1) mark** will be awarded.
7. For each question in **Section II**, you will be **awarded 4 marks** if you darken the bubble(s) corresponding to the correct choice(s) for the answer, and **zero mark** if no bubble is darkened. In all other cases, **Minus one (-1) mark** will be awarded.
8. For each question in **Section III**, you will be **awarded 4 marks** if you darken the bubble(s) corresponding to the correct answer and **zero mark** if no bubble is darkened. In all other cases, **minus one (-1) mark** will be awarded.
9. For each question in **Section IV**, you will be **awarded 2 marks** for **each row** in which you have darkened the bubble(s) corresponding to the correct answer. Thus, each question in this section carries a maximum of **8** marks. There is **no negative marking** for incorrect answer(s) for this section.

IITJEE 2009 (PAPER-1, CODE-1)

PART I: CHEMISTRY

SECTION-I
Single Correct Choice Type

This section contains 8 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONLY ONE** is correct.

1. The Henry's law constant for the solubility of N_2 gas in water at 298 K is 1.0×10^5 atm. The mole fraction of N_2 in air is 0.8. The number of moles of N_2 from air dissolved in 10 moles of water at 298 K and 5 atm pressure is

(A) 4.0×10^{-4} (B) 4.0×10^{-5}
(C) 5.0×10^{-4} (D) 4.0×10^{-6}

Sol. **(A)**

$P = K_H \chi_{N_2}$

$0.8 \times 5 = 1 \times 10^5 \times \chi_{N_2}$

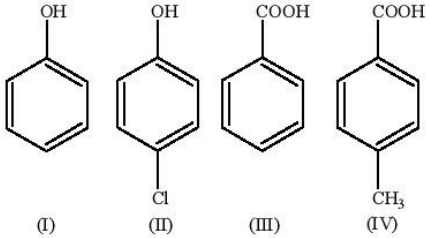
$\chi_{N_2} = 4 \times 10^{-5}$ (in 10 moles of water)

$$\Rightarrow 4\times10^{-5} = \frac{n_{N_2}}{n_{N_2}+10}$$

$n_{N_2} \times 5\times10^{-5} + 4\times10^{-4} = n_{N_2}$

$\Rightarrow n_{N_2} = 4\times10^{-4}$

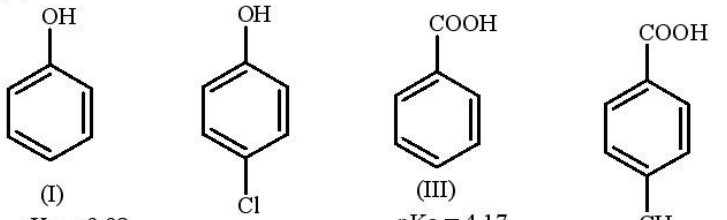
2. The correct acidity order of the following is



(I) (II) (III) (IV)

(A) (III) > (IV) > (II) > (I) (B) (IV) > (III) > (I) > (II)
(C) (III) > (II) > (I) > (IV) (D) (II) > (III) > (IV) > (I)

Sol. **(A)**



(I) pKa = 9.98
(II) pKa = 9.38
(III) pKa = 4.17
(IV) pKa = 4.37

Decreasing order of acidic strength: III > IV > II > I

3. The reaction of P_4 with X leads selectively to P_4O_6. The X is

(A) Dry O_2 (B) A mixture of O_2 and N_2

(C) Moist O_2 (D) O_2 in the presence of aqueous NaOH

Sol. **(B)**

$P_4 + 3O_2 \xrightarrow{N_2} P_4O_6$ (exclusively)

(N_2 is used to retard the further oxidation.)

4. Among cellulose, poly(vinyl chloride), nylon and natural rubber, the polymer in which the intermolecular force of attraction is weakest is

(A) Nylon (B) Poly(vinyl chloride)

(C) Cellulose (D) Natural Rubber

Sol. **(D)**

As chain of natural rubber involves weak van der Waal force of interaction.

5. Given that the abundances of isotopes ^{54}Fe, ^{56}Fe and ^{57}Fe are 5%, 90% and 5% respectively, the atomic mass of Fe is

(A) 55.85 (B) 55.95

(C) 55.75 (D) 56.05

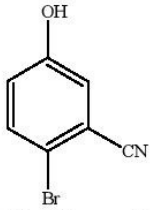
Sol. **(B)**

$$\overline{A} = \frac{\sum A_i x_i}{\sum x_i}$$

$\bar{A} = 54 \times 0.05 + 56 \times 0.90 + 57 \times 0.05$ (where $\bar{A}$ is atomic mass of Fe)

$\bar{A} = 55.95$

6. The IUPAC name of the following compound is



(A) 4-Bromo-3-cyanophenol (B) 2-Bromo-5-hydroxybenzonitrile

(C) 2-Cyano-4-hydroxybromobenzene (D) 6-Bromo-3-hdyroxybenzonitrile

Sol. **(B)**

Priority of CN is highest.

7. Among the electrolytes Na_2SO_4, $CaCl_2$, $Al_2(SO_4)_3$ and NH_4Cl, the most effective coagulating agent for Sb_2S_3 sol is

(A) Na_2SO_4 (B) $CaCl_2$

(C) $Al_2(SO_4)_3$ (D) NH_4Cl

Sol. **(C)**

As Sb_2S_3 is a negative sol, so, $Al_2(SO_4)_3$ will be the most effective coagulant due to higher charge density on Al^{3+} in accordance with Hardy-Schulze rule.

Order of effectiveness of cations: $Al^{3+} > Ca^{++} > Na^{+} > NH_4^{+}$

8. The term that corrects for the attractive forces present in a real gas in the van der Waals equation is

(A) nb (B) $\frac{an^2}{V^2}$

(C) $-\frac{an^2}{V^2}$ (D) $-nb$

Sol. **(B)**

The measure of force of attraction for 'n' moles of real gas $\left(\frac{n^2a}{V^2}\right)$

$$\left(P+\frac{n^2a}{V^2}\right)(V-nb)=nRT$$

SECTION-II
Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

9. The compound(s) formed upon combustion of sodium metal in excess air is(are)

(A) Na_2O_2 (B) Na_2O

(C) NaO_2 (D) NaOH

Sol. **(A, B) in dry air**

10. The correct statement(s) about the compound $H_3C(HO)HC–CH=CH–CH(OH)CH_3$ (X) is(are)

(A) The total number of stereoisomers possible for X is 6

(B) The total number of diastereomers possible for X is 3

(C) If the stereochemistry about the double bond in X is *trans*, the number of enantiomers possible for X is 4

(D) If the stereochemistry about the double bond in X is *cis*, the number of enantiomers possible for X is 2

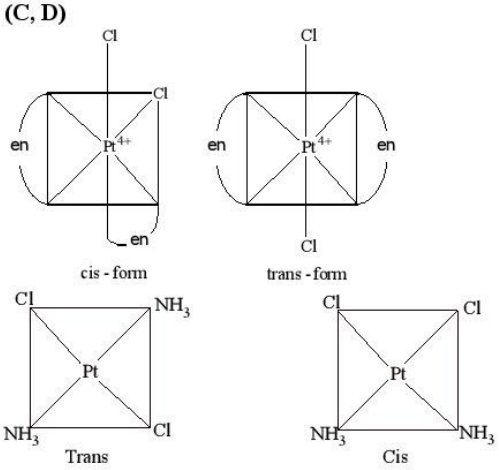
Sol. **(A, D)**

11. The compound(s) that exhibit(s) geometrical isomerism is(are)

(A) $[Pt(en)Cl_2]$ (B) $[Pt(en)_2]Cl_2$

(C) $[Pt(en)_2Cl_2]Cl_2$ (D) $[Pt(NH_3)_2Cl_2]$

Sol. **(C, D)**



12. The correct statement(s) regarding defects in solids is(are)
(A) Frenkel defect is usually favoured by a very small difference in the sizes of cation and anion
(B) Frenkel defect is a dislocation defect
(C) Trapping of an electron in the lattice leads to the formation of F-center
(D) Schottky defects have no effect on the physical properties of solids

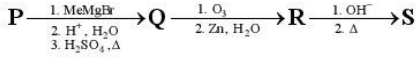
Sol. **(B, C)**

SECTION-III
Comprehension Type

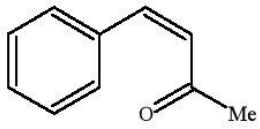
This section contains 2 groups of questions. Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

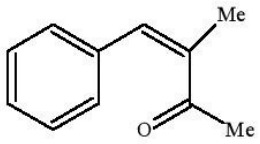
Paragraph for Question Nos. 13 to 15

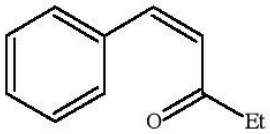
A carbonyl compound **P**, which gives positive iodoform test, undergoes reaction with MeMgBr followed by dehydration to give an olefin **Q**. Ozonolysis of **Q** leads to a dicarbonyl compound **R**, which undergoes intramolecular aldol reaction to give predominantly **S**.

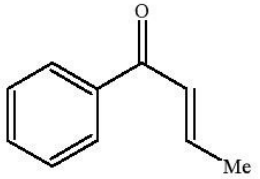


13. The structure of the carbonyl compound **P** is

(A) 

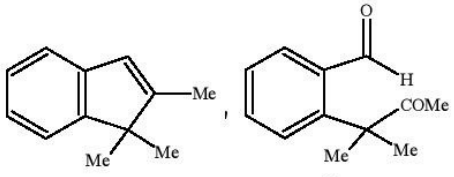
(B) 

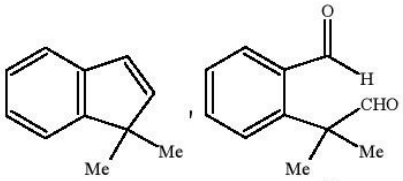
(C) 

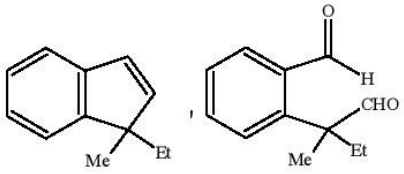
(D) 

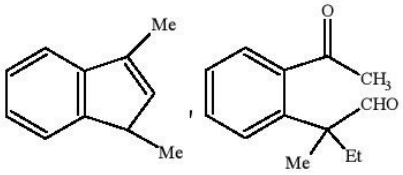
Sol. **(B)**

14. The structure of the products **Q** and **R**, respectively, are

(A) 

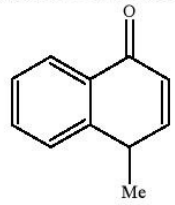
(B) 

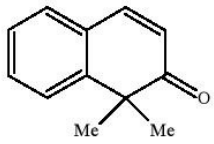
(C) 

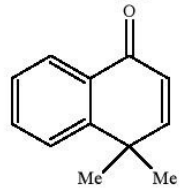
(D) 

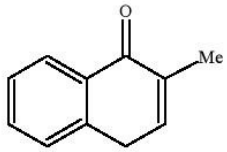
Sol. **(A)**

15. The structure of the product **S** is

(A) 

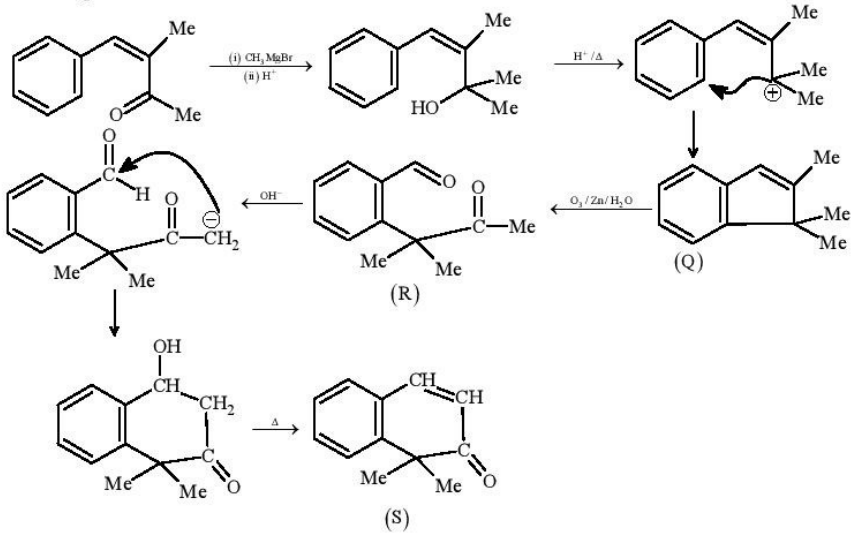
(B) 

(C) 

(D) 

Sol. **(B)**

Solution for the question nos. 13 to 15



Paragraph for Question Nos. 16 to 18

p-Amino-*N*, *N*-dimethylaniline is added to a strongly acidic solution of **X**. The resulting solution is treated with a few drops of aqueous solution of **Y** to yield blue coloration due to the formation of methylene blue. Treatment of the aqueous solution of **Y** with the reagent potassium hexacyanoferrate (II) leads to the formation of an intense blue precipitate. The precipitate dissolves on excess addition of the reagent. Similarly, treatment of the solution of **Y** with the solution of potassium hexacyanoferrate (III) leads to a brown coloration due to the formation of **Z**.

16. The compound **X** is

(A) $NaNO_3$ (B) NaCl

(C) Na_2SO_4 (D) Na_2S

Sol. **(D)**

17. The compound Y is

(A) $MgCl_2$ (B) $FeCl_2$

(C) $FeCl_3$ (D) $ZnCl_2$

Sol. **(C)**

18. The compound Z is

(A) $Mg_2[Fe(CN)_6]$ (B) $Fe[Fe(CN)_6]$

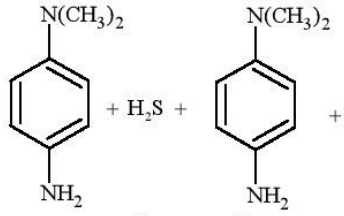
(C) $Fe_4[Fe(CN)_6]_3$ (D) $K_2Zn_3[Fe(CN)_6]_2$

Sol. **(B)**

Solution for the question nos. 16 to 18

$$Na_2S + 2H^+ \longrightarrow H_2S + 2Na^+$$

(X)



$$+ 6Fe^{3+} \longrightarrow 6Fe^{2+} + NH_4^+ + 4H^+ + \text{Methylene Blue}$$

(Y)

$$4FeCl_3 + 3K_4\left[\overset{II}{Fe}(CN)_6\right] \longrightarrow Fe_4\left[Fe(CN)_6\right]_3 + 2KCl$$

Intense blue

$$FeCl_3 + K_3\left[Fe(CN)_6\right] \longrightarrow Fe\left[Fe(CN)_6\right] + 3KCl$$

Brown coloration

(X) – Na_2S

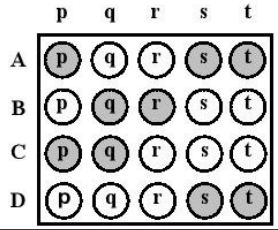
(Y) – $FeCl_3$

(Z) – $Fe[Fe(CN)_6]$

SECTION – IV
Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



19. Match each of the compounds in **Column I** with its characteristic reaction(s) in **Column II**.

	Column – I		**Column – II**
(A)	$CH_3CH_2CH_2CN$	(p)	Reduction with $Pd–C/H_2$
(B)	$CH_3CH_2OCOCH_3$	(q)	Reduction with $SnCl_2/HCl$
(C)	$CH_3–CH=CH–CH_2OH$	(r)	Development of foul smell on treatment with chloroform and alcoholic KOH
(D)	$CH_3CH_2CH_2CH_2NH_2$	(s)	Reduction with diisobutylaluminium hydride (DIBAL-H)
		(t)	Alkaline hydrolysis

Sol. **((A – p, q, s, t) (B – s, t) (C – p) (D – r))**

20. Match each of the diatomic molecules in **Column I** with its property/properties in **Column II**.

	Column – I		**Column – II**
(A)	B_2	(p)	Paramagentic
(B)	N_2	(q)	Undergoes oxidation
(C)	O_2^-	(r)	Undergoes reduction
(D)	O_2	(s)	Bond order ≥ 2
		(t)	Mixing of 's' and 'p' orbitals

Sol. **((A – p, r, t) (B – s, t) (C – p, q) (D – p, q, s))** [According to MOT]

PART II: MATHEMATICS

SECTION–I
Single Correct Choice Type

This section contains 8 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

21. Let $z = x + iy$ be a complex number where x and y are integers. Then the area of the rectangle whose vertices are the roots of the equation $\bar{z}z^3 + z\bar{z}^3 = 350$ is

(A) 48 (B) 32

(C) 40 (D) 80

Sol. **(A)**

$z\bar{z}(\bar{z}^2 + z^2) = 350$

Put $z = x + iy$

$(x^2 + y^2)(x^2 - y^2) = 175$

$(x^2 + y^2)(x^2 - y^2) = 5 \cdot 5 \cdot 7$

$x^2 + y^2 = 25$

$x^2 - y^2 = 7$

$x = \pm 4, y = \pm 3$

$x, y \in I$

Area $= 8 \times 6 = 48$ sq. unit.

22. If $\vec{a}$, $\vec{b}$, $\vec{c}$ and $\vec{d}$ are unit vectors such that $(\vec{a} \times \vec{b}) \cdot (\vec{c} \times \vec{d}) = 1$ and $\vec{a} \cdot \vec{c} = \frac{1}{2}$, then

(A) $\vec{a}$, $\vec{b}$, $\vec{c}$ are non-coplanar (B) $\vec{b}$, $\vec{c}$, $\vec{d}$ are non-coplanar

(C) $\vec{b}$, $\vec{d}$ are non-parallel (D) $\vec{a}$, $\vec{d}$ are parallel and $\vec{b}$, $\vec{c}$ are parallel

Sol. **(C)**

$(\vec{a} \times \vec{b}) \cdot (\vec{c} \times \vec{d}) = 1$ possible only when $|\vec{a} \times \vec{b}| = |\vec{c} \times \vec{d}| = 1$

and $(\vec{a} \times \vec{b}) \parallel (\vec{c} \times \vec{d})$

Since $\vec{a} \cdot \vec{c} = 1/2$ and $\vec{b} \parallel \vec{d}$, then $|\vec{c} \times \vec{d}| \neq 1$.

23. The line passing through the extremity A of the major axis and extremity B of the minor axis of the ellipse $x^2 + 9y^2 = 9$ meets its auxiliary circle at the point M. Then the area of the triangle with vertices at A, M and the origin O is

(A) $\frac{31}{10}$ (B) $\frac{29}{10}$

(C) $\frac{21}{10}$ (D) $\frac{27}{10}$

Sol. **(D)**

Equation of line AM is $x + 3y - 3 = 0$

Perpendicular distance of line from origin $= \frac{3}{\sqrt{10}}$

Length of AM $= 2\sqrt{9-\frac{9}{10}} = 2\times\frac{9}{\sqrt{10}}$

$\Rightarrow$ Area $= \frac{1}{2}\times 2\times\frac{9}{\sqrt{10}}\times\frac{3}{\sqrt{10}} = \frac{27}{10}$ sq. units.

24. Let $z = \cos\theta + i\sin\theta$. Then the value of $\sum_{m=1}^{15} \text{Im}(z^{2m-1})$ at $\theta = 2°$ is

(A) $\frac{1}{\sin 2°}$ (B) $\frac{1}{3\sin 2°}$

(C) $\frac{1}{2\sin 2°}$ (D) $\frac{1}{4\sin 2°}$

Sol. **(D)**

$X = \sin\theta + \sin3\theta + \ldots + \sin29\theta$

$2(\sin\theta)X = 1 - \cos2\theta + \cos2\theta - \cos4\theta + \ldots + \cos28\theta - \cos30\theta$

$X = \frac{1-\cos30\theta}{2\sin\theta} = \frac{1}{4\sin 2°}$

25. Let P(3, 2, 6) be a point in space and Q be a point on the line $\vec{r} = (\hat{i} - \hat{j} + 2\hat{k}) + \mu(-3\hat{i} + \hat{j} + 5\hat{k})$. Then the value of μ for which the vector $\overrightarrow{PQ}$ is parallel to the plane $x - 4y + 3z = 1$ is

(A) $\frac{1}{4}$ (B) $-\frac{1}{4}$

(C) $\frac{1}{8}$ (D) $-\frac{1}{8}$

Sol. **(A)**

Any point on the line can be taken as

$Q \equiv \{(1-3\mu),\ (\mu-1),\ (5\mu+2)\}$

$\overrightarrow{PQ} = \{-3\mu - 2,\ \mu - 3,\ 5\mu - 4\}$

Now, $1(-3\mu - 2) - 4(\mu - 3) + 3(5\mu - 4) = 0$

$\Rightarrow -3\mu - 2 - 4\mu + 12 + 15\mu - 12 = 0$

$8\mu = 2 \Rightarrow \mu = 1/4.$

26. The number of seven digit integers, with sum of the digits equal to 10 and formed by using the digits 1, 2 and 3 only, is

(A) 55 (B) 66

(C) 77 (D) 88

Sol. **(C)**

Coefficient of x^{10} in $(x + x^2 + x^3)^7$

IIT JEE QUESTION PAPERS PAPER 1 WITH SOLUTIONS 2009

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