

FIITJEE INTERNAL TEST

IIT – JEE SECOND YEAR 2019-21 2015 P2

Time: 3 hours

INSTRUCTIONS:

Maximum Marks: 240

Dated: 27-05-2020

A. General

1. This booklet is your Question Paper containing 60 questions.
2. Blank papers, clipboards, log tables, slide rules, calculators, cellular phones, pagers and electronic gadgets in any form are not allowed to be carried inside the examination hall.
3. Fill in the boxes provided for Name and Enrolment No.
4. The answer sheet, a machine-readable Objective Response (ORS), is provided separately.
5. DO NOT TAMPER WITH / MULTILATE THE ORS OR THE BOOKLET.

B. Filling in the OMR:

6. The instructions for the OMR sheet are given on the OMR itself.

C. Question paper format:

7. The question paper consists of **3 parts (Physics, Chemistry and Mathematics)**. Each part consists of **two sections**.
8. **Section I** contains **8 questions**. The answer to each question is a **single digit integer**, ranging from 0 to 9 (both inclusive).
9. **Section II** contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE** are correct.
10. **Section III** contains **2 paragraphs** type questions. Each paragraph describes an experiment, a situation or a problem. Two multiple choice questions will be asked based on this paragraph. One or more than one option can be correct.

D. Marking Scheme

11. For each question in **Section I**, you will be awarded **4 marks** if you darken ALL the bubble(s) corresponding to the correct answer(s) **ONLY**. In all other cases **zero (0) marks** will be awarded. **No negative marks** will be awarded for incorrect answers in this section.
12. For each question in **Section II**, you will be awarded **4 marks** if you darken ALL the bubble(s) corresponding to the correct answer(s) **ONLY**. In all other cases **zero (0) marks** will be awarded. **-2 marks** will be awarded for incorrect answers in this section.
13. For each question in **Section III**, you will be awarded **4 marks** if you darken ALL the bubble(s) corresponding to the correct answer(s) **ONLY**. In all other cases **zero (0) marks** will be awarded. **-2 marks** will be awarded for incorrect answers in this section.

Don't write / mark your answers in this question booklet.

If you mark the answers in question booklet, you will not be allowed to continue the exam.

NAME:

ENROLLMENT NO.:

PAPER – II
PART I: PHYSICS
SECTION 1 (Maximum Marks: 32)

- ◆ This section contains **EIGHT** questions
- ◆ The answer to each question is a **SINGLE DIGIT INTEGER** ranging from **0 to 9**, both inclusive
- ◆ For each question, darken the bubble corresponding to the correct integer in the ORS

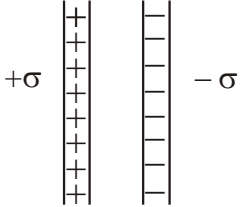
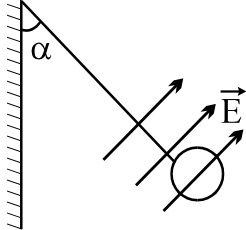
◆ **Marking scheme:**

- +4** If the bubble corresponding to the answer is darkened
0 In all other cases

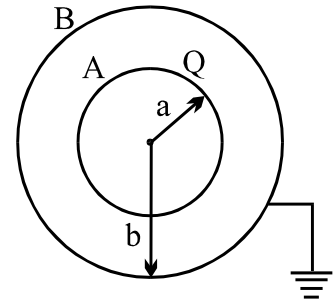
1. A uniform surface charge density 8σ exists over the entire xy -plane except for a circular hole of radius 'a' centered at the origin. The electric field at a point $P(0,0,\sqrt{3}a)$. On the z -axis is found to be $2\sqrt{x}\sigma/\epsilon_0$. $x = ?$
2. A thin fixed ring of radius 1m and charge 10^{-5}C is uniformly distributed over it. A particle of mass 0.9 g and a $-ve$ charge of 10^{-6}C is released on its axis at 1 cm from its centre. Time period of oscillations of the mass is π/k . Find k .
3. A solid sphere of radius R and charge Q distributed over its volume. Its charge density is $\rho = kr^a$, where k and a are constants. If electric field at $r = R/2$ is $1/8$ times that at $r = R$, find $a = ?$
4. The half part of a hollow hemisphere of radius R has a uniform charge density σ over its surface. The electric field at its centre is $\sigma/4\sqrt{k}\epsilon_0$. $k = ?$
5. The electric field in a region is given by $\vec{E} = \frac{2(x\hat{i} + y\hat{j} + z\hat{k})}{(x^2 + y^2 + z^2)^{3/2}}$. The flux through the surface of a cube of side 'L' centered at the origin is $a\pi$. Find a .
6. Two point particles of mass M and charges $+q$ and $-q$ are attached to the ends of a light rod of length L . It is held in a region of uniform electric field E at a small angle θ with the field ($\theta < 5^\circ$). If it is released now the time taken by it to become parallel to the field is $\frac{\pi}{x} \left(\frac{ML}{2qE} \right)^{1/2}$. Find x ?
7. An assembly of charges $+q, -q, +q, -q$ are placed at $x = 1, 2, 4, 8, \dots$ from origin on a plane. The potential at $x = 0$ is $\frac{q}{a\pi\epsilon_0}$ then $a = ?$
8. Two small spheres of equal masses 'm' are connected by a spring of constant 'k'. The arrangement is placed on a smooth surface. Time period of small oscillations is T_1 . Now the spheres are given equal charge 'q' each. The time period of small oscillations is T_2 . $\frac{T_1}{T_2} = ?$

SECTION 2 (Maximum Marks: 32)

- ◆ This section contains **EIGHT** questions
- ◆ Each question has FOUR options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct
- ◆ For each question, darken the bubble(s) corresponding to all the correct option(s) in the ORS
- ◆ **Marking scheme:**
 - +4** If only the bubble(s) corresponding to all the correct option(s) is(are) darkened
 - 0** If none of the bubbles is darkened
 - 2** In all other cases

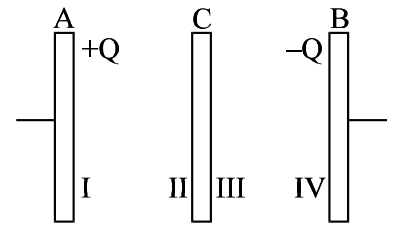
9. Five balls numbered 1 to 5 are suspended using separate threads. Pairs (1,2), (2,4) and (4,1) show electrostatic attraction while pairs (2,3) and (4,5) show repulsion. Therefore ball 1 must be
 (A) positively charged (B) negatively charged
 (C) neutral (D) made of metal
10. Two infinite sheets of uniform charge density $+\sigma$ and $-\sigma$ are parallel to each other as shown in the figure. Electric field at the
 (A) points to the left or to the right of the sheets is zero.
 (B) midpoint between the sheets is zero.
 (C) midpoint of the sheets is σ/ϵ_0 and is directed towards right.
 (D) midpoint of the sheets is σ/ϵ_0 and is directed towards left.
- 
11. At distance of 5cm and 10cm outwards from the surface of a uniformly charged solid sphere, the potentials are 100V and 75V respectively. Then
 (A) potential at its surface is 150V
 (B) the charge on the sphere is $(5/3) \times 10^{-10}\text{C}$
 (C) the electric field on the surface is 1500 V/m
 (D) the electric potential at its centre is 225V
12. A charged cork of mass m suspended by a light string is placed in uniform electric field of strength $E = (\hat{i} + \hat{j}) \times 10^5 \text{ NC}^{-1}$ as shown in the fig. If in equilibrium position tension in the string is $\frac{2mg}{(1 + \sqrt{3})}$ then angle 'a' with the vertical is
 (A) 60° (B) 30° (C) 45° (D) 18°
- 
13. An electric field converges at the origin whose magnitude is given by the expression $E = 100r\text{Nt/Coul}$, where r is the distance measured from the origin.
 (A) total charge contained in any spherical volume with its centre at origin is negative
 (B) total charge contained at any spherical volume, irrespective of the location of its centre, is negative
 (C) total charge contained in a spherical volume of radius 3 cm with its centre at origin has magnitude $3 \times 10^{-13}\text{C}$
 (D) total charge contained in a spherical volume of radius 3 cm with its centre at origin has magnitude $3 \times 10^{-9} \text{Coul}$

14. A conducting sphere A of radius a , with charge Q , is placed concentrically inside a conducting shell B of radius b . B is earthed. C is the common centre of the A and B



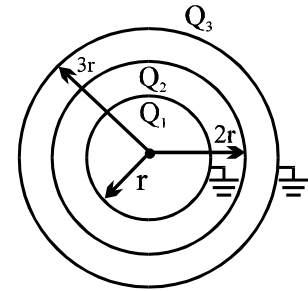
- (A) The field is a distance r from C, where $a \leq r \leq b$ is $\frac{1}{4\pi\epsilon_0} \frac{Q}{r^2}$
- (B) The potential at a distance r from C, where $a \leq r \leq b$, is $\frac{1}{4\pi\epsilon_0} \frac{Q}{r}$
- (C) The potential difference between A and B is $\frac{1}{4\pi\epsilon_0} Q \left(\frac{1}{a} - \frac{1}{b} \right)$
- (D) The potential at a distance r from C, where $a \leq r \leq b$, is $\frac{1}{4\pi\epsilon_0} Q \left(\frac{1}{r} - \frac{1}{b} \right)$

15. Plates A and B constitute an isolated, charge parallel-plate capacitor. The inner surfaces (I and IV) of A and B have charges $+Q$ and $-Q$ respectively. A third plate C with charge $+Q$ is now introduced midway between A and B. Which of the following statements is not correct?



- (A) The surfaces I and II will have equal and opposite charges
- (B) The surfaces III and IV will have equal and opposite charges
- (C) The charge on surface III will be greater than Q
- (D) The potential difference between A and C will be equal to the potential difference between C and B

16. Three concentric conducting spherical shells have radius r , $2r$ and $3r$ and Q_1 , Q_2 and Q_3 are final charges respectively. Innermost and outermost shells are already earthed as shown in figure. Choose the wrong statement.



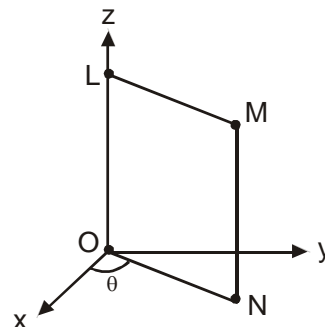
- (A) $Q_1 + Q_3 = -Q_2$
- (B) $Q_1 = \frac{-Q_2}{4}$
- (C) $\frac{Q_3}{Q_1} = 3$
- (D) $\frac{Q_3}{Q_1} = -\frac{1}{3}$

SECTION 3 (Maximum Marks: 16)

- ◆ This section contains **TWO** paragraphs
- ◆ Based on each paragraph, there will be **TWO** questions
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Paragraph for 17 to 18

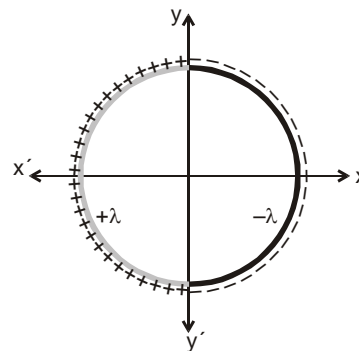
The electric field intensity at all points in space is given by $\vec{E} = \sqrt{3} \hat{i} - \hat{j}$ volts/metre. A square frame LMNO of side 1 metre is shown in figure. The point N lies in x-y plane. The initial angle between line ON and x-axis is $\theta = 60^\circ$



17. The magnitude of electric flux through area enclosed in square frame LMNO is –
 (A) 0 volt metre (B) 1 volt metre (C) 2 volt metre (D) 4 volt metre
18. The work done by electric field in taking a point charge of $1 \mu\text{C}$ from origin O to point M is –
 (A) $0 \mu\text{J}$ (B) $1 \mu\text{J}$ (C) $2 \mu\text{J}$ (D) $4 \mu\text{J}$

Paragraph for 19 to 20

A thin ring of radius R metres is placed in x-y plane such that its centre lies on origin. The half ring in region $x < 0$ carries uniform linear charge density $+\lambda \text{ C/m}$ and the remaining half ring in region $x > 0$ carries uniform linear charge density $-\lambda \text{ C/m}$.



19. Then the direction of electric field at point P whose coordinates are $\left(0\text{m}, +\frac{R}{2}\text{m}\right)$ is
 (A) along positive x-direction (B) along negative x-direction
 (C) along negative y-direction (D) none of these
20. Then the dipole moment of the ring in C-m is
 (A) $-(2\pi R^2\lambda)$ (B) $(2\pi R^2\lambda)$ (C) $-(4R^2\lambda)$ (D) $(4R^2\lambda)$

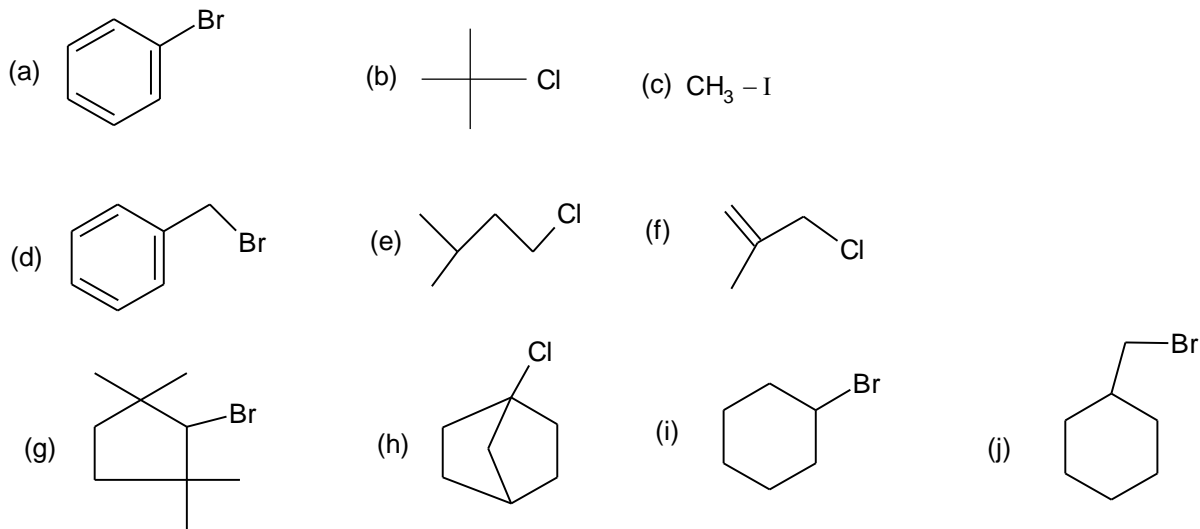
PART II: CHEMISTRY
SECTION 1 (Maximum Marks: 32)

- ◆ This section contains **EIGHT** questions
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- ◆ For each question, darken the bubble corresponding to the correct integer in the ORS

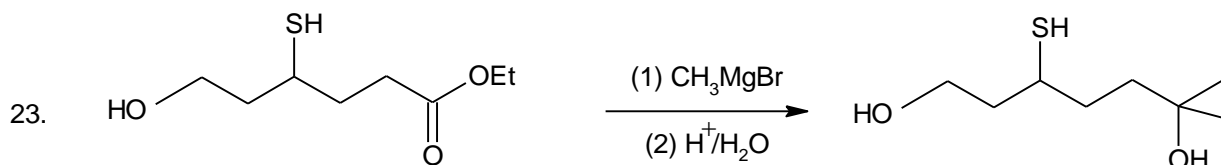
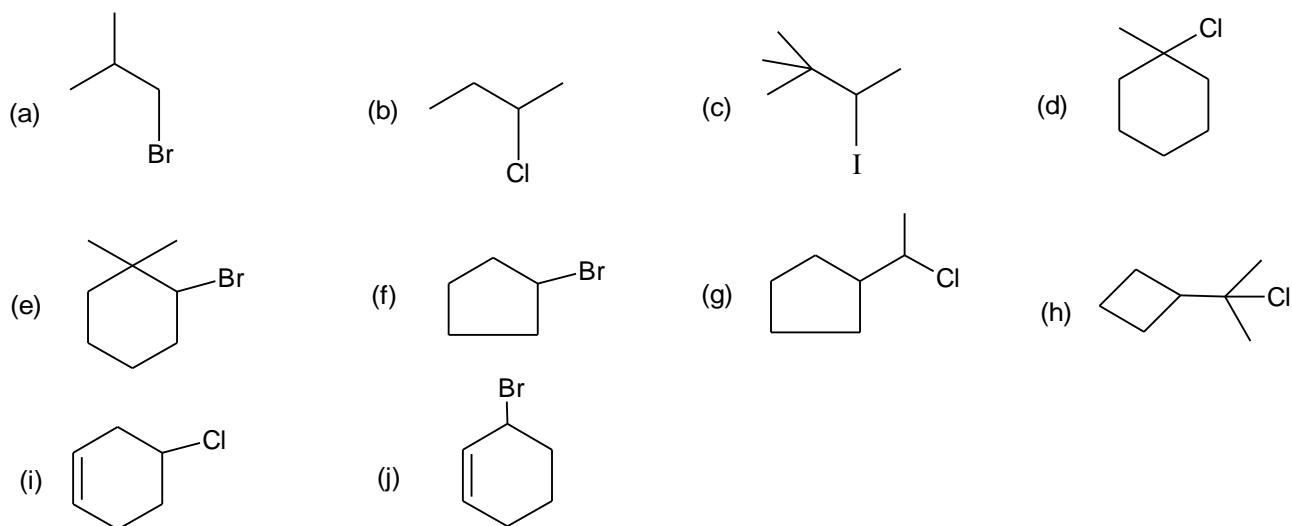
◆ **Marking scheme:**

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0 In all other cases

21. How many of following compounds give S_N2 reaction with NaSH?

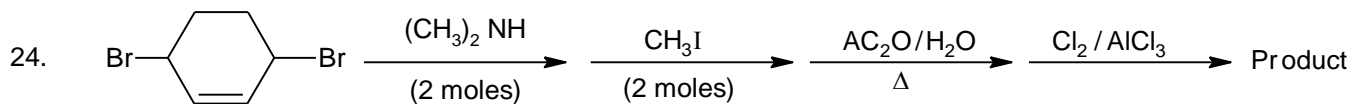


22. How many substrates will show rearrangement during S_N1 reaction

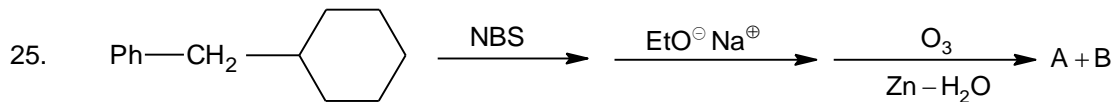


Find no. of moles of ' CH_3MgBr ' reacted per mole of reactant?

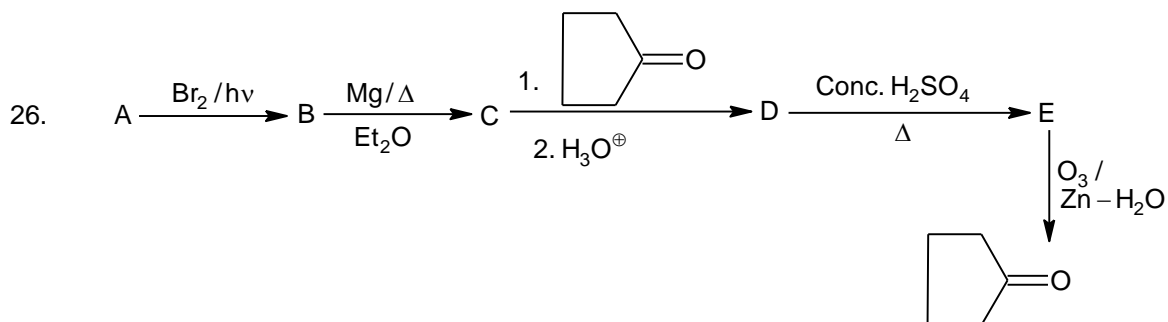
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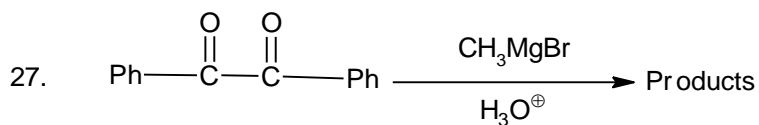
The degree of unsaturation in final product?



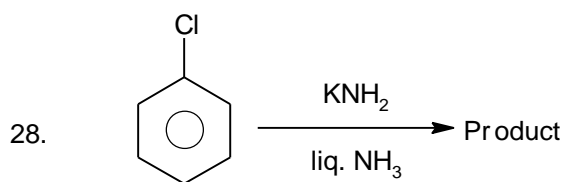
Sum of total no. of lone pairs and π -bonds in A and B?



Find no. of Hydrogen atoms present in 'B'?



Find the sum of no. of total products and no. of compounds that can be separated by fractional distillation?

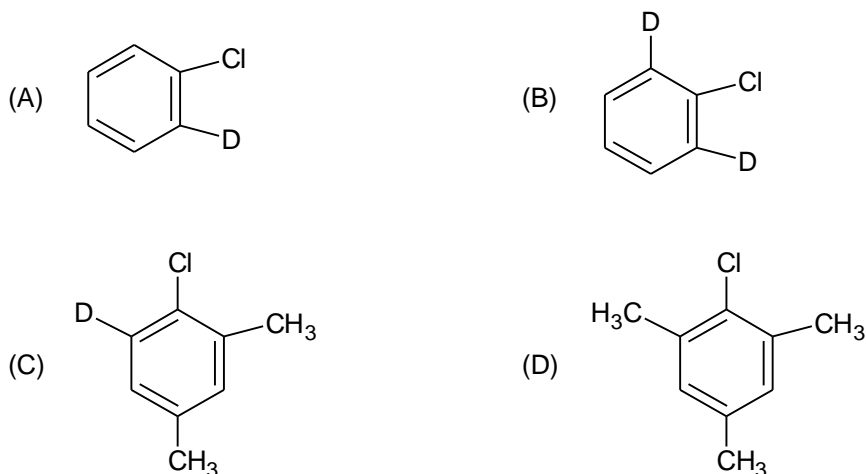


The degree of unsaturation of 'intermediate' formed in the above reaction is

SECTION 2 (Maximum Marks: 32)

- ◆ This section contains **EIGHT** questions
- ◆ Each question has FOUR options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct
- ◆ For each question, darken the bubble(s) corresponding to all the correct option(s) in the ORS
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29. Which of the following will undergo nucleophilic substitution reaction?



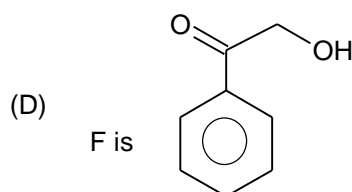
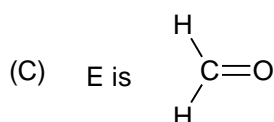
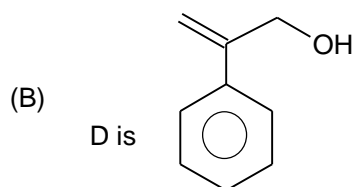
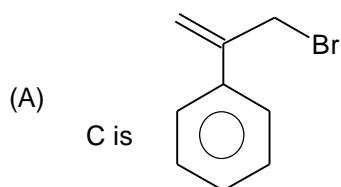
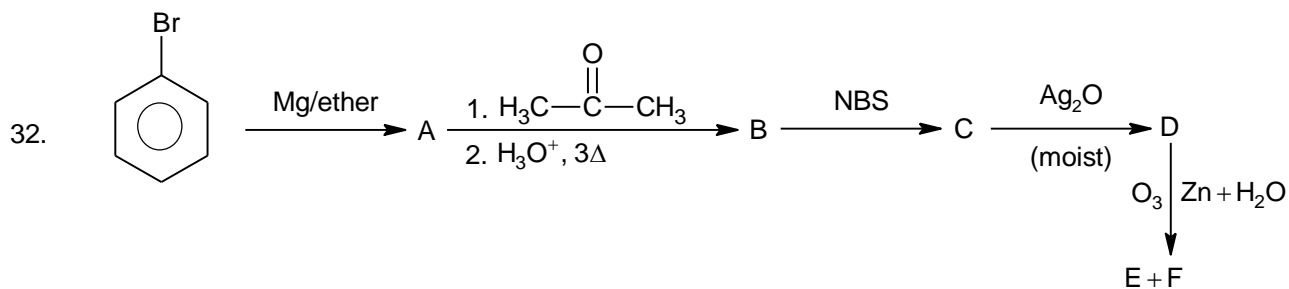
30. In the reaction $(Z) + \text{RMgX} \xrightarrow[\text{(excess)}]{\text{H}^+ / \text{H}_2\text{O}} 3^\circ \text{ alcohol 'Z'}$, may be



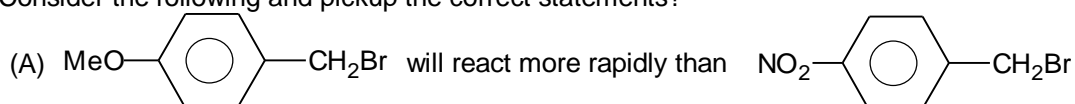
31. $\text{R-X} + \text{Mg} \xrightarrow{\text{Dry Ether}} \text{R-Mg-X} \xrightarrow{\text{CH}_3\text{OH}} \text{n-butane}$

What can be 'R' in the above reaction?

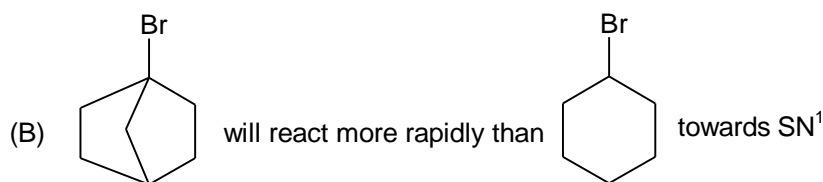
- (A) n-propyl (B) n-butyl (C) Sec-butyl (D) Isopropyl



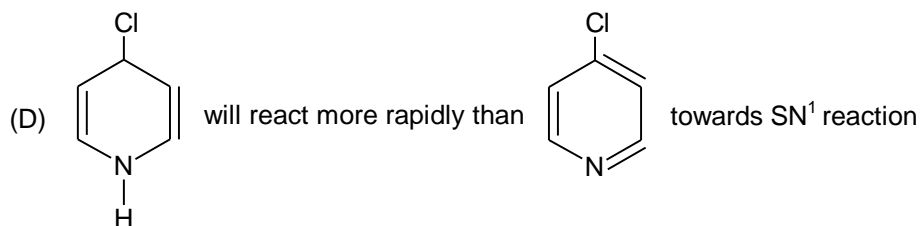
33. Consider the following and pickup the correct statements?



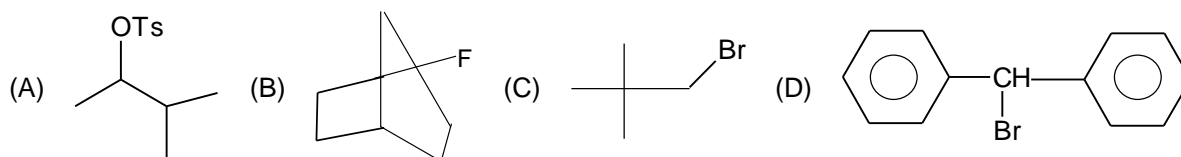
towards S_N1 reaction



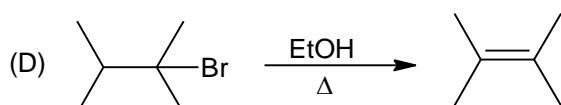
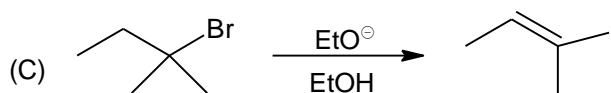
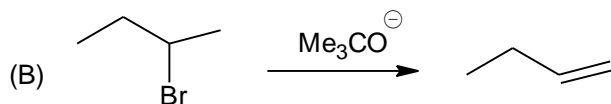
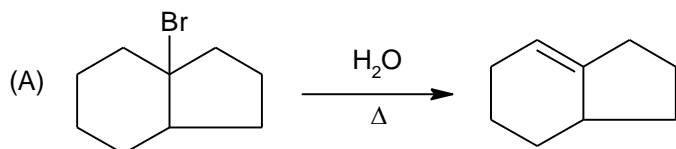
(C) S_N1 reaction occur better in polar protic solvents



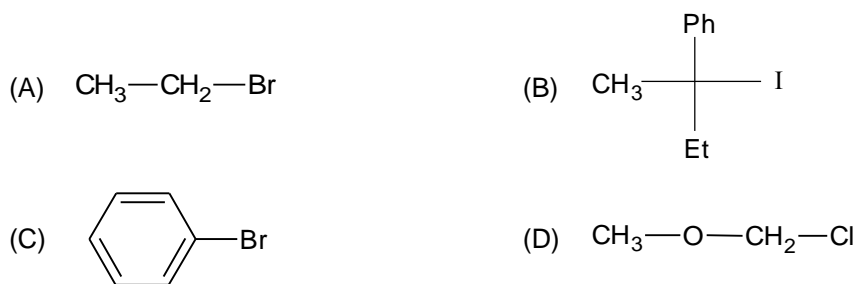
34. Which of the following cannot give E_2 reaction with strong base?



35. In which of the following cases, the major product has been correctly shown?



36. Which of the following compounds will give S_N1 reaction

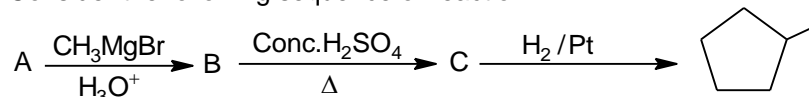


SECTION 3 (Maximum Marks: 16)

- ◆ This section contains **TWO** paragraphs
- ◆ Based on each paragraph, there will be **TWO** questions
- ◆ Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct
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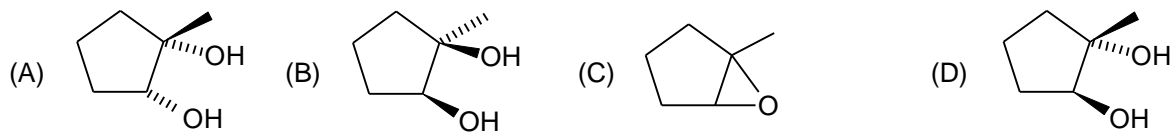
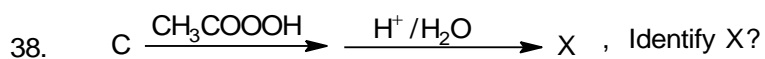
Paragraph for 37 to 38

Consider the following sequence of reaction



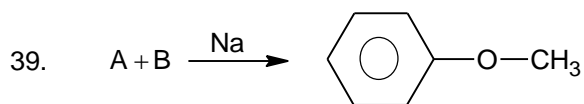
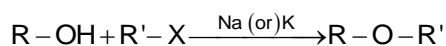
37. Find the structure of 'A'?



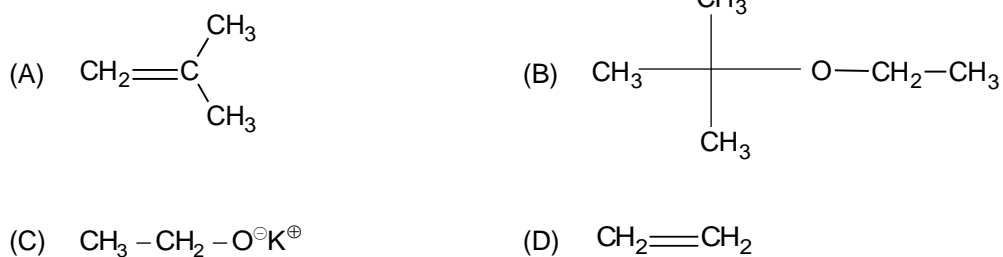
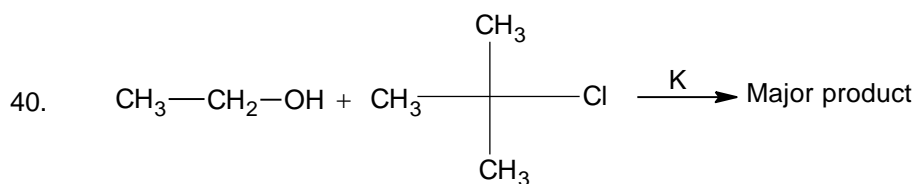
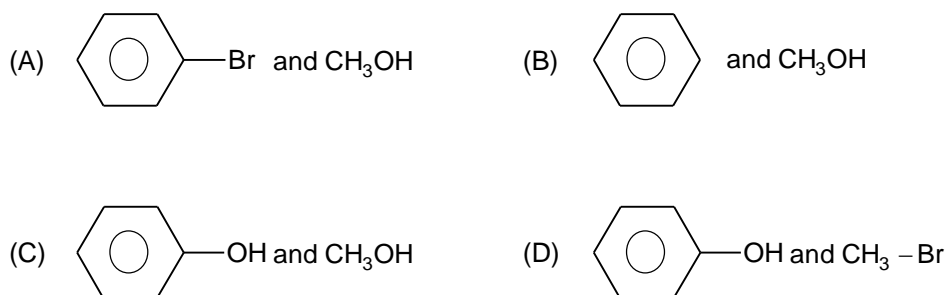


Paragraph for 39 to 40

Williamson's synthesis is an important method for the preparation of symmetrical and unsymmetrical ether, in this method halide is allowed to react with alcohol in presence of Na or K metal.



Find out A and B



PART III: MATHEMATICS

SECTION 1 (Maximum Marks: 32)

- ◆ This section contains **EIGHT** questions
 - ◆ The answer to each question is a **SINGLE DIGIT INTEGER** ranging from **0 to 9**, both inclusive
 - ◆ For each question, darken the bubble corresponding to the correct integer in the ORS
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-

41. Let α_i be solutions of the equation $[x]^2 - \{x\} - \frac{7}{2} = 0$, $-2 \leq x \leq 3$ where $[x]$ and $\{x\}$ represent greatest integer and fractional part of x respectively. Then value of $\left[\sum \alpha_i^2\right] =$
42. Let $f(x)$ is polynomial of degree 4 with leading coefficient as 1 and also satisfy $f(1) = 1$, $f(2) = 2$, $f(3) = 3$ then value of $f(5) - f(-2) + 14f(0) =$
43. Let m_i represents the distinct values of 'm' so that two equations $x^2 - (m+5)x + (m+4) = 0$ and $(m-3)x^2 + (m-11)x - 8 = 0$ has exactly two distinct roots or three distinct roots but not 4 distinct roots. Then $\sum m_i =$
44. If $a+b+c = 15$, $a^2 + b^2 + c^2 = 83$ and $abc = 105$, $a, b, c \in \mathbb{R}$ and let α is the least value of $a - b - c$ then $|\alpha| =$
45. Let $P(x) = x^2 + bx + c$, where b and c are integers. If $P(x)$ is a factor of both $x^4 + 6x^2 + 25$ and $3x^4 + 4x^2 + 28x + 5$, then find the value of $P(1)$
46. Find the number of integral value of 'a' in $[0, 5]$ for which both roots of the quadratic equation $(a^2 - 6a + 5)x^2 - \sqrt{a^2 + 2a}x + (6a - a^2 - 8) = 0$ lie on either side of origin
47. Find the greatest value of 'c' for which the inequality has atleast one solution $1 + \log_2\left(2x^2 + 2x + \frac{7}{2}\right) \geq \log_2(cx^2 + c)$
48. If α, β are roots of equation $x^2 - 2x - a^2 + 1 = 0$ and γ, δ are the roots of the equation, $x^2 - 2(a+1)x + a(a-1) = 0$ such that $\alpha, \beta \in (\gamma, \delta)$. Let set of values of 'a' satisfying this is (s,t) then value of $4s + t$ is

SECTION 2 (Maximum Marks: 32)

- ◆ This section contains **EIGHT** questions
- ◆ Each question has FOUR options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct
- ◆ For each question, darken the bubble(s) corresponding to all the correct option(s) in the ORS
- ◆ **Marking scheme:**
 - +4** If only the bubble(s) corresponding to all the correct option(s) is(are) darkened
 - 0** If none of the bubbles is darkened
 - 2** In all other cases

49. If the graph of the quadratic function $f(x) = ax^2 + (a-3)x + 1$ has to pass through 4th quadrant of X – Y plane then possible values of $\log_{10} a$ may be
 (A) -2021 (B) -2020 (C) 0 (D) 2020
50. If the equation $\sqrt[3]{x+3t+1} - \sqrt[3]{x} = 1$ has real solutions of x then 't' can belong to
 (A) $[-5, 0]$ (B) $[0, 5]$ (C) $\left[-\frac{1}{8}, 5\right]$ (D) $[3, \infty)$
51. Let a, b, c and $m \in \mathbb{R}^+$ and atleast one of the following equations have real root $ax^2 + bx + cm = 0$, $bx^2 + cx + am = 0$, $cx^2 + ax + bm = 0$ then $\frac{1}{\sqrt{m}}$ can be
 (A) 2 (B) 3 (C) 4 (D) 1
52. If $\cos^4 \alpha + k$ and $\sin^4 \alpha + k$ are the roots of $x^2 + \lambda(2x+1) = 0$ and $\sin^2 \alpha + t$, $\cos^2 \alpha + t$ are roots of $x^2 + 8x + 4 = 0$ then for possible values of λ (λ_1 & λ_2)
 (A) λ_1 and λ_2 are of same sign (B) λ_1 and λ_2 are of opposite sign
 (C) $\lambda_1^2 + \lambda_2^2 = 25$ (D) $|\lambda_1 + \lambda_2| < |\lambda_1 - \lambda_2|$
53. Suppose 'a' and 'b' are integers and $b \neq -1$. If the quadratic equation $x^2 + ax + b + 1 = 0$ has a positive integer root, then
 (A) The other root is also a positive integer (B) The other root is an integer
 (C) $a^2 + b^2$ is a composite number (D) $a^2 + b^2$ has no factor of itself
54. Let p, q, r be real numbers and $f(x) = px^2 + qx + r$. Suppose that whenever x is an integer, f(x) is also an integer, then
 (A) 2p is an integer (B) p is an integer
 (C) p – q is an integer (D) p + q is an integer
55. Let p and q be two real numbers. If the roots of the equation $x^2 - px - q = 0$ have absolute values less than 1, then
 (A) $|q| < 1$ (B) $p + q < 1$ (C) $q - p < 1$ (D) $p + q = 0$
56. If α and β are roots of the equation $x^2 - 2ax + b^2 = 0$ and γ and δ are the roots of the equation $x^2 - 2bx + a^2 = 0$, then
 (A) $\alpha + \beta = 2\sqrt{\gamma\delta}$ (B) $\alpha + \beta = 2(\gamma + \delta)$ (C) $(\gamma + \delta)^2 = 4\alpha\beta$ (D) $(\alpha + \beta)(\gamma + \delta) = 4\gamma\delta$

SECTION 3 (Maximum Marks: 16)

- ◆ This section contains **TWO** paragraphs
 - ◆ Based on each paragraph, there will be **TWO** questions
 - ◆ Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct
 - ◆ For each question, darken the bubble(s) corresponding to all the correct option(s) in the ORS
 - ◆ **Marking scheme:**
 - +4** If only the bubble(s) corresponding to all the correct option(s) is(are) darkened
 - 0** If none of the bubbles is darkened
 - 2** In all other cases
-

Paragraph for 57 to 58

α and β are the roots of the equation $ax^2 + bx + c = 0$ and α^4, β^4 are the roots of the equation $\ell x^2 + mx + n = 0$ (α, β are real and distinct). Let $f(x) = a^2 \ell x^2 - 4ac \ell x + 2c^2 \ell + a^2 m = 0$, then

57. Roots of $f(x) = 0$, are

- | | |
|----------------------------|--------------------------------|
| (A) $\frac{b^2}{a^2}$ | (B) $\frac{4ac - b^2}{a^2}$ |
| (C) Roots are of same sign | (D) Roots are of opposite sign |

58. If $\alpha^3 + \beta^3 = 0$ with $b \neq 0$ then

- | | |
|--------------------------|-------------------------|
| (A) a, b, c are in G.P | (B) 3a, b, c are in G.P |
| (C) $\frac{a}{b} \neq 0$ | (D) $m^2 = \ell n$ |

Paragraph for 59 to 60

Let $f(x) = ax^2 + bx + c$, where a, b and c are real numbers and $a \neq 0$. If $b^2 - 4ac < 0$, then for all real x, $f(x)$ and 'a' will have the same sign.

59. If $(a-1)x^2 - (a+1)x + (a+1) > 0$ for all real x, then

- | | | | |
|------------------------|--------------------------------------|-----------------------|-----------------------|
| (A) $a < -\frac{5}{3}$ | (B) $-\frac{5}{3} < a < \frac{5}{3}$ | (C) $a < \frac{5}{3}$ | (D) $a > \frac{5}{3}$ |
|------------------------|--------------------------------------|-----------------------|-----------------------|

60. If $(a+4)x^2 - 2ax + (2a-6) < 0$ for all real x, then

- | | | | |
|--------------|------------------|------------------|-------------|
| (A) $a < -6$ | (B) $-6 < a < 0$ | (C) $-6 < a < 6$ | (D) $a > 6$ |
|--------------|------------------|------------------|-------------|

❖ *Wish You^{est} all the Best* ❖