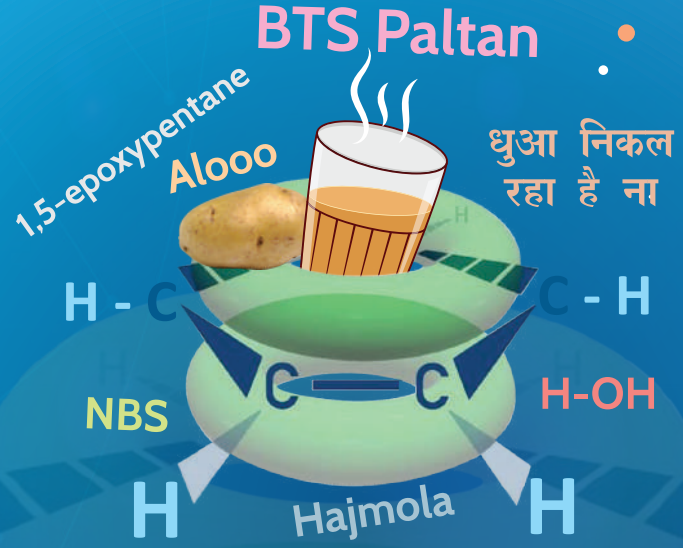
Class-11th + 12th

EaJEE NOTES

for

ORGANIC CHEMISTRY

Basic से
Kattar Advanced की feel
बाबा के साथ



BACKLOG KILLER ❤

Blue Book

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(RA Baba)

Shubh Karan Choudhary
(SKC Sir)

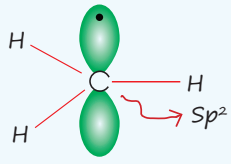
4 Hydrocarbons

Free Radical

A free radical is a molecule or atom with an unpaired electron, making it highly reactive.

Properties

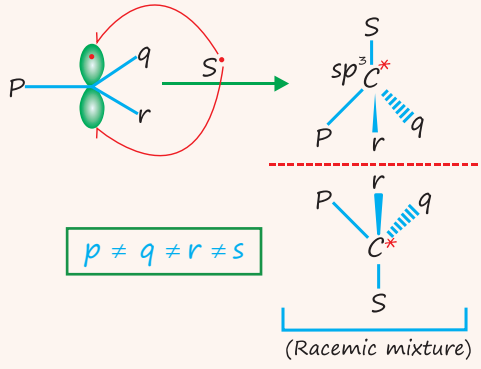
- Octet incomplete
- Highly unstable
- Paramagnetic
- 1 U.P. (U.P. : unpaired electron)
- $\sqrt{1(1+2)}$ B.M $\Rightarrow \sqrt{3}$ B.M.
- 0 l. P. (l.p. : lone pair)
- 3 B.P. (B.P. : Bond Pair)
- sp^2, Planar
- 0 A.E. for Rxⁿ (A.E. (Activation energy)



Factors

- Sunlight (hv, uv rays)
- High temperature (Δ)
- Metal
- Electrolysis
- Gaseous phase
- Another radical

Attack by Radical



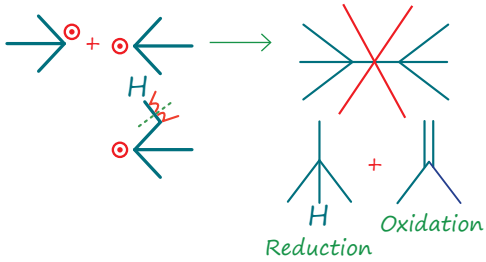
Reaction By Free Radical

Combination

$R^{\odot} + R^{\odot} \longrightarrow R - R$

$R^{\odot} + R'^{\odot} \longrightarrow R - R' + R - R$ (Major) $+ R' - R'$

Disproportionation



Rearrangement

Just as free radicals initiate powerful chains, your small steps today start unstoppable progress.

Wurtz Reaction

The Wurtz reaction is an organic chemical reaction used to couple two alkyl halides to form a higher alkane. It involves the reaction of alkyl halides with sodium metal in dry ether.

Reaction

$$2R - X + 2Na \xrightarrow{dry\ Et_2O} R - R + 2NaX$$

Mechanism 1

Involves homolytic cleavage of R–X by sodium metal, forming alkyl radicals (R•), which then couple to form R–R.

1. $R\overset{\delta+}{-}X\overset{\delta-}{} + Na \xrightarrow{rds} R^{\bullet} + Na^{\oplus}X^{\ominus}$ ($e^{\ominus}$)

2. $R^{\bullet} + R^{\bullet} \longrightarrow R - R$

Mechanism 2

Sodium donates electrons to R–X forming R–Na+, which acts as a nucleophile and displaces halide from another R–X to form R–R.

1. $R\overset{\delta+}{-}X\overset{\delta-}{} + 2Na \xrightarrow{rds} {}^{\ominus\oplus}RNa + NaX$ ($2e^{\ominus}$)

(rds = Rate determining step)

2. $^{\ominus\oplus}RNa + R\overset{\delta+}{-}X\overset{\delta-}{} \longrightarrow R - R + NaX$

Wurtz: Two alkyl halides walk into a room, sodium says 'Let's team up!' and bam – a new alkane is born!

Baba Tea-Stall (BTS)

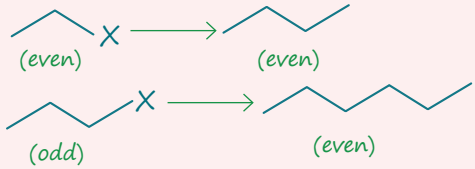
(i) Both Carbanion and free intermediate obtained

(ii) As the stability of (•) ↑ ⇒ Rate of reaction ↑

(iii) Rate of reaction for different R – X is :

R – I > R – Br > R – Cl > R – F

(iv) Symmetrical alkane obtained as major product



(v) In case of 3° – X, major product is disproportionation reaction.

Wurtz ka khandaan

$$R - X + Ar - X \xrightarrow[\Delta]{Na} R - Ar$$

Wurtz-Fittig Reaction

Wurtz Reaction

Fittig Reaction

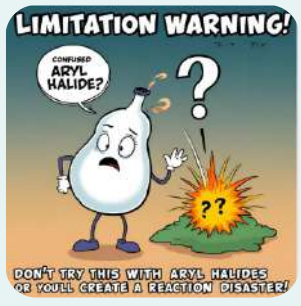
$$R - X \xrightarrow[Dry\ Et_2O]{Na} R - R + Nax$$

$$Ar - X \xrightarrow{Na} \text{No reaction}$$

$$Ar - X \xrightarrow[\Delta]{Na} Ar - Ar + NaX$$

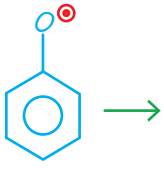
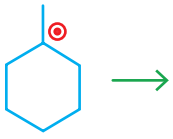
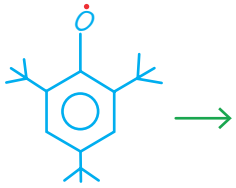
Ulmann Reaction: $Ar - X \xrightarrow[\Delta]{Cu} Ar - Ar$

Frankland Reaction: $R - X \xrightarrow{Zn} R - R$

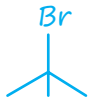
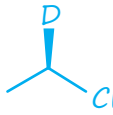
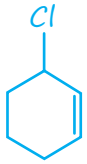
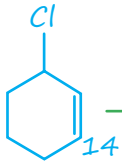
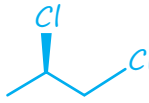
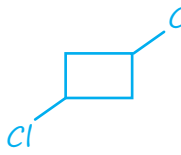
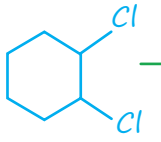
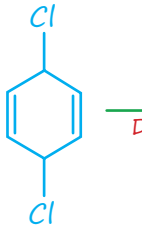
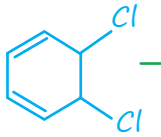


Practice Questions

➢ Free Radical

1. $\dot{C}H_3 \longrightarrow$
2. $\dot{C}H_3 + \dot{C}l \longrightarrow$
3. $\dot{C}l \longrightarrow$
4.  $+ \dot{B}r \longrightarrow$
5.  $\longrightarrow$
6.  $+ \dot{C}H_3 \longrightarrow$
7.  $+ \dot{C}l \longrightarrow$
8.  $+ \dot{B}r \longrightarrow$
9.  $\longrightarrow$
10.  $\longrightarrow$
11.  $\longrightarrow$
12.  $\longrightarrow$
13.  $\longrightarrow$
14.  $\longrightarrow$

➢ Wurtz Reaction

15. $CH_3Cl \xrightarrow[dryEt_2O]{Na}$
16. $PhCH_2Br \xrightarrow[dryEt_2O]{Na}$
17.  $\xrightarrow[Dry\ Et_2O]{Na}$
18.  $\xrightarrow[Dry\ Et_2O]{Na}$
19.  $\xrightarrow[Dry\ Et_2O]{Na}$
20.  $\xrightarrow[Dry\ Et_2O]{Na}$
21.  $\xrightarrow[Dry\ Et_2O]{Na}$
22.  $\xrightarrow[Dry\ Et_2O]{Na}$
23.  $\xrightarrow[Dry\ Et_2O]{Na}$
24.  $\xrightarrow[Dry\ Et_2O]{Na}$
25.  $\xrightarrow[Dry\ Et_2O]{Na}$
26.  $\xrightarrow[Dry\ Et_2O]{Na}$
27.  $\xrightarrow[Dry\ Et_2O]{Na}$

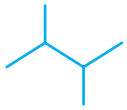
52. $CH_3 - CHCl_2 \xrightarrow[\Delta]{\text{Ag Powder}}$

53. $CH_3 - CCl_3 \xrightarrow[\Delta]{\text{Ag Powder}}$

54. How many of the following compounds can be obtained in good yield by wurtz reaction using single reactant?

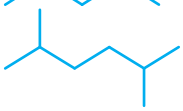
(a) 

(b) CH_4

(c) 

(d) 

(e) 

(f) 

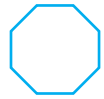
(g) 

(h) 

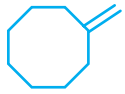
(i) 

(j) 

(k) 

(l) 

(m) 

(n) 

(o) 

Previous Year Questions

1. Which of the following alkane cannot be made in good yield by Wurtz reaction? (NEET, 2020)

(a) 2, 3-Dimethylbutane

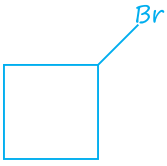
(b) n-Heptane

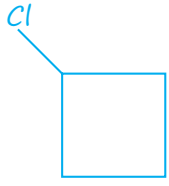
(c) n-Butane

(d) n-Hexane

Sol. (b)

2. 1-bromo-3-chlorocyclobutane when treated with two equivalents of Na, in the presence of ether which of the following will be formed? (IIT JEE 2005)

(a) 

(b) 

(c) 

(d) 

Sol. (d)

3. Hydrocarbon (A) reacts with bromine by substitution to form an alkyl bromide which by Wurtz reaction is converted to gaseous hydrocarbon containing less than four carbon atoms. (A) is (NEET, 2018)

(a) $CH \equiv CH$

(b) $CH_2 = CH_2$

(c) CH_4

(d) $CH_3 - CH_3$

Sol. (c)

4. Hydrocarbon (A) reacts with bromine by substitution to form an alkyl bromide which by Wurtz reaction is converted to gaseous hydrocarbon containing less than four carbon atoms. (A) is (2018)

(a) $CH \equiv CH$

(b) $CH_2 = CH_2$

(c) CH_4

(d) $CH_3 - CH_3$

Sol. (c) Wurtz reaction gives symmetrical alkane with even no. of carbon atoms and since hydrocarbon containing less than four carbon atoms need to be obtained, therefore, the hydrocarbon A would be CH_4. The reaction takes place as:

$$CH_4 \xrightarrow[\text{Substitution reaction}]{Br_2/hv} CH_3Br \xrightarrow[\text{Wurtz reaction}]{\text{Na/dry ether}} CH_3 - CH_3$$

Reaction with Metal and Acid

When an alkyl halide reacts with zinc and hydrochloric acid (HCl), the halide is reduced, resulting in the formation of an alkane (R–H).

Reaction

$$R-X \xrightarrow[HCl]{Zn} R-H \quad (x = Cl, Br, I)$$

Mechanism

$$R-X \xrightarrow{Zn} R^- \xrightarrow[HCl]{\delta+\ \delta-} R-H$$

($Zn \rightarrow 2e^{\ominus}$)

Other Example

1. $R^{\delta-}-Mg^{\delta+}-X + H-OH \rightarrow R-H$
2. $R_2Zn^{2+} + H^+ \rightarrow R-H$
3. $R_2^{\delta-}Culi \xrightarrow{H_2O} R-H$

Formation of Grignard Reagent

When an alkyl halide (R–X) reacts with magnesium (Mg) in dry ether, it forms a Grignard reagent (R–Mg–X), which is an organometallic compound.

Reaction

$$R-X + Mg \xrightarrow{Et_2O} R-Mg+X$$

When life gives you alkyl halides, throw in some Mg and make a Grignard!

Mechanism

$$R^{\delta+}-X^{\delta-} + Mg \xrightarrow{Et_2O} R^- + Mg^{2+} + X^- \rightarrow R-MgX$$

($Mg \rightarrow 2e^{\ominus}$)

Grignard reagent (more Covalent)

Baba Tea-Stall (BTS)

(i) Carbanion and free radical Intermediate

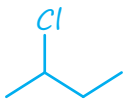
(ii) Organometallic compound obtained

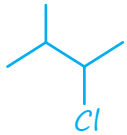
(iii) R–Mg–X known as Grignard reagent

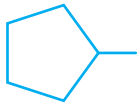
Practice Questions

55. $CH_3Cl \xrightarrow[dil\ HCl]{Zn}$

56. $Et-Br \xrightarrow[dil\ HCl]{Zn}$

57.  $\xrightarrow[dil\ HCl]{Zn}$

58.  $\xrightarrow[dil\ HCl]{Zn}$

59.  $\xrightarrow[EtOD]{Na}$

60. $PhCH_2Br$ → (i) Na/Et_2O (ii) $Na/EtOH$

61. $PhCH_2Br$ → (i) $Zn/dil.HCl$ (ii) Zn/Δ

62.  → (i) Na/Et_2O (ii) $Zn/dil.HCl$

63. $CH_3Cl \xrightarrow[Et_2O]{Mg}$

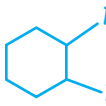
64. $CH_3-CH_2Br \xrightarrow[Et_2O]{Mg}$

65. $PhCH_2Cl \xrightarrow[Et_2O]{Mg}$

66. $CH_3F \xrightarrow[Et_2O]{Mg}$

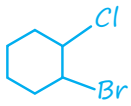
67.  $\xrightarrow[Et_2O]{Mg}$

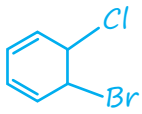
68.  $\xrightarrow[Et_2O]{Mg(excess)}$

69.  $\xrightarrow[Et_2O]{Mg}$

70.  $\xrightarrow[Et_2O,\ \Delta]{Mg}$

71.  $\xrightarrow[Et_2O,\ \Delta]{Mg}$

72.  $\xrightarrow[Et_2O]{Mg(excess)}$

73.  $\xrightarrow[Et_2O]{Mg}$

74.  $\xrightarrow[Et_2O]{Mg}$

75.  $\xrightarrow[Et_2O,\ \Delta]{Mg}$

76. 

Q. Which of the following is (are) Grignard reagents?

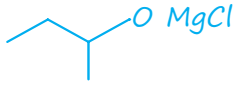
77. 

78. 

79. $(CH_3)_2CuLi$

80. CH_3MgCl

81. $PhMgI$

82. 

Previous Year Questions

5. Grignard reagent is prepared by the reaction between: (1994)

(a) Magnesium and alkane
(b) Magnesium and aromatic hydrocarbon
(c) Zinc and alkyl halide
(d) Magnesium and alkyl halide

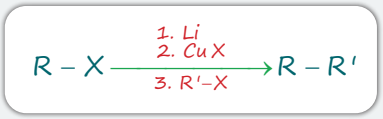
Sol. (c) $R-X \xrightarrow[HCl]{Zn} R-H$

Grignard reagent is prepared by heating an alkyl halide with dry magnesium powder in dry ether.

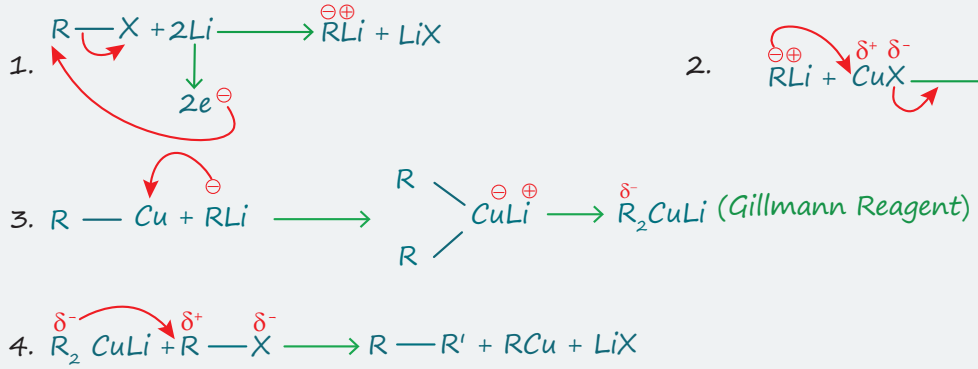
Corey House Synthesis

The Corry-House synthesis involves reacting an alkyl halide (R-X) with lithium (Li) to form an alkyl lithium (R-Li), which then reacts with copper halide (CuX) to form an organocuprate (R-Cu-Li). The organocuprate then reacts with another alkyl halide (R'-X) to form a new carbon-carbon bond (R-R').

Reaction



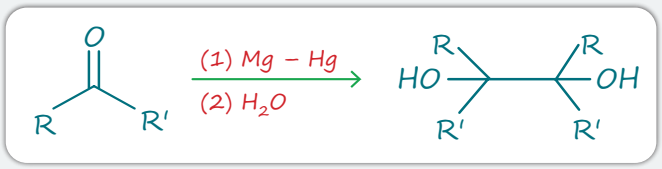
Mechanism



Pinacol Formation

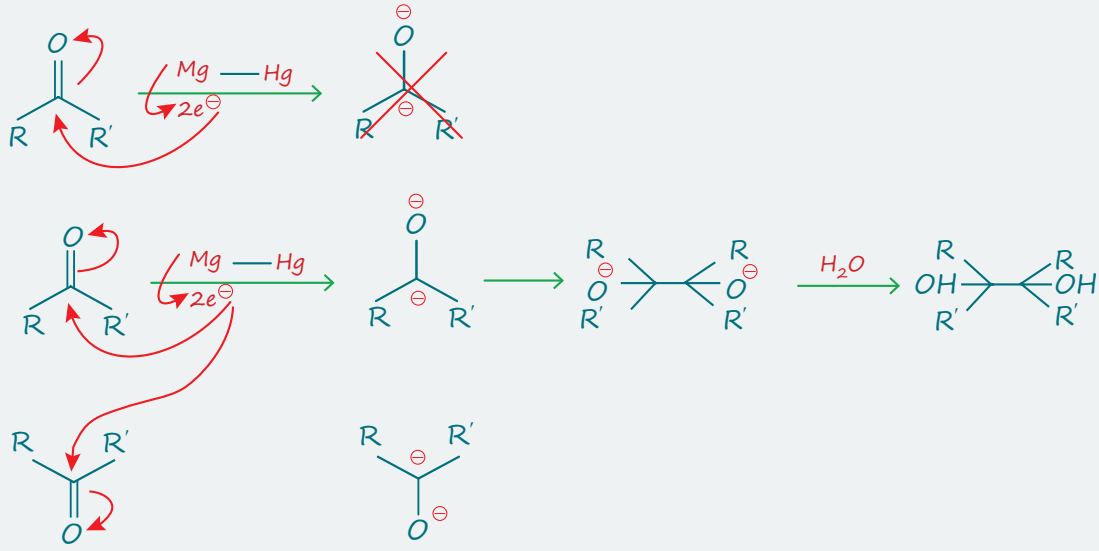
Pinacol formation is a reduction reaction where the carbonyl group (-C=O) is reduced to a hydroxyl group (-OH), leading to the formation of a vicinal diol (pinacol).

Reaction



- If R = R' ⇒ 1 pinacol
- If R ≠ R' ⇒ 3 pinacol

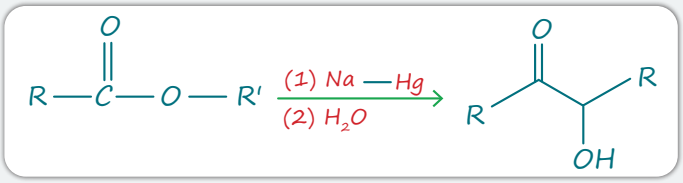
Mechanism



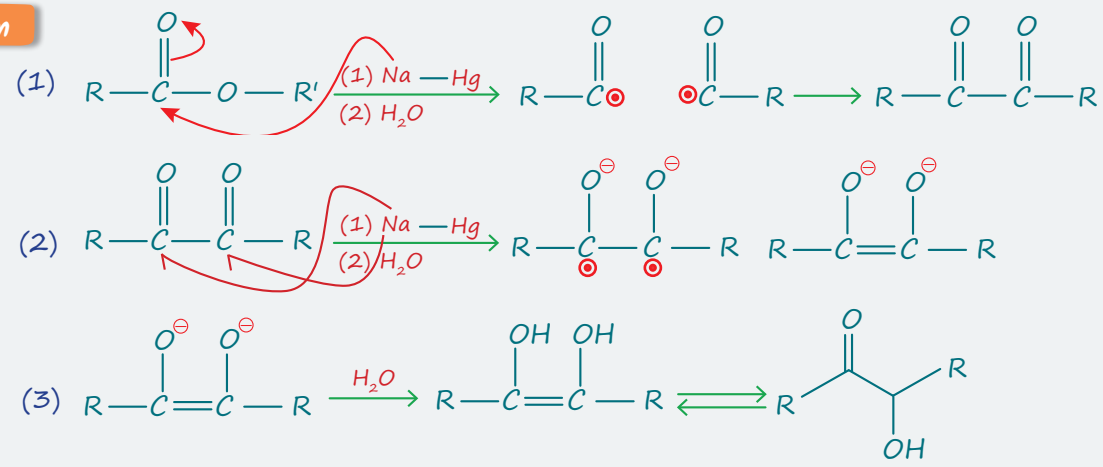
Acyloin Condensation

The Acyloin Condensation involves the reaction of two molecules of aldehydes or ketones in the presence of a $Na-Hg/H_2O$, resulting in the formation of an α-hydroxy ketone (acyloin).

Reaction



Mechanism

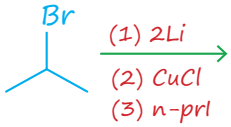


Practice Questions

➤ Corey House Synthesis

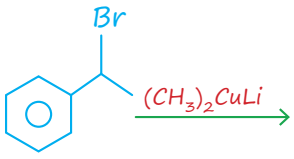
83. $CH_3Br \xrightarrow[(3)\,EtBr]{(1)\,2Li,\ (2)\,CuCl}$

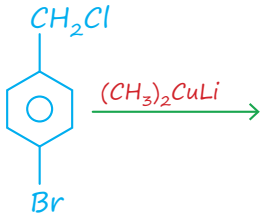
84. $PhCH_2Cl \xrightarrow[(3)\,CH_3Cl]{(1)\,2Li,\ (2)\,CuCl}$

85. 

86. $P \xrightarrow[(3)\,EtBr]{(1)\,2Li,\ (2)\,CuCl}$ Iso-hexane

87. $CH_3CH_2Cl \xrightarrow{(C_2H_5)_2CuLi}$

88. 

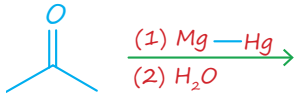
89. 

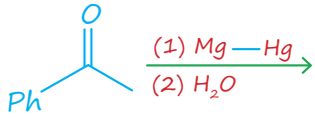
90. $PhCH_2CH_2Br \xrightarrow{(i\text{-}Pr)_2CuLi}$

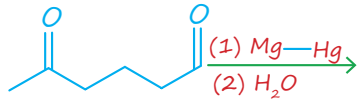
➤ Pinacol Formation

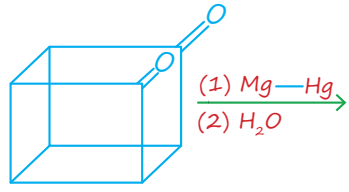
91. 

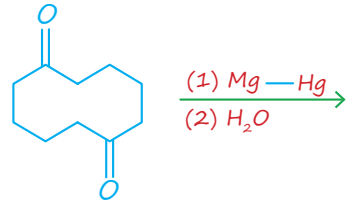
92. $CH_3\text{-}CHO \xrightarrow[(2)\,H_2O]{(1)\,Mg\text{-}Hg}$

93. 

94. 

95. 

96. 

97. 

Kolbe's Electrolysis

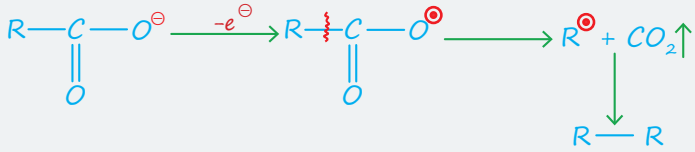
Kolbe's electrolytic method: An aqueous solution of sodium or potassium salt of a carboxylic acid on electrolysis gives alkane containing even number of carbon atoms at the anode.

Reaction

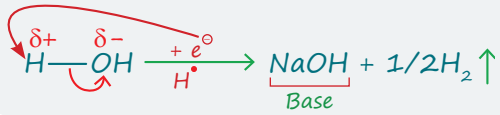
$$R-COOH + NaOH \xrightarrow{\text{Electrolysis}} R-COO^{\ominus}Na^{\oplus} + H_2O \longrightarrow R-R + CO_2 + H_2 + NaOH$$

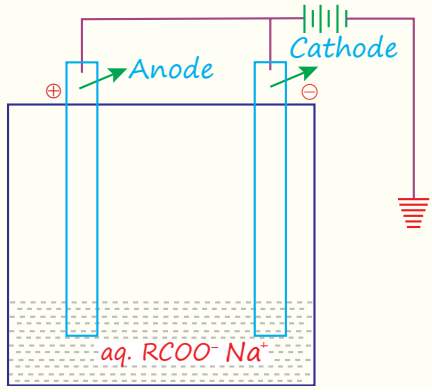
Mechanism

Anode:



Cathode:





Baba Tea-Stall (BTS)

(i) Free radical Obtained as intermediate
(ii) CO_2 and R – R at anode, H_2 at cathode obtained.
(iii) pH of the medium increases (due to NaOH)
(iv) CH_4 can never be obtained
(v) In case of 3°–COOH, ester (RCOOR) will be obtained.

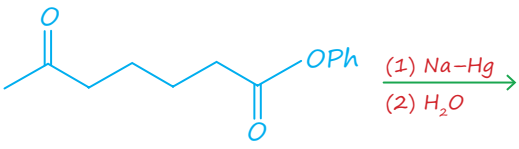
Practice Questions

➢ Acyloin Condensation

98. $CH_3COOCH_3 \xrightarrow[(2)H_2O]{(1)\,Na-Hg}$

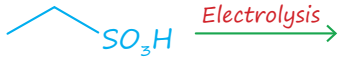
99. $PhCOOCH_3 \xrightarrow[(2)H_2O]{(1)\,Na-Hg}$

100. $CH_3COOPh \xrightarrow[(2)H_2O]{(1)\,Na-Hg}$

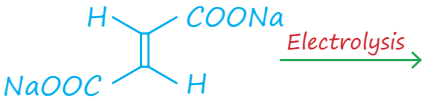
101. 

➢ Kolbe's Electrolysis

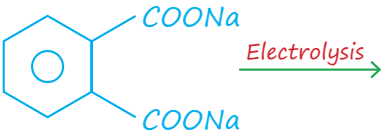
102. $CH_3COOH \xrightarrow[\text{Electrolysis}]{NaOH,}$

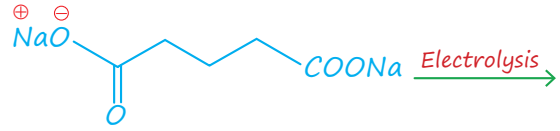
103. 

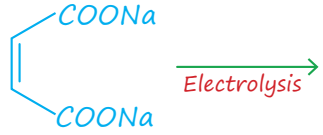
104. $\begin{matrix} CH_2-COONa \\ | \\ CH_2-COONa \end{matrix} \xrightarrow{\text{Electrolyis}}$

105. 

106. 

107. 

108. 

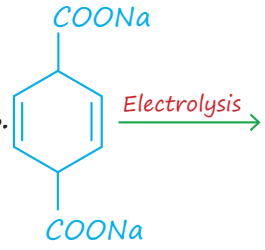
109. 

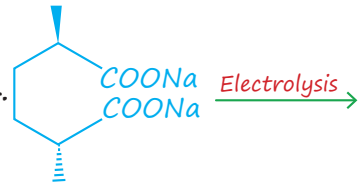
110. $CH_3COONa + C_2H_5COONa \xrightarrow[\text{Electrolysis}]{NaOH}$

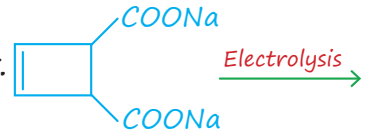
111. $CH_3COONa + C_2H_5COONa \xrightarrow{\text{Electrolysis}}$

Hydrogen act both anode and cathode.

112. $CH_3\overset{14}{C}OONa \xrightarrow{\text{Electrolysis}}$

113. 

114. 

115. 

116. $aq.\ NaCl \xrightarrow{\text{Electrolysis}}$

117. $P \xrightarrow[\text{Electrolysis}]{NaOH,} Q \xleftarrow[Et_2O]{Na} CH_3Cl$

Previous Year Questions

6. Number of alkanes obtained on electrolysis of a mixture of CH_3COONa and C_2H_5COONa is____.

[31 Jan, 2024 (Shift-I)]

Sol. [3] $CH_3COONa \longrightarrow \dot{C}H_3$

$C_2H_5COONa \longrightarrow \dot{C}_2H_5$

$2\dot{C}_2H_5 \longrightarrow CH_3-CH_2-CH_2-CH_3$

$2\dot{C}H_3 \longrightarrow CH_3-CH_3$

$\dot{C}H_3 + \dot{C}_2H_5 \longrightarrow CH_3-CH_2-CH_3$

7. Which of the following reaction is expected to readily give a hydrocarbon product in good yields?

(1997)

(a) $CH_3CH_3 \xrightarrow[h\nu]{Cl_2}$

(b) $(CH_3)_2CHCl \xrightarrow{C_2H_5OH}$

(c) $RCOOK \xrightarrow[\text{Oxidation}]{\text{Electrolysis}}$

(d) $RCOOAg \xrightarrow{I_2}$

Sol. (c) When an aqueous solution of sodium or potassium salt of carboxylic acid is electrolysed, then an alkane containing even number of carbon atoms is formed at the anode. The reaction occurs as:

$RCOOK \xrightarrow{\text{Electrolysis}} RH + CO_2 + KOH$

Photohalogenation

Halogenation takes place either at higher temperature (573-773 K) or in the presence of diffused sunlight or ultraviolet light. Lower alkanes do not undergo nitration and sulphonation reactions. These reactions in which hydrogen atoms of alkanes are substituted are known as substitution reactions

Reaction

$$R - H + X_2 \xrightarrow[\text{or hv or sunligh}]{\text{UV rays}} R - X + H - X$$

Mechanism

Initiation: $X_2 \xrightarrow{h\nu} 2X^{\odot}$

Propagation:

$R - H + X^{\odot} \xrightarrow{rds} R - X + H^{\odot}$

$R^{\odot} + H - X$

$R^{\odot} + X - X \longrightarrow R - X + X^{\odot}$

Termination:

(1) $R^{\odot} + R^{\odot} \longrightarrow R - R$

(2) $X^{\odot} + X^{\odot} \longrightarrow X_2$

(3) $R^{\odot} + X^{\odot} \longrightarrow X - X$

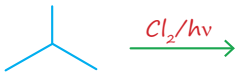
Baba Tea-Stall (BTS)

(i) Example of Substitution Reaction
(ii) Free radical intermediate
(iii) UV rays/hv is used to initiate the reaction
(iv) Rate of reaction for different X_2 is $F_2 > Cl_2 > Br_2 > I_2$
(v) Kinetic isotopic effect (R — H > R — D)
(vi) RDS is formation of $R^{\odot}$

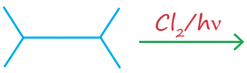
Types of Photohalogenation

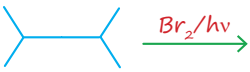
Fluorination	Iodination
➢ Highly Exothermic and explosive $CH_4 + 2F_2 \longrightarrow C_{black} + 4HF$	➢ Least reactive and reversible $CH_4 + I_2 \rightleftharpoons CH_3-I + H-I$ O.A. (HIO_3, HNO_3) oxidises I_2
Chlorination	**Bromination**
➢ More reactive ➢ Less Selective ⇓ 1:3.8:4.5 → 3° — H 1° — H, 2° — H	➢ Less Reactive ➢ More selective ⇓ 1:80:1600 3° — H or Reso/BB/Aro

Practice Questions

118. 

119. 

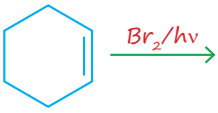
120. 

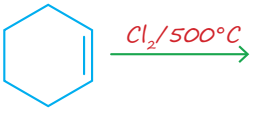
121. 

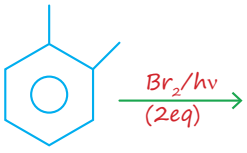
122. Toluene $\xrightarrow{Cl_2/h\nu}$

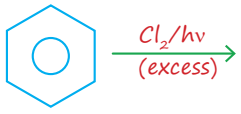
123. Toluene $\xrightarrow{Br_2/h\nu}$

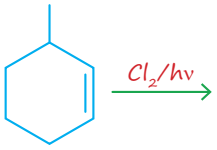
124. 

125. 

126. 

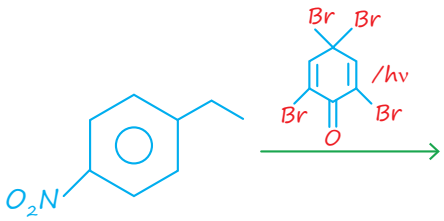
127. 

128. 

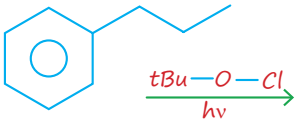
129. 

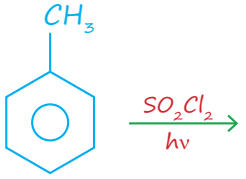
130. 

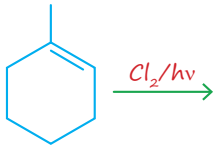
131. $(CH_3)_2CHCH_2CH_2CH_3 \xrightarrow{Br_2/h\nu}$

132. 

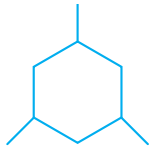
133. 

134. 

135. 

136. 

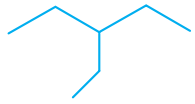
137. **Find % yield of each monochlorinated product**

(a) 

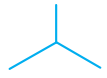
[1 : 3.8 : 4.5]

(b) 

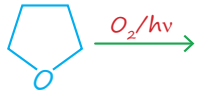
[1 : 4 : 6]

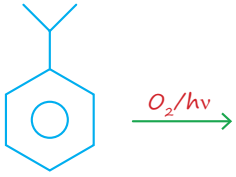
(c) 

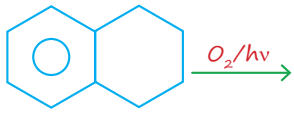
[1 : 3.8 : 4.5]

(d) 

[1 : 3.8 : 4.5]

138. 

139. 

140. 

141. 2—butene $\xrightarrow{tBu-OCl}$

142. **After monohchlonination reaction on given compound, find**

(a) Structures obtained

(b) Total products

(c) Optically active

(d) Meso

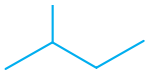
(e) Fractions

143. 

144. 

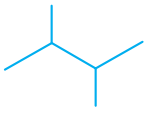
145. 

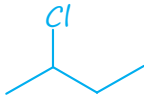
146. 

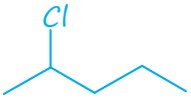
147. 

148. 

149. 

150. 

151. 

152. 

153. 

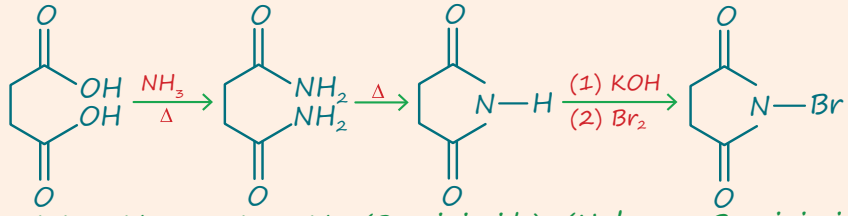
154. 

155. 

N-bromo succinimide (NBS)

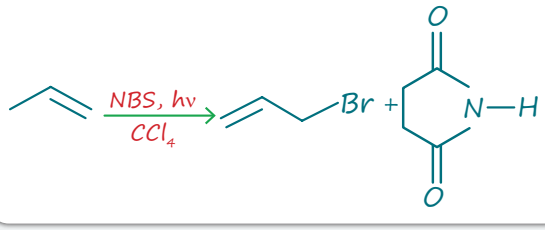
N-Bromosuccinimide (NBS) is a mild brominating agent used mainly for allylic and benzylic bromination via a radical mechanism, and for α-bromination of carbonyl compounds under acidic conditions.

➤ Formation



(Succinic acid) (Succinamide) (Succinimide) (N-bromo Succinimide)

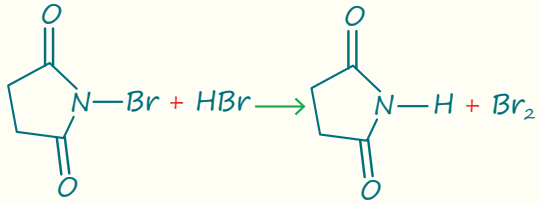
Reaction

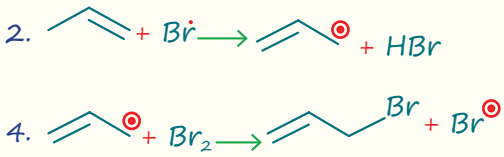


Mechanism 1.

Impurity of Br_2

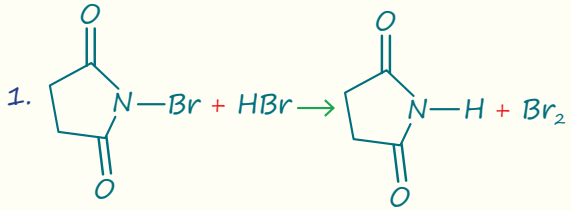
1. $Br_2 \xrightarrow{h\nu} 2Br^{\bullet}$

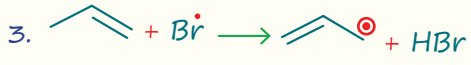




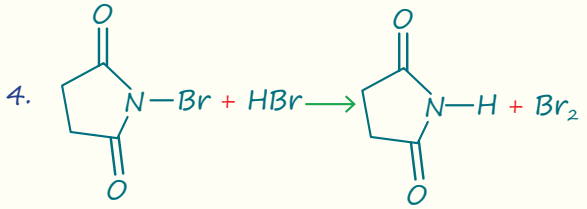
Mechanism 2.

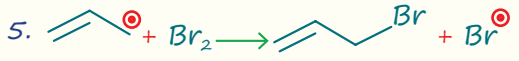
Impurity of HBr





2. $Br_2 \xrightarrow{h\nu} 2Br^{\bullet}$





Baba Tea-Stall (BTS)

(i) NBS is inert in nature
(ii) trace amount of impurity Br_2 or HBr is added
(iii) Reacts only with allylic ($C=C-\dot{C}$) and benzylic ($Ph-\dot{C}H_2$) positions.

Practice Questions

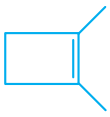
170. When following compound treated with NBS/hv then find:

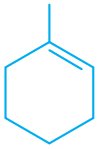
(a) Structure of monobrominated product

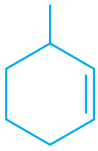
(b) Total monobrominated product

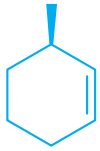
(c) optically active product

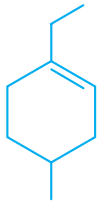
(d) Fractions obtained.

171. 

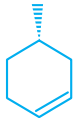
172. 

173. 

174. 

175. 

176. 

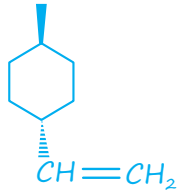
177. 

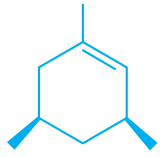
178. 

179. 

180. 

181. 

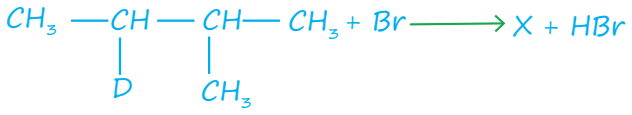
182. 

183. 

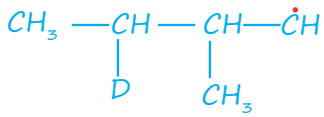
184. 

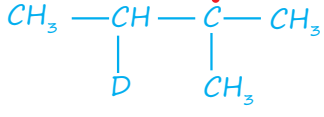
Previous Year Questions

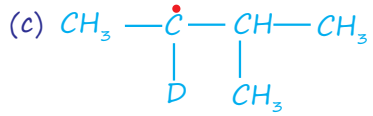
10. Consider the following reaction

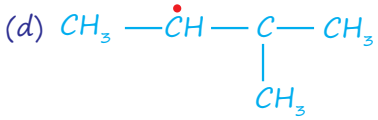


Identify the structure of the major product X (IIT JEE 2002)

(a) 

(b) 

(c) 

(d) 

Sol. (b)

11. Which of the following is a free radical substitution reaction? (2020-Covid)

(a) Acetylene with HBr

(b) Methane with Br_2/hv

(c) Propene with $HBr/(C_6H_5COO)_2$

(d) Benzene with $Br_2/AlCl_3$

Sol. (b)

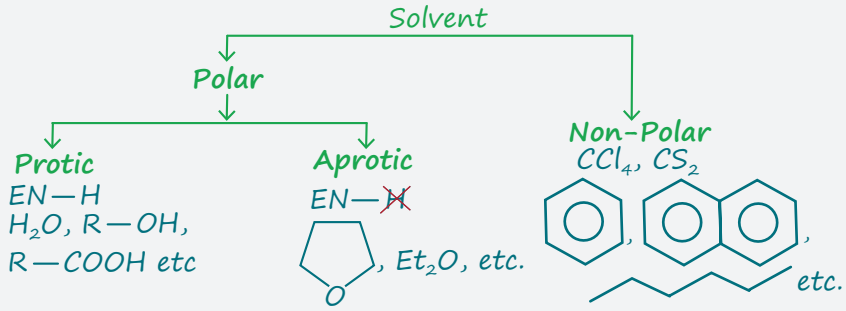
Attacking Reagents

In chemistry, an attacking reagent is a molecule or ion that initiates a chemical reaction by interacting with a substrate molecule or an intermediate. It acts as an electron donor or electron acceptor, leading to the formation of a new chemical bond.

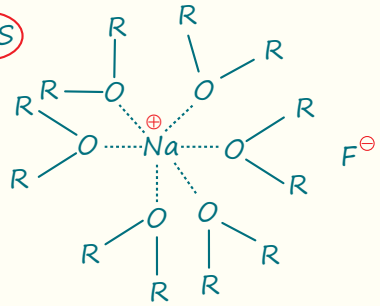
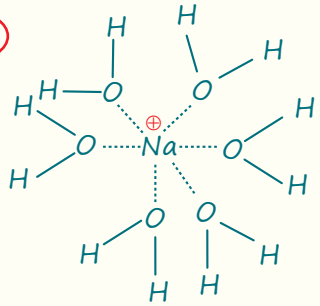
Attacking Reagents

- **Electrophile**
  - Electrons loving
    Or
  - Electron deficient species
    Or
  - electron seeking species
- **Nucleophile**
  - Nucleus loving
    Or
  - electron rich species
    Or
  - Electron donating species.
- **Solvent**

Nucleophilicity	Basicity
Electron donating tendency to any $E^{\oplus}$	Electron donating tendency to H^{+}
$Nu^{\ominus} + E^{\oplus} \rightleftharpoons E - Nu$	$B^{\ominus} + H^{\oplus} \rightleftharpoons B - H$
Kinetic property	Thermodynamics properties



Nucleophilicity in different solvent

NaF NaCl NaBr NaI	NaF NaCl NaBr NaI	NaF NaCl NaBr NaI
PAS 	PPS 	NPS
$F^{\ominus} > Cl^{\ominus} > E > I^{\ominus}$	NaI > NaBr > NaCl > NaF	NaI > NaBr > NaCl > NaF

Electrophile	Nucleophile
1. Positive changed incomplete octet $\overset{\oplus}{C}H_3$, $F^{\oplus}$, $Cl^{\oplus}$, $Br^{\oplus}$, $I^{\oplus}$, $NO^{\oplus}$, $NO_2^{\oplus}$, $OH^{\oplus}$, $H^{\oplus}$, $D^{\oplus}$, $T^{\oplus}$, $R-\overset{\oplus}{C}=O$ etc.	1. Negatively Changed & complete octet $\overset{\ominus}{C}H_3$, $Cl^{\ominus}$, $F^{\ominus}$, $Br^{\ominus}$, $I^{\ominus}$, $\overset{\ominus}{O}H$, $\overset{\ominus}{S}H$, $\overset{\ominus}{C}N$, $N_3^{\ominus}$, $RCOO^{\ominus}$, $H^{\ominus}$, $D^{\ominus}$, $\overset{\ominus}{N}O_2$ $\left(\overset{\ominus}{O}-\overset{\oplus}{N}=O\right)$
2. Neutral & incomplete octet $AlCl_3$, $AlBr_3$, BF_3, BBr_3, Fe etc.	2. Neutral & Complete octet (lone pair) H_2O, NH_3, NR_3, $R-\ddot{N}H_2$, $H_2N-\ddot{N}H_2$
3. Neutral & Complete octet (π^*, σ^*) FeX_3, sbF_5, $ZnCl_2$, $R-C(=O)-H$, $R-C(=O)-X$, CO_2, SO_3, Br_2, I_2, $I-Cl$ etc.	$Ph-NH-NH_2$, $H_2\ddot{N}-NH-C(=O)-NH_2$ 3. π – electrons Alkene, Alkyne,  Napthalene  etc.

Practice Questions

185. Which of the following statements are correct for nucleophile?

(a) All negatively charged species are nucleophiles
(b) Nucleophiles are Lewis bases
(c) Alkenes, alkynes, benzene and pyridine are nucleophiles
(d) All are correct

186. Consider the species.

(I) $\overset{\ominus}{O}H$ (II) $CH_3-\overset{\ominus}{O}$
(III) $\overset{\ominus}{C}H_3$ (IV) $\overset{\ominus}{N}H_2$

Arrange these nucleophilic species in their decreasing order of nucleophilicity:

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

187. The nucleophilicity of CH_3^-, NH_2^-, OH^- and F^- decrease in which order?

(a) $CH_3^- > NH_2^- > OH^- > F^-$
(b) $OH^- > NH_2^- > CH_3^- > F^-$
(c) $NH_2^- > OH^- > CH_3^- > F^-$
(d) $CH_3^- > OH^- > F^- > NH_2^-$

188. Arrange the following nucleophiles in the order of their nucleophilic strength:

(a) $OH^- > CH_3COO^- > OCH_3^- > C_6H_5O^-$
(b) $CH_3COO^- < C_6H_5O^- < OCH_3^- < OH^-$
(c) $C_6H_5O^- > CH_3COO^- < CH_3O^- < OH^-$.
(d) $CH_3\ COO^- < C_6H_5O^- < OH^- < CH_3O^-$

189. Correct order of leaving group tendency is :

(a) $I^- > Br^- > Cl^- > F^-$ (b) $F^- > Cl^- > Br^- > I^-$
(c) $Cl^- > F^- > Br^- > I^-$ (d) $I^- > Cl^- > Br^- > F^-$

190. Match the following

Column – I	Column – II
(a) I^-	(P) A good leaving group
(b) F^-	(Q) Very weak base
(c) CH_3–  –SO_3^-	(R) A good nucleophile in polar protic solvent
(d) OH^-	(S) A poor leaving group

191. The most reactive nucleophile among the following is

(a) CH_3O^- (b) $C_6H_5O^-$
(c) $(CH_3)_2CHO^-$ (d) $(CH_3)_2CO^-$

192. Which of the following is not an electrophile?

(a) CH_2CH_2 (b) BF_3 (c) $^+NO_2$ (d) Fe^{+3}

193. Which is the MOST basic nucleophile in the following series?

(a) F^- (b) $CH_3CH_2\ OH$
(c) H_2O (d) $CH_3CH_2\ O^-$

194. How are basicity and leaving group ability related?

(a) They are not related to each other
(b) Good leaving groups are strong bases
(c) Good leaving groups are weak bases
(d) Leaving group $\propto$ Basic strength

195. Correct order of leaving group character is :

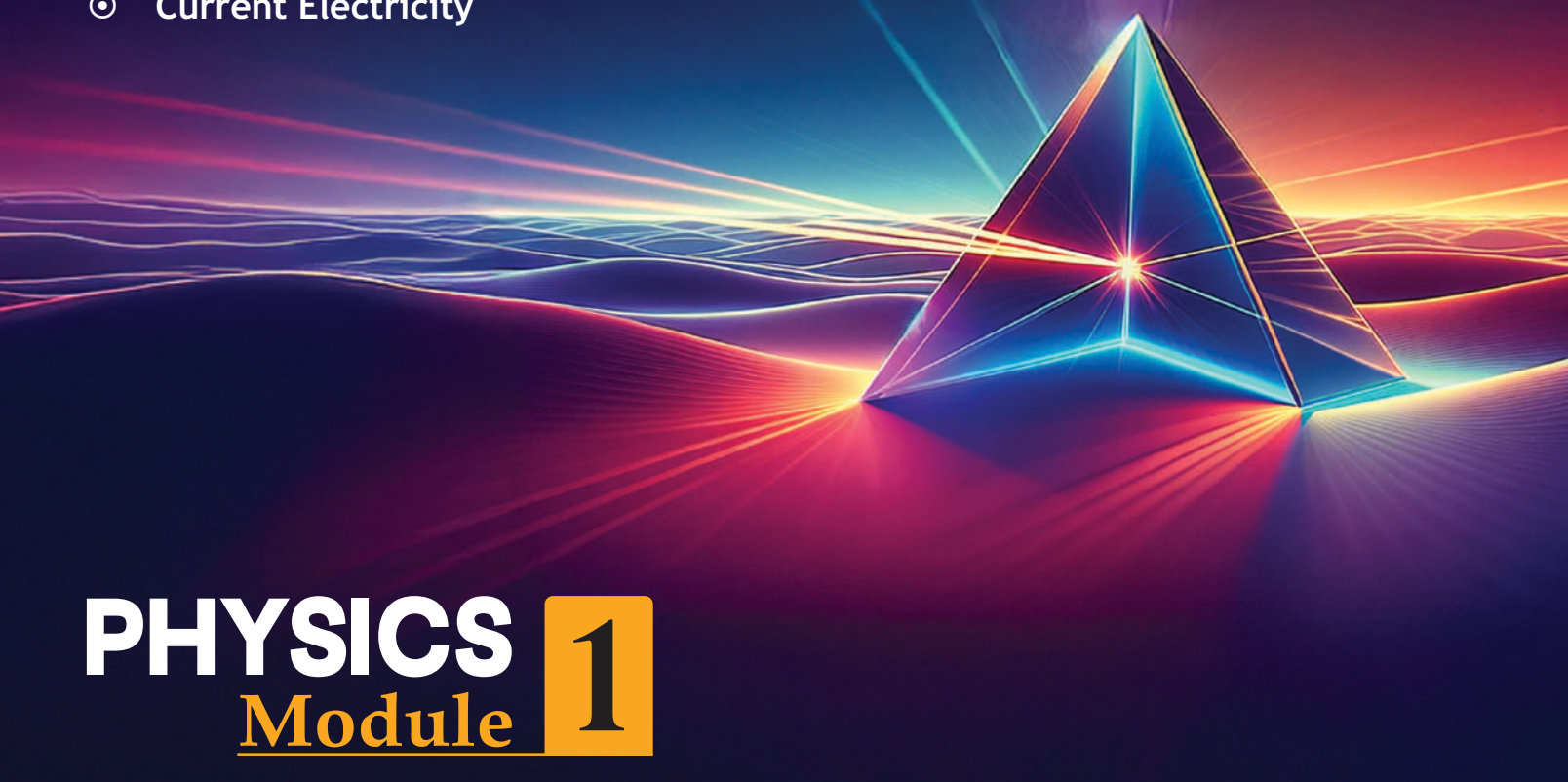
(a) $CCl_3COO^{(-)} > CH_3COO^{(-)} > CH_3O^{(-)} > PhO^{(-)}$
(b) $OTs^{(-)} > CH_3SO_3^{(-)} > PhO^{(-)} > OH^{(-)}$
(c) $CCl_3COO^{(-)} > PhO^{(-)} > CH_2=CH-O^{(-)} > CH_3O^{(-)}$
(d) $HCOO^{(-)} > PhO^{(-)} > CH_3COO^{(-)} > CH_3\ O^{(-)}$

PHYSICS WALLAH

LAKSHYA JEE

CLASS-XII

- Electric Charges and Fields
- Electrostatic Potential and Capacitance
- Current Electricity



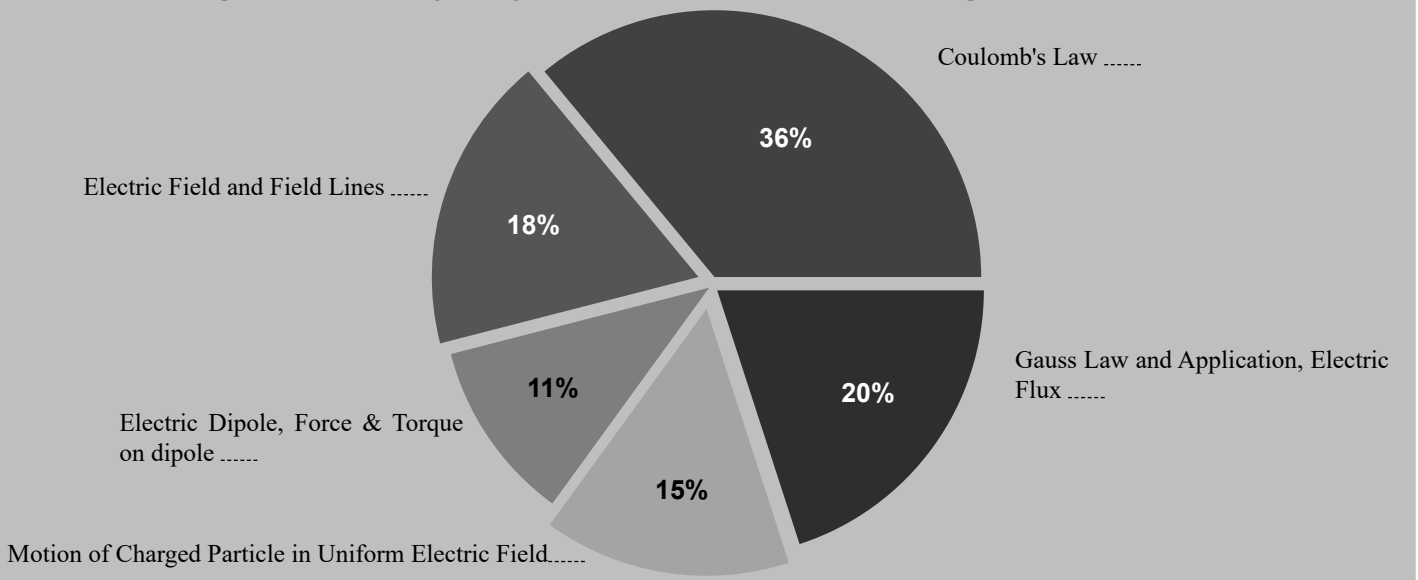
PHYSICS Module 1

CHAPTER

1

Electric Charges and Fields

Topicwise Weightage of JEE Main 6 Years Paper (124 Sets)



"How's the Josh?" for these Topics: *Mark your confidence level in the blank space around the topic (Low-L, Medium-M, High-H)*

ELECTROSTATICS

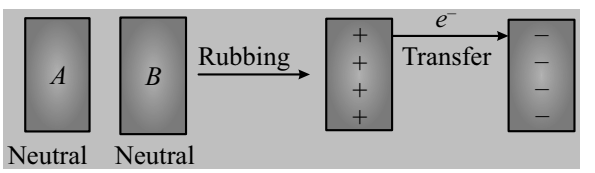
The branch of physics which deals with properties of charges at rest is called electrostatics.

ELECTRIC CHARGE

Charge is scalar physical quantity associated with matter due to which it produces and experiences electrical and magnetic effects. The excess or deficiency of electrons in a body gives it a net charge. A negatively charged body has excess of electrons while a positively charged body has deficiency of electrons.

Properties of Electric Charge

1. Charges interact with each other i.e., they exert force on each other. Like point charges repel each other while unlike point charges attract each other.
2. **Charge is of two kinds:** Positive and negative.
3. **Total charge of an isolated system is conserved** (Conservation of charge).
4. **Charge is quantised:** Charge is an integral multiple of electronic charge i.e., $Q = Ne$, where $e = 1.6 \times 10^{-19}$ C and N is an integer.
5. **Charge can be transferred:** Charge can be transferred from one body to another. This occurs due to transfer of electrons from one body to another. One of the common example of transfer of charge is charging by friction.



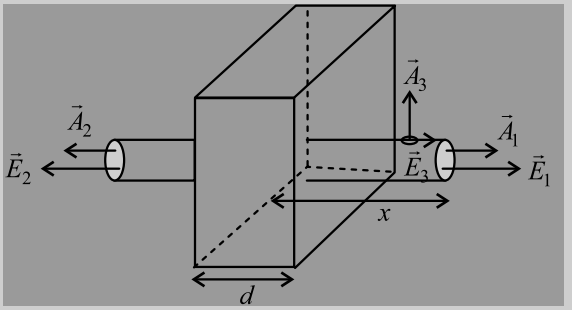
Frictional Electricity: When two bodies are rubbed with each other, they are found to attract each other. This is so because, on rubbing, transfer of electrons takes place from one body to another. One of them acquires a positive charge and other acquires a negative charge.

6. **Charge is invariant:** Charge of a particle is independent of its speed.
7. Charge cannot exist without mass, while mass can exist without charge. e.g., neutron, neutrino, antineutrino all are neutral particles having mass.

   SI Unit: coulomb (C)

   [1 coulomb = 1 ampere × 1 second]

   C.G.S. unit: stat coulomb or franklin



$$\oint \vec{E}\cdot\overrightarrow{dA} = \oint_{A_1} \vec{E}_1\cdot\overrightarrow{dA_1} + \oint_{A_2} \vec{E}_2\cdot\overrightarrow{dA_2} + \oint_{A_3} \vec{E}_3\cdot\overrightarrow{dA_3}$$

$$\frac{q_{enc}}{\varepsilon_0} = E_1A_1 + E_2A_2$$

$$\boxed{E_x = \frac{\rho d}{2\varepsilon_0}}$$

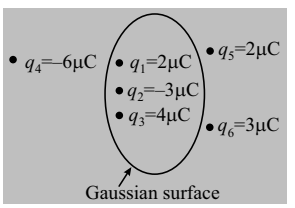
Train Your Brain

Example 18: Find out flux through the given Gaussian surface.

Sol. $\phi = \dfrac{Q_{in}}{\varepsilon_0}$

$= \dfrac{2\mu C - 3\mu C + 4\mu C}{\varepsilon_0}$

$= \dfrac{3\times10^{-6}}{\varepsilon_0}$ Nm²/C



Example 19: If a point charge q is placed at the center of a cube then find out flux through any one surface of cube.

Sol. Flux through 6 surfaces = $\dfrac{q}{\varepsilon_0}$

Since all the surfaces are symmetrical

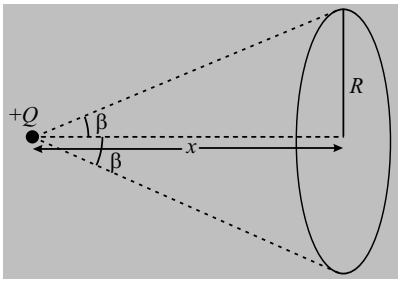
so, flux through one surface = $\dfrac{1}{6}\dfrac{q}{\in_0}$

Example 20: The electric field in a region is given by $\vec{E} = \frac{3}{5}E_0\hat{i} + \frac{4}{5}E_0\hat{j}$ with E_0 = 2.0 × 10³ N/C. Find the flux of this field through a rectangular surface of area 0.2 m² parallel to the $Y-Z$ plane.

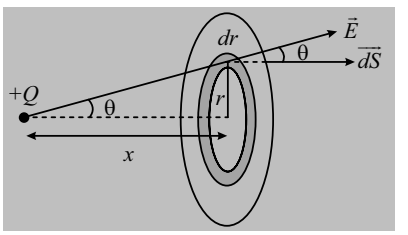
Sol. $\phi = \vec{E}\cdot\vec{S} = \left(\frac{3}{5}E_0\hat{i} + \frac{4}{5}E_0\hat{j}\right)\cdot\left(0.2\hat{i}\right)$

$= 240\dfrac{\text{N-m}^2}{\text{C}}$

Example 21: Find the electric flux due to a point charge 'Q' through the circular region of radius R if the charge is placed on the axis at a distance x as shown in figure.



Sol. We can divide the circular region into small rings.



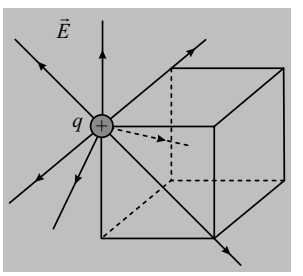
Let us take a ring of radius r and width dr. Flux through this small element $d\phi = E\ ds\cos\theta$

$$\therefore\ \phi_{net} = \int E ds\cos\theta = \int_{r=0}^{r=R} \frac{kQ}{\left(x^2+r^2\right)}\left(2\pi r dr\right)\left(\frac{x}{\sqrt{x^2+r^2}}\right)$$

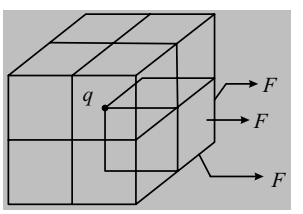
$$= \frac{Q}{2\varepsilon_0}\left[1 - \frac{x}{\sqrt{x^2+R^2}}\right] = \frac{Q}{2\varepsilon_0}[1-\cos\beta]$$

Example 22: Consider a point charge q = 1mC placed at a corner of a cube of side 10 cm. Determine the electric flux through each face of the cube.

Sol. Here we will use the symmetry of the situation, which involves the faces joining at the corner at which the charge resides.



(*a*) A charge q is placed at the corner of a cube



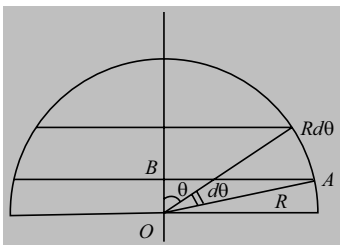
(*b*) By surrounding the charge with a series of cubes such that the charge is at the center of a larger cube, we have created a symmetric arrangement.

The total flux is $\frac{q}{\varepsilon_0}$. So that the flux through each of the sides of the large cube is $\frac{q}{6\varepsilon_0}$ and one quarter of that $\frac{q}{24\varepsilon_0}$ goes through each of the far sides of the small cube (because the faces of small cube which touch the charge have electric field parallel to them). Numerical evaluation gives

$$\phi = \frac{q}{24\varepsilon_0} = \frac{1\times10^{-3}\,\text{C}}{24\left(8.85\times10^{-12}\,\text{C}^2/\text{Nm}^2\right)} = 5\times10^6\,\text{Nm}^2/\text{C}$$

Example 23: Find by direct integration the electric field at the center of a hemispherical surface of charge having uniform surface density σ.

Sol.



Consider a ring-shaped element on the surface of the hemisphere at an angle θ as shown.

AB = the radius of the ring = $R\sin\theta$

Distance of center of ring B from O = $R\cos\theta$

Charge on the element = $dq = \sigma$ (area)

$dq = \sigma\,(2\pi R\sin\theta)\,Rd\theta$

Field at O due to this infinitesimal element = dE

$$dE = \frac{(dq)(R\cos\theta)}{4\pi\varepsilon_0\left(R^2\sin^2\theta + R^2\cos^2\theta\right)^{3/2}}$$

(using the result for the field at axis of a ring)

$$\Rightarrow E = \int dE = \int_0^{\pi/2} \frac{R\sin\theta\left(2\pi\sigma R^2\right)\cos\theta}{4\pi\varepsilon_0 R^3}\,d\theta$$

$$= \frac{\sigma}{2\varepsilon_0}\int_0^{\pi/2}\sin\theta\cos\theta\,d\theta = \frac{\sigma}{2\varepsilon_0}\left|\frac{\sin^2\theta}{2}\right|_0^{\pi/2}$$

$$= \frac{\sigma}{4\varepsilon_0}$$

Example 24: A system consists of a ball of radius R carrying a spherically symmetric charge and the surrounding space is filled with a charge of volume density $\rho = a/r$ where a is a constant, r is the distance from the center of ball. Find the ball's charge for which the magnitude of the electric field is independent of r outside the ball. How high is this strength?

Sol. Let us consider a spherical surface of radius $r(r > R)$ concentric with the ball and apply Gauss's Law.

$$\oint \vec{E}\cdot\overrightarrow{dA} = \frac{q}{\varepsilon_0}$$

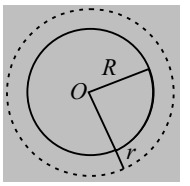
Let Q = Total charge on the ball

$$\varepsilon_0 E\left(4\pi r^2\right) = Q + \int_R^r \rho\, 4\pi x^2\,dx$$

$$\varepsilon_0 E\left(4\pi r^2\right) = Q + 4\pi\int_R^r \frac{a}{x}x^2\,dx$$

$$\varepsilon_0 E\left(4\pi r^2\right) = Q + 2\pi a\left(r^2 - R^2\right)$$

$$\Rightarrow E = \left(\frac{Q - 2\pi aR^2}{4\pi\varepsilon_0}\right)\frac{1}{r^2} + \frac{2\pi a}{4\pi\varepsilon_0}$$



For E to be independent of r,

$Q = 2\pi aR^2$

$$E = \frac{a}{2\varepsilon_0}$$

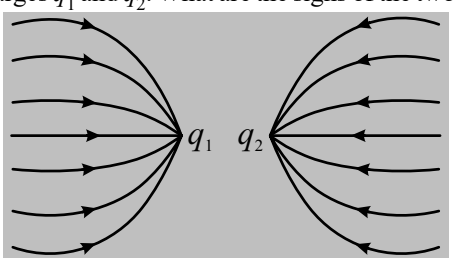
Concept Application

10. If an insulated non-conducting sphere of radius R has charge density ρ. The electric field at a distance r from the center of sphere ($r < R$) will be

(*a*) $\frac{\rho R}{3\varepsilon_0}$ (*b*) $\frac{\rho r}{\varepsilon_0}$

(*c*) $\frac{\rho r}{3\varepsilon_0}$ (*d*) $\frac{3\rho R}{\varepsilon_0}$

11. The given figure gives electric lines of force due to two charges q_1 and q_2. What are the signs of the two charges?



(*a*) Both are negative

(*b*) Both are positive

(*c*) q_1 is positive but q_2 is negative

(*d*) q_1 is negative but q_2 is positive

12. If electric field is uniform, then the electric lines of forces are

(*a*) Divergent

(*b*) Convergent

(*c*) Circular

(*d*) Parallel

13. A non-conducting solid sphere of radius R is uniformly charged. The magnitude of the electric field due to the sphere at a distance r from its center.

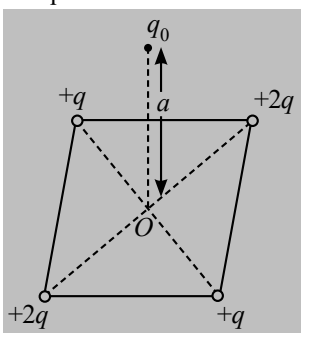
(*a*) Increases as r increases, for $r \le R$

(*b*) Decreases as r increases, for $0 < r < \infty$.

(*c*) Decreases as r increases, for $R < r < \infty$.

(*d*) Is discontinuous at $r = R$

1. Four point charges are fixed at the corners of a square of side length a. A positive charge q_0 is placed at a distance a from center of square perpendicular to the plane of square. If point charge q_0 is in equilibrium then its mass m is $\left(a=\sqrt{\frac{3}{2}}\text{m}\right)$.



(*a*) $\frac{2qq_0}{9\pi\varepsilon_0 g}\sqrt{\frac{3}{2}}$ (*b*) $\frac{4qq_0}{9\pi\varepsilon_0 g}\sqrt{\frac{3}{2}}$

(*c*) $\frac{5qq_0}{9\pi\varepsilon_0 g}\sqrt{\frac{3}{2}}$ (*d*) $\frac{8}{9}\frac{qq_0}{\pi\varepsilon_0 g}\sqrt{\frac{3}{2}}$

Sol. $F_E = mg$

$$\frac{2(k)(2q)q_0}{\left(a^2+\frac{a^2}{2}\right)}\frac{a}{\sqrt{a^2+\frac{a^2}{2}}}+\frac{2kqq_0}{\left(a^2+\frac{a^2}{2}\right)}\frac{a}{\sqrt{a^2+\frac{a^2}{2}}}=mg$$

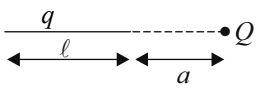
$$\frac{2kqq_0a}{\left(\frac{3a^2}{2}\right)^{3/2}}(3)=mg$$

$$m=\frac{(2kqq_0)(a)8}{9g}=\left(\frac{2\times8}{4\pi\varepsilon_0}\right)\frac{(qq_0)}{9g}\sqrt{\frac{3}{2}}$$

$$m=\frac{4qq_0}{9\pi\varepsilon_0 g}\sqrt{\frac{3}{2}}$$

Therefore, option (*b*) is the correct answer.

2. A thin straight rod of length l carrying a uniformly distributed charge q is located in vacuum. Find the magnitude of the electric force on a point charge 'Q' kept as shown in the figure.

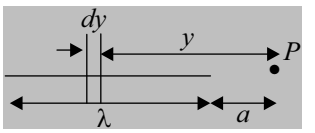


(*a*) $\frac{KQq}{(a+\ell)^2}$ (*b*) $\frac{KQq}{a\ell}$ (*c*) $\frac{KQq}{a(a+\ell)}$ (*d*) $\frac{KQq}{a(a-\ell)}$

Sol. As the charge on the rod is not point charge, therefore, first we have to find force on charge Q due to charge over a very small part on the length of the rod. This part called element of length, dy can be considered as point charge.

Charge on element, $dq = \lambda dy = \frac{q}{l}dy$

Electric force on 'Q' due to element



$$dF=\frac{k.dq.Q}{y^2}=\frac{k.Q.q.dy}{y^2l}$$

All forces are along the same direction,

$\therefore\ F=\sum dF$. This sum can be calculated using integration,

therefore $F=\int_a^{a+l}\frac{KQqdy}{y^2l}=\frac{KqQ}{l}=\left[-\frac{1}{y}\right]_a^{a+l}$

$$=\frac{KQ.q}{l}\left[\frac{1}{a}-\frac{1}{a+l}\right]=\frac{KQq}{a(a+l)}$$

NOTE: (1) The total charge of the rod cannot be considered to be placed at the center of the rod as we do in mechanics for mass in many problems.

(2) If $a >> l$ then, $F=\frac{KQq}{a^2}$

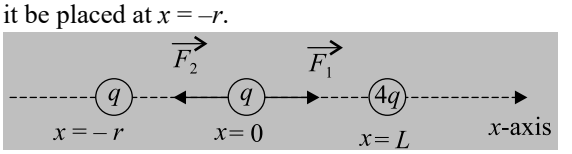
i.e., behavior of the rod is just like a point charge for very far away points.

Therefore, option (*c*) is the correct answer.

3. Two charges q and $4q$ are placed at $x = 0$ and $x = L$ along x-axis. Where should another particle of charge q, be placed on x-axis, so that net force on charge at $x = 0$ becomes zero?

(*a*) $x=\frac{L}{2}$ (*b*) $x=2L$ (*c*) $x=-2L$ (*d*) $x=-\frac{L}{2}$

Sol. The charge $4q$ repels the charge q towards negative x-axis. So the charge q has to be placed on the left of charge q. Let it be placed at $x = -r$.



Let $\vec{F}_1$ be the force on q (at $x = 0$) due to charge at $x = -r$, given as

$$\vec{F}_1=\left(\frac{1}{4\pi\varepsilon_0}\right)\frac{q^2}{r^2}\hat{i}$$

Let $\vec{F}_2$ be the force on q (at $x = 0$) due to charge $4q$ at $x = L$, given as

$$\vec{F}_2=-\left(\frac{1}{4\pi\varepsilon_0}\right)\frac{q\times4q}{L^2}\hat{i}$$

According to the condition given,

Net force $\vec{F}_1+\vec{F}_2 \Rightarrow \frac{q^2}{r^2}=\frac{4q^2}{L^2} \Rightarrow r=\frac{L}{2}$

$\therefore$ The charge q should be placed at $x=\frac{-L}{2}$.

Therefore, option (*d*) is the correct answer.

SINGLE CORRECT TYPE QUESTIONS

1. If a body has positive charge on it, then it means it has
(*a*) Gained some protons
(*b*) Lost some protons
(*c*) Gained some electrons
(*d*) Lost some electrons

2. Sure check for presence of electric charge is
(*a*) Process of induction
(*b*) Repulsion between bodies
(*c*) Attraction between bodies
(*d*) Frictional force between bodies

3. If a solid and a hollow conducting sphere have same radius then
(*a*) Hollow sphere will hold more maximum charge
(*b*) Solid sphere will hold more maximum charge
(*c*) Both the spheres will hold same maximum charge
(*d*) Both the sphere can't hold charge

4. When a conducting soap bubble is negatively charged then
(*a*) Its size starts varying arbitrarily
(*b*) It expands
(*c*) It contracts
(*d*) No change in its size takes place

5. Consider three-point charges P, Q and R. R and Q repel each other, while P and R attract. What is the nature of force between P and Q?
(*a*) Repulsive force (*b*) Attractive force
(*c*) No force (*d*) None of these

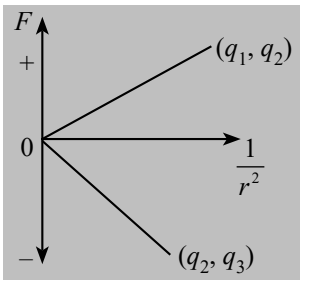
6. Which of the following process involves the principle of electrostatic induction?
(*a*) Pollination (*b*) Chocolate making
(*c*) Xerox copying (*d*) All of these

7. The electric field intensity at a point in vacuum is equal to
(*a*) Zero
(*b*) Force a proton would experience there
(*c*) Force an electron would experience there
(*d*) Force a unit positive charge would experience there

8. A sphere of radius R has electric charge uniformly distributed in its entire volume. At a distance d, from the centre inside the sphere, the electric field intensity is directly proportional to
(*a*) $\frac{1}{d}$ (*b*) $\frac{1}{d^2}$ (*c*) d (*d*) d^2

9. Two identical small conducting balls B_1 and B_2 are given $-7\ pC$ and $+4\ pC$ charges respectively. They are brought in contact with a third identical ball B_3 and then separated. If the final charge on each ball is $-2pC$. the initial charge on B_3 was
(*a*) $-2\ pC$ (*b*) $-3\ pC$ (*c*) $-5\ pC$ (*d*) $-15\ pC$

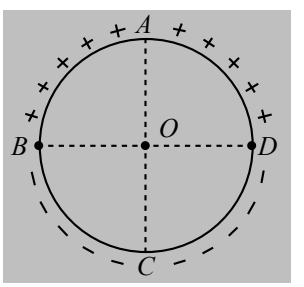
10. The Coulomb force (F) versus ($1/r^2$) graphs for two pairs of point charges (q_1 and q_2) and (q_2 and q_3) are shown in figure. The charge q_2 is positive and has least magnitude. Then



(*a*) $q_1 > q_2 > q_3$ (*b*) $q_1 > q_3 > q_2$
(*c*) $q_3 > q_2 > q_1$ (*d*) $q_3 > q_1 > q_2$

Directions: These questions consist of two statements each, printed as Assertion (A) and Reason (R). While answering these questions, you are required to choose any one of the following four responses.
(*a*) Both Assertion (A) and Reason (R) are True and the Reason (R) is a correct explanation of the Assertion (A).
(*b*) Both Assertion (A) and Reason (R) are True but Reason (R) is not a correct explanation of the Assertion (A).
(*c*) Assertion (A) is True but the Reason (R) is False.
(*d*) Assertion (A) is False but Reason (R) is True.

11. **Assertion (A):** Equal amount of positive and negative charges are distributed uniformly on two halves of a thin circular ring as shown in figure. The resultant electric field at the centre O of the ring is along OC.
Reason (R): It is so because the net potential at O is not zero.



12. **Assertion (A):** Gauss' theorem is applicable on any closed surface.
Reason (R): In order to find the value of electric field due to a charge distribution, Gauss' theorem should be applied on a symmetrical closed surface.

COULOMB FORCE

1. When 10^{14} electrons are removed from a neutral metal sphere, the net charge that appears on the sphere is

(*a*) 16 μC (*b*) –16 μC

(*c*) 32 μC (*d*) –32 μC

2. Number of electrons in one coulomb of charge will be ($1e = 1.6 \times 10^{-19}$ C)

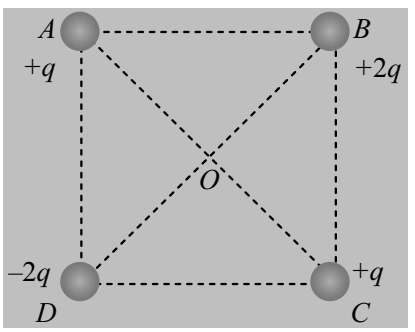
(*a*) 5.46×10^{29} (*b*) 6.25×10^{18}

(*c*) 1.6×10^{19} (*d*) 9×10^{11}

3. The ratio of the forces between two small spheres with constant charge in air to that in a medium of dielectric constant K is

(*a*) $1 : K$ (*b*) $K : 1$ (*c*) $1 : K^2$ (*d*) $K^2 : 1$

4. Four charges are arranged at the corners of a square $ABCD$, as shown in the adjoining figure. The force on a charge kept at the center O is



(*a*) Zero (*b*) Along the diagonal AC

(*c*) Along the diagonal BD (*d*) Perpendicular to side AB

5. A total charge Q is broken in two parts Q_1 and Q_2 and they are placed at a distance R from each other. The maximum force of repulsion between them will occur, when

(*a*) $Q_2 = \frac{Q}{R}, Q_1 = Q - \frac{Q}{R}$ (*b*) $Q_2 = \frac{Q}{4}, Q_1 = Q - \frac{2Q}{3}$

(*c*) $Q_2 = \frac{Q}{4}, Q_1 = \frac{3Q}{4}$ (*d*) $Q_1 = \frac{Q}{2}, Q_2 = \frac{Q}{2}$

6. Two charged spheres separated by a distance R exert a force F on each other. If they are immersed in a liquid of dielectric constant 5, then what is the new force between them?

(*a*) $\frac{F}{5}$ (*b*) F (*c*) $5F$ (*d*) $\frac{F}{2}$

7. A charge q is placed at the center of the line joining two equal charges Q. The system of the three charges will be in equilibrium, if q is equal to

(*a*) $-\frac{Q}{2}$ (*b*) $-\frac{Q}{4}$

(*c*) $+\frac{Q}{4}$ (*d*) $+\frac{Q}{2}$

8. Two charged particles having charge 2×10^{-8} C each are joined by an insulating string of length 1m and the system is kept on a smooth horizontal table, what is the tension in the string?

(*a*) 3.6×10^{-6}N (*c*) 3.4×10^{-6}N

(*b*) 4×10^{-7}N (*d*) 3×10^{-4}N

9. Point charges $+4q$, $-q$ and $+4q$ are kept on the X-axis at point $x = 0$, $x = a$ and $x = 2a$ respectively.

(*a*) Only $-q$ is in stable equilibrium

(*b*) All the charges are in stable equilibrium

(*c*) All of the charges are in unstable equilibrium

(*d*) None of the charges is in equilibrium

10. Charges on two spheres are +10μC and –5μC respectively. They experience a force F. If each of them is given an additional charge +2μC then new force between them, if kept at the same distance, is

(*a*) $18F$ (*b*) $25F$ (*c*) $\frac{18F}{25}$ (*d*) $\frac{25}{18}F$

11. Two charges each of $1\mu C$ are at $P\left(2\hat{i}+3\hat{j}+\hat{k}\right)$m and $Q\left(\hat{i}+\hat{j}-\hat{k}\right)$m. Then the force acting on any one of them is

(*a*) 50N (*b*) 10N (*c*) 10^4 dyne (*d*) 100 dyne

12. A charged particle q_1 is at position (2, – 1, 3). The electrostatic force on another charged particle q_2 at (0, 0, 0) is

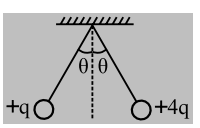
(*a*) $\frac{q_1 q_2}{56\pi\epsilon_0}(2\hat{i} - \hat{j} + 3\hat{k})$

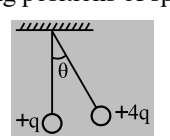
(*b*) $\frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{\left(\sqrt{14}\right)^3}(-2\hat{i} + \hat{j} - 3\hat{k})$

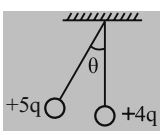
(*c*) $\frac{q_1 q_2}{56\pi\epsilon_0}(\hat{j} - 2\hat{i} - 3\hat{k})$

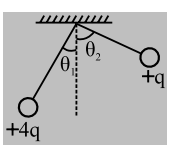
(*d*) $\frac{q_1 q_2}{56\sqrt{14}\ \pi\epsilon_0}(2\hat{i} - \hat{j} + 3\hat{k})$

13. Two point sized metal spheres of same mass are suspended from a common point by two light insulating strings. The length of each string is same. The spheres are given electric charges $+q$ on one of them and $+4q$ on the other. Which of the following diagrams best shows the resulting positions of spheres?

(*a*) 

(*b*) 

(*c*) 

(*d*) 

49. A charged particle having mass m and charge q is released from rest in a uniform electric field E. The kinetic energy of the charged particle moving on a horizontal plane after 't' seconds is

(*a*) $\frac{Eq^2m}{2t^2}$ (*b*) $\frac{2E^2t^2}{3mq}$ (*c*) $\frac{E^2q^2t^2}{2m}$ (*d*) $\frac{Eqm}{t}$

50. A particle having charge q and mass m is projected with velocity $\vec{v} = 2\hat{i} - 3\hat{j}$ in a uniform electric field $\vec{E} = E_0\hat{j}$. What is the magnitude of change in momentum $|\Delta\vec{P}|$ during any time interval t?

(*a*) $\sqrt{13}\,m$ (*b*) qE_0t (*c*) $\frac{qE_0t}{3m}$ (*d*) Zero

51. The bob of a simple pendulum is hanging vertically down from a fixed identical bob by means of a string of length 'l'. If both bobs are charged with a charge 'q' each, time period of the pendulum is (ignore the radii of the bobs).

(*a*) $2\pi\sqrt{\frac{l}{g+\left(\frac{Kq^2}{l^2m}\right)}}$ (*b*) $2\pi\sqrt{\frac{l}{g-\left(\frac{Kq^2}{l^2m}\right)}}$

(*c*) $2\pi\sqrt{\frac{l}{g}}$ (*d*) $2\pi\sqrt{\frac{l}{g-\left(\frac{Kq^2}{lm^2}\right)}}$

Prabal (JEE Main Level)

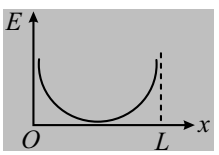
1. Two small balls having equal positive charge Q (Coulomb) on each are suspended by two insulating strings of equal length 'L' metre, from a hook fixed to a stand. The whole setup is taken in a satellite into space where there is no gravity (state of weightlessness). Then the angle (θ) between the two strings is

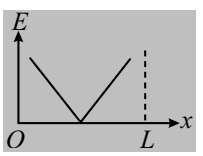
(*a*) 0º (*b*) 90º
(*c*) 180º (*d*) 0º < θ < 180º

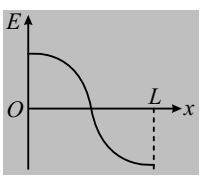
2. Two charges $4q$ and q are placed 30 cm apart. At what point the value of electric field will be zero?

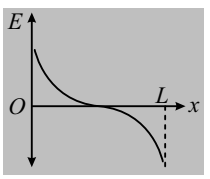
(*a*) 10 cm away from q and between the charges
(*b*) 20 cm away from q and between the charges
(*c*) 10 cm away from q and outside the line joining the charges
(*d*) 10 cm away from $4q$ and outside the line joining the charges

3. Two identical point charges are placed at a separation of L. P is a point on the line joining the charges, at a distance x from any one charge. The field at P is E. E is plotted against x for values of x from close to zero to slightly less than L. Which of the following best represents the resulting curve?

(*a*) 

(*b*) 

(*c*) 

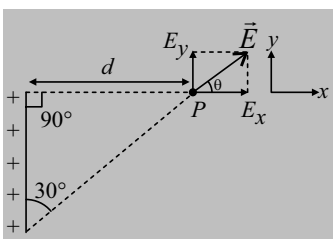
(*d*) 

4. The maximum electric field intensity on the axis of a uniformly charged ring of charge q and radius R will be

(*a*) $\frac{1}{4\pi\varepsilon_0}\,\frac{q}{3\sqrt{3}R^2}$ (*b*) $\frac{1}{4\pi\varepsilon_0}\,\frac{2q}{3R^2}$

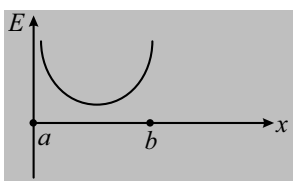
(*c*) $\frac{1}{4\pi\varepsilon_0}\,\frac{2q}{3\sqrt{3}R^2}$ (*d*) $\frac{1}{4\pi\varepsilon_0}\,\frac{3q}{2\sqrt{3}R^2}$

5. The direction (θ) of $\vec{E}$ at point P due to the uniformly charged finite rod will be



(*a*) At 30° from x-axis (*b*) At 45° from x-axis
(*c*) At 60° from x-axis (*d*) None of these

6. Two point charges a and b, whose magnitudes are same, are positioned at a certain distance from each other with a at origin. Graph is drawn between electric field strength E at points between a and b and distance x from a. E is taken positive if it is along the line joining from a to b. From the graph, it can be decided that



(*a*) a is positive, b is negative
(*b*) a and b both are positive
(*c*) a and b both are negative
(*d*) a is negative, b is positive

7. If $\vec{E} = \hat{i} + \sqrt{2}\,\hat{j} + \sqrt{3}\,\hat{k}$ then electric flux through a surface of area 100 m^2 lying in the xy plane is (in V-m)

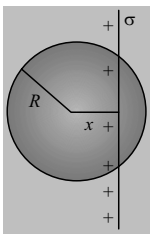
(*a*) 100 (*b*) 141.4
(*c*) 173.2 (*d*) 200

8. A cone of radius (R) and length (L) is placed in a uniform electrical field (E) parallel to the axis of the cone. The total flux for the total surface of the cone is given by

(a) $2\pi R^2 LE$ (b) $\pi R^2 LE$

(c) $\dfrac{2\pi R^2 L}{E}$ (d) zero

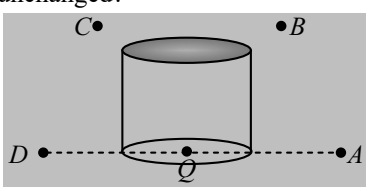
9. An infinite, uniformly charged sheet with surface charge density σ cuts through a spherical Gaussian surface of radius R at a distance x from its center, as shown in the figure. The electric flux ϕ through the Gaussian surface is



(a) $\dfrac{\pi R^2 \sigma}{\varepsilon_0}$ (b) $\dfrac{2\pi(R^2 - x^2)\sigma}{\varepsilon_0}$

(c) $\dfrac{\pi(R-x)^2\sigma}{\varepsilon_0}$ (d) $\dfrac{\pi(R^2 - x^2)\sigma}{\varepsilon_0}$

10. Figure shows a charge Q placed at the center of open face of a cylinder as shown in figure. A second charge q is placed at one of the positions A, B, C and D, out of which positions A and D are lying on a straight line parallel to open face of cylinder. In which position(s) of this second charge, the flux of the electric field through the cylinder remains unchanged?



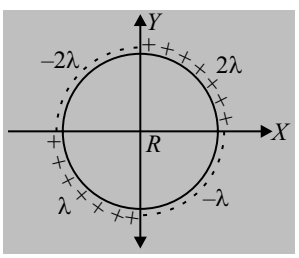
(a) A and D (b) B

(c) C (d) B and C

11. Two similar conducting spherical shells having charges 40 μC and –20μC are large distance apart. Now they are touched and kept at the same distance. The ratio of the initial to the final force between them is

(a) 8 : 1 (b) 4 : 1 (c) 1 : 8 (d) 1 : 1

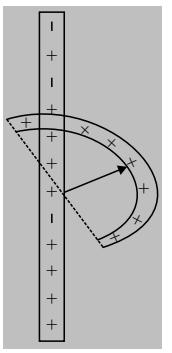
12. The charge per unit length of the four quadrants of the ring is 2λ, –2λ, λ and –λ respectively. The electric field at the center is



(a) $\dfrac{-\lambda}{2\pi\varepsilon_0 R}\hat{i}$ (b) $\dfrac{\lambda}{2\pi\varepsilon_0 R}\hat{j}$

(c) $\dfrac{\sqrt{2}\lambda}{4\pi\varepsilon_0 R}\hat{i}$ (d) None of these

13. Find the force experienced by the semicircular rod charged with a charge q, placed as shown in figure. Radius of the semi circular rod is R and the infinite line of charge with linear charge density λ is passing through the centre of semicircular rod and perpendicular to its plane.



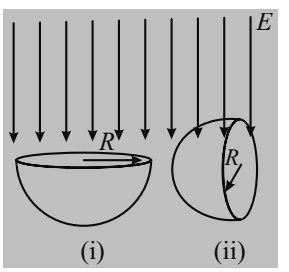
(a) $\dfrac{\lambda q}{2\pi^2\varepsilon_0 R}$ (b) $\dfrac{\lambda q}{\pi^2\varepsilon_0 R}$ (c) $\dfrac{\lambda q}{4\pi^2\varepsilon_0 R}$ (d) $\dfrac{\lambda q}{4\pi\varepsilon_0 R}$

14. In a certain region electric dipole having dipole moment $\vec{p} = 2\hat{i}$ is placed at a point having coordinates (x, y) where external electric field $\vec{E} = 3x^2y^2\hat{i} + 3x^3y\hat{j}$ V/m is also present. Find magnitude of force experienced by the dipole.

(a) $xy\sqrt{36x^2 + 81y^2}$ (b) $2xy\sqrt{36x^2 + 81y^2}$

(c) $xy\sqrt{36y^2 + 81x^2}$ (d) $2xy\sqrt{36y^2 + 81x^2}$

15. Two identical hemispherical bowls are placed inside an external uniform electric field E as shown in the figure. Find the ratio of electric flux entering both the bowls.



(a) $\dfrac{\phi_1}{\phi_2} = 2$ (b) $\dfrac{\phi_1}{\phi_2} = 3$

(c) $\dfrac{\phi_1}{\phi_2} = 4$ (d) $\dfrac{\phi_1}{\phi_2} = 5$

16. A spherical shell of radius R = 8 cm is having Q = –16 e charge is uniformly distributed over its surface. A point charge q = +2e is placed at its center. The electric field at point P at a distance r = 10 cm, is $x \times 10^{-6}$ NC^{-1}. Find x.

(a) 5.0 (b) 4.0 (c) 3.0 (d) 2.0

COULOMB FORCE

1. Force between two point charges q_1 and q_2 placed in vacuum at 'r' cm apart is *F*. Force between them when placed in a medium having dielectric constant = 5 at 'r/5' cm apart will be: **[31 Jan, 2024 (Shift-II)]**

(*a*) *F*/25 (*b*) 5*F* (*c*) *F*/5 (*d*) 25*F*

2. Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle θ with each other. When suspended in water the angle remains the same. If density of the material of the sphere is 1.5 g/cc, the dielectric constant of water will be _____ **[30 Jan, 2024 (Shift-I)]**

3. Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle of 37° with each other. When suspended in a liquid of density 0.7 g/cm^3, the angle remains same. If density of material of the sphere is 1.4 g/cm^3, the dielectric constant of the liquid is _____. $\left(\tan 37° = \frac{3}{4}\right)$

[30 Jan, 2024 (Shift-II)]

4. A thin metallic wire having cross sectional area of 10^{-4} m^2 is used to make a ring of radius 30 cm. A positive charge of 2π C is uniformly distributed over the ring, while another positive charge of 30 pC is kept at the centre of the ring. The tension in the ring is _____ N; provided that the ring does not get deformed (neglect the influence of gravity).

(given $\frac{1}{4\pi \in_0} = 9\times10^9$ SI units)

[27 Jan, 2024 (Shift-I)]

5. Suppose a uniformly charged wall provides a uniform electric field of 2×10^4 N/C normally. A charged particle of mass 2 g being suspended through a silk thread of length 20 cm and remain stayed at a distance of 10 cm from the wall. Then the charge on the particle will be $\frac{1}{\sqrt{x}}\mu C$ where x =_____. [use g = 10 m/s^2]

[1 Feb, 2024 (Shift-II)]

6. In hydrogen like system the ratio of coulombian force and gravitational force between an electron and a proton is of the order of: **[05 April, 2024 (Shift-I)]**

(*a*) 10^{39} (*b*) 10^{19}

(*c*) 10^{29} (*d*) 10^{36}

7. Two identical conducting spheres *P* and *S* with charge *Q* on each, repel each other with a force 16N. A third identical uncharged conducting sphere *R* is successively brought in contact with the two spheres. The new force of repulsion between *P* and *S* is: **[06 April, 2024 (Shift-II)]**

(*a*) 4 N (*b*) 6 N

(*c*) 1 N (*d*) 12 N

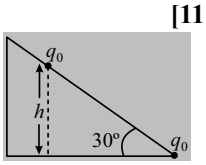
8. If two charges q_1 and q_2 are separated with distance '*d*' and placed in a medium of dielectric constant *K*. What will be the equivalent distance between charges in air for the same electrostatic force? **[24 Jan, 2023 (Shift-I)]**

(*a*) $d\sqrt{k}$ (*b*) $k\sqrt{d}$ (*c*) $1.5d\sqrt{k}$ (*d*) $2d\sqrt{k}$

9. As shown in the figure. a configuration of two equal point charges (q_0= +2μ *C*) is placed on an inclined plane. Mass of each point charge is 20 g. Assume that there is no friction between charge and plane. For the system of two point charges to be in equilibrium (at rest) the height $h = x \times 10^{-3}$ m The value of *x* is _____ mm.

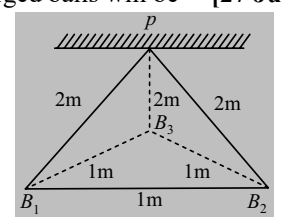
(Take $\frac{1}{4\pi\varepsilon_0} = 9\times10^9\ N m^2 C^{-2}$, $g = 10\,\text{ms}^{-1}$)

[11 April, 2023 (Shift-I)]



10. Three identical charged balls each of charge 2C are suspended from a common point *P* by silk threads of 2 m each (as shown in figure). They form an equilateral triangle of side 1 m.

The ratio of net force on a charged ball to the force between any two charged balls will be **[27 June, 2022 (Shift-II)]**



(*a*) 1 : 1 (*b*) 1 : 4 (*c*) $\sqrt{3}:2$ (*d*) $\sqrt{3}:1$

11. A disk of radius *R* with uniform positive charge density σ is placed on the *xy* plane with its center at the origin. The Coulomb potential along the *z*-axis is

$$V(z) = \frac{\sigma}{2\in_0}\left(\sqrt{R^2+z^2} - z\right)$$

A particle of positive charge *q* is placed initially at rest at a point on the *z* axis with $z = z_0$ and $z_0 > 0$. In addition to the Coulomb force, the particle experiences a vertical force $\vec{F} = -c\hat{k}$ with $c > 0$. Let $\beta = \frac{2c\in_0}{q\sigma}$. Which of the following statements is (are) correct? **[JEE Adv, 2022]**

(*a*) For $\beta = \frac{1}{4}$ and $z_0 = \frac{25}{7}R$, the particle reaches the origin

(*b*) For $\beta = \frac{1}{4}$ and $z_0 = \frac{3}{7}R$, the particle reaches the origin

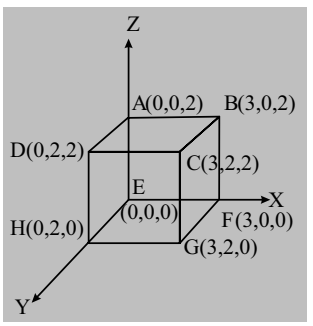
(*c*) For $\beta = \frac{1}{4}$ and $z_0 = \frac{R}{\sqrt{3}}$, the particle returns back to $z = z_0$

(*d*) For $\beta > 1$ and $z_0 > 0$, the particle always reaches the origin

48. A charge q is surrounded by a closed surface consisting of an inverted cone of height h and base radius R, and a hemisphere of radius R as shown in the figure. The electric flux through the conical surface is $\frac{nq}{6\in_0}$ (in SI units). The value of n is _____. **[JEE Adv, 2022]**

49. The electric field in a region is given by $\vec{E}=\left(\frac{3}{5}E_0\hat{i}+\frac{4}{5}E_0\hat{j}\right)\frac{N}{c}$. The ratio of flux of reported field through the rectangular surface of area 0.2 m^2 (parallel to $y-z$ plane) to that of the surface of area 0.3 m^2 (parallel to $x-z$ plane) is a:b, where a = _____ (round off to nearest integer) [Here $\hat{i}$, $\hat{j}$ and $\hat{k}$ are unit vectors along x, y and z-axes respectively] **[25 Feb, 2021 (Shift-I)]**

50. An electric field $\vec{E}=4x\hat{i}-(y^2+1)\hat{j}$ N/C passes through the box shown in figure. The flux of the electric field through surface $ABCD$ and $BCGF$ and marked as ϕ_I and ϕ_{II} respectively. The difference between $(\phi_I-\phi_{II})$ is (in Nm^2/C) **[9 Jan, 2020 (Shift-II)]**



51. A circular disc of radius R carries surface charge density $\sigma(r)=\sigma_0\left(1-\frac{r}{R}\right)$, where σ_0 is a constant and r is the distance from the center of the disc. Electric flux through a large spherical surface that encloses the charged disc completely is ϕ_0. Electric flux through another spherical surface of radius $\frac{R}{4}$ and concentric with the disc is ϕ. Then the ratio $\frac{\phi_0}{\phi}$ is ..... **[JEE Adv, 2020]**

52. A charged shell of radius R carries a total charge Q. Given ϕ as the flux of electric field through a closed cylindrical surface of height h, radius r and with its center same as that of the shell. Here, center of the cylinder is a point on the axis of the cylinder which is equidistant from its top and bottom surfaces. Which of the following option(s) is/are correct? [ε_0 is the permittivity of free space] **[JEE Adv, 2019]**

(a) If $h>2R$ and $r>R$ then $\phi=\frac{Q}{\varepsilon_0}$

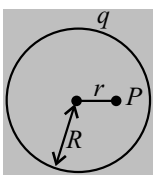
(b) If $h<\frac{8R}{5}$ and $r=\frac{3R}{5}$ then $\phi=0$

(c) If $h>2R$ and $r=\frac{4R}{5}$ then $\phi=\frac{Q}{5\varepsilon_0}$

(d) If $h>2R$ and $r=\frac{3R}{5}$ then $\phi=\frac{Q}{5\varepsilon_0}$

PW Challengers

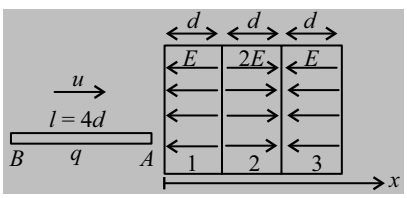
1. Charge q is uniformly distributed over the circumference of a ring of radius R. The electric field at a distance r from the center of ring and in the plane of ring is ($r << R$) [Hint: You may use Gauss's law]



(a) $\frac{qr}{4\pi\varepsilon_0R^3}$ (b) $\frac{3qr}{4\pi\varepsilon_0R^3}$

(c) $\frac{qr}{8\pi\varepsilon_0R^3}$ (d) $\frac{3qr}{8\pi\varepsilon_0R^3}$

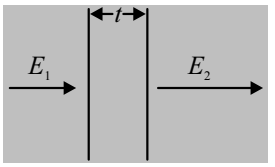
2. A thin insulator rod of mass m and length $l=4d$ carrying a uniform positive charge q, moving with velocity u enters a three section region of electric field. All the three sections are of equal thickness d each. Electric field in section 1 and section 3 has magnitude E and is opposite to the direction of initial velocity while it is in direction of initial velocity and of magnitude $2E$ in the second section. Assume charge distribution of the rod to be uniform. The minimum velocity u with which rod should be projected so that it passes through all the three sections is:



(a) $\sqrt{\frac{3qE}{2ml}}d$ (b) $\sqrt{\frac{5qE}{2ml}}d$

(c) $\sqrt{\frac{7qE}{2ml}}d$ (d) $\sqrt{\frac{9qE}{2ml}}d$

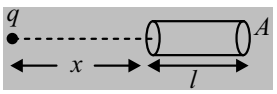
3. An infinitely large layer of charge of uniform thickness t is placed normal to an existing uniform electric field. Presence of this charge layer so alters the electric field that it remains uniform on both the sides and assumes values E_1 and E_2 as shown in the figure. Charge distribution in the layer is not uniform and depends only on distance from its faces. Find expression for the force per unit area experienced by the charge layer.



(a) $\frac{\varepsilon_0}{2}(E_1 - E_2)^2$ (b) $\frac{1}{4}\varepsilon_0 (E_1 - E_2)^2$

(c) $\frac{\varepsilon_0}{4}(E_2^2 - E_1^2)$ (d) $\frac{1}{2}\varepsilon_0 (E_2^2 - E_1^2)$

4. A particle of charge q is placed on the axis of a neutral conducting cylinder of volume V at a distance x from one end of the cylinder as shown in the figure. Linear dimensions of the cylinder are much smaller than x. Using suitable approximations, the force F of electrostatic interaction between the charge and the cylinder is



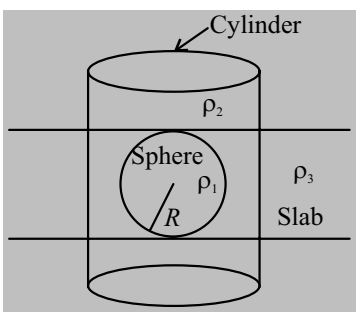
(a) $\frac{q^2V}{8\pi^2\varepsilon_0 x^5}$ (b) $\frac{q^2V}{4\pi^2\varepsilon_0 x^5}$ (c) $\frac{q^2V}{2\pi^2\varepsilon_0 x^5}$ (d) $\frac{q^2V}{\pi^2\varepsilon_0 x^5}$

5. If in the previous problem, cylinder is made of insulating material of relative permeability ε_r, then the force of electrostatic interaction between the cylinder and point charge q will be:

(a) $\frac{q^2V}{2\pi^2\varepsilon_0 x^5}\frac{\varepsilon_r}{(\varepsilon_r+1)}$ (b) $\frac{q^2V}{8\pi^2\varepsilon_0 x^5}\frac{(\varepsilon_r-1)}{\varepsilon_r}$

(c) $\frac{q^2V}{4\pi^2\varepsilon_0 x^5}\left(\frac{\varepsilon_r-1}{\varepsilon_r}\right)$ (d) $\frac{q^2V}{4\pi^2\varepsilon_0 x^5}\frac{\varepsilon_r}{(\varepsilon_r+1)}$

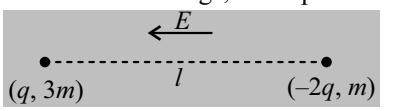
6. In the figure shown, a sphere with radius R is centered at the origin, an infinite cylinder with radius R has its axis along z-axis and an infinite slab with thickness $2R$ lies between the plane $z = -R$ and $z = R$. The uniform densities of objects are ρ_1, ρ_2 and ρ_3 respectively. The objects are superposed on top of each other, the densities add where objects overlap. It electric field inside the sphere is zero everywhere then choose the correct option(s).



(a) $\rho_2 = \frac{-2}{3}\rho_1$ (b) $\rho_3 = \frac{-\rho_1}{3}$

(c) $\rho_2 = \frac{-1}{3}\rho_1$ (d) $\rho_3 = \frac{-2}{3}\rho_1$

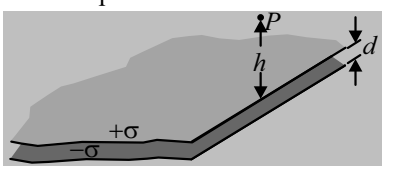
7. Two particles of charges and masses $(q, 3m)$ and $(-2q, m)$ are released at different locations in a uniform field E in free space as shown figure. If in subsequent motion separation between them does not change, find separation between them.



(a) $\sqrt{\frac{2q}{7\pi\varepsilon_0 E}}$ (b) $\sqrt{\frac{2q}{9\pi\varepsilon_0 E}}$

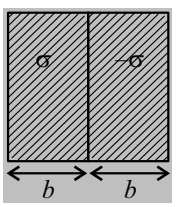
(c) $\sqrt{\frac{2q}{11\pi\varepsilon_0 E}}$ (d) $\sqrt{\frac{2q}{13\pi\varepsilon_0 E}}$

8. Two parallel half-planes (infinite on one side) are uniformly charged with surface charge densities $+\sigma$ and $-\sigma$. Find magnitude and direction of electric field due to these half planes at a point P located at a height h above the edge of the positively charged half-plane (see figure). Distance d between the half-planes is much smaller than h.



(a) $\frac{\sigma d}{\pi\varepsilon_0 h}$ (b) $\frac{\sigma d^2}{\pi\varepsilon_0 h}$ (c) $\frac{\sigma d}{2\pi\varepsilon_0 h}$ (d) $\frac{\sigma d^2}{2\pi\varepsilon_0 h^2}$

9. In the figure shown, two infinite strips of width b are placed as side by side and touch each other. One of strips has surface charge density σ and other has surface charge density $-\sigma$. The force of attraction between them is

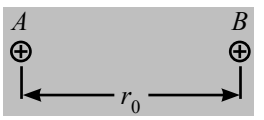


(a) $\frac{\sigma^2 b\ln(2)}{2\pi\varepsilon_0}$ (b) $\frac{\sigma^2 b\ln(2)}{\pi\varepsilon_0}$

(c) $\frac{\sigma^2 b\ln(2)}{4\pi^2\varepsilon_0}$ (d) $\frac{\sigma^2 b\ln(2)}{2\pi^2\varepsilon_0}$

SUBJECTIVE TYPE QUESTION

10. When two identical particles A and B each having charge q are released in free space with initial separation r_0 between them, their separation becomes double in time t_0. How long will it take to double the separation, if charge of particle A is made aq, that of particle B is made bq and they are released with initial separation ηr_0?



ANSWER KEY

CONCEPT APPLICATION

1. (*b*) **2.** (*d*) **3.** (*d*) **4.** (*b*, *c*) **5.** (*b*) **6.** (*a*) **7.** (*d*) **8.** (*a*) **9.** (*c*) **10.** (*c*)
11. (*a*) **12.** (*d*) **13.** (*a*, *c*) **14.** (*b*) **15.** (*c*) **16.** (*c*)

BOARD LEVEL PROBLEMS

1. (*d*) **2.** (*b*) **3.** (*c*) **4.** (*b*) **5.** (*b*) **6.** (*c*) **7.** (*d*) **8.** (*c*) **9.** (*b*) **10.** (*d*)
11. (*c*) **12.** (*b*) **24.** (*i*)-(*b*), (*ii*)-(*b*) **25.** (*i*)-(*a*), (*ii*)-(*a*)

PRARAMBH (TOPICWISE)

1. (*a*) **2.** (*b*) **3.** (*b*) **4.** (*c*) **5.** (*d*) **6.** (*a*) **7.** (*b*) **8.** (*a*) **9.** (*c*) **10.** (*c*)
11. (*d*) **12.** (*b*) **13.** (*a*) **14.** (*c*) **15.** (*a*) **16.** (*c*) **17.** (*b*) **18.** (*a*) **19.** (*b*) **20.** (*c*)
21. (*a*) **22.** (*c*) **23.** (*b*) **24.** (*b*) **25.** (*d*) **26.** (*d*) **27.** (*c*) **28.** (*c*) **29.** (*b*) **30.** (*c*)
31. (*b*) **32.** (*b*) **33.** (*b*) **34.** (*c*) **35.** (*c*) **36.** (*b*) **37.** (*a*) **38.** (*c*) **39.** (*c*) **40.** (*b*)
41. (*d*) **42.** (*b*) **43.** (*b*) **44.** (*a*) **45.** (*d*) **46.** (*a*) **47.** (*d*) **48.** (*d*) **49.** (*c*) **50.** (*b*)
51. (*c*)

PRABAL (JEE MAIN LEVEL)

1. (*c*) **2.** (*a*) **3.** (*d*) **4.** (*c*) **5.** (*a*) **6.** (*a*) **7.** (*c*) **8.** (*d*) **9.** (*d*) **10.** (*a*)
11. (*a*) **12.** (*a*) **13.** (*b*) **14.** (*d*) **15.** (*a*) **16.** (*d*) **17.** (*a*) **18.** (*a*) **19.** (*b*) **20.** (*a, b*)
21. (*a*) **22.** (*d*) **23.** (*b*) **24.** (*d*) **25.** (*a*) **26.** (*b*) **27.** (*c*) **28.** (*a*) **29.** (*a*) **30.** [9]
31. [3] **32.** [72] **33.** [9] **34.** [8] **35.** [2] **36.** [148] **37.** [9] **38.** [208]

PARIKSHIT (JEE ADVANCED LEVEL)

1. (*b*,*d*) **2.** (*a*,*d*) **3.** (*a*,*b*,*c*,*d*) **4.** (*b*,*c*) **5.** (*a*,*b*,*c*) **6.** (*a*, *c*) **7.** (*a*,*b*,*c*,*d*) **8.** (*b*,*c*) **9.** (*a*,*b*,*d*) **10.** (*b*,*c*)
11. (*a*,*b*,*c*) **12.** (*a*,*c*) **13.** (*c*,*d*) **14.** (*b*,*c*) **15.** (*a*,*c*) **16.** (*a*,*c*) **17.** (*a*,*c*) **18.** (*c*) **19.** (*a*) **20.** (*b*)
21. (*a*) **22.** (*d*) **23.** (*b*) **24.** (*c*) **25.** (*a*) **26.** (*b*) **27.** [0.33] **28.** [208.33] **29.** [4.25] **30.** [0.50]
31. [9.30] **32.** [2.08] **33.** [0.65] **34.** [100] **35.** [24] **36.** [5] **37.** [7] **38.** [10] **39.** [4] **40.** [3]
41. [648] **42.** (*b*) **43.** (*c*) **44.** (*c*) **45.** (*a*) **46.** (*c*) **47.** (*a*) **48.** (*b*) **49.** (*b*) **50.** (*c*)
51. (*c*) **52.** (*a*) **53.** (*a*) **54.** (*a*) **55.** (*a*)

PYQ's (PAST YEAR QUESTIONS)

1. (*b*) **2.** [3] **3.** [2] **4.** [3] **5.** [3] **6.** (a) **7.** (*b*) **8.** (*a*) **9.** [300] **10.** (*d*)
11. (*a*,*c*,*d*) **12.** (*b*) **13.** (*a*,*c*) **14.** (*c*) **15.** (*c*) **16.** [5] **17.** (*b*) **18.** (*c*) **19.** (*a*) **20.** (*c*)
21. (*d*) **22.** [2] **23.** [16] **24.** (*c*) **25.** [6] **26.** (*d*) **27.** (*a*) **28.** (*d*) **29.** (*b*) **30.** [8]
31. (*c*) **32.** [8] **33.** (*b*) **34.** [1] **35.** (*b, c*) **36.** [6] **37.** (*a*) **38.** (*c*) **39.** (*b*) **40.** (*b*)
41. (16) **42.** (*b*) **43.** (*c*) **44.** [12] **45.** (*b*) **46.** (16) **47.** [640] **48.** [3] **49.** [1] **50.** [–48]
51. [6.40] **52.** (*a, b, d*)

PW CHALLENGERS

1. (*c*) **2.** (*a*) **3.** (*d*) **4.** (*a*) **5.** (*b*) **6.** (*a*,*b*) **7.** (*a*) **8.** (*c*) **9.** (*b*) **10.** $\sqrt{\frac{\eta^3}{ab}}t_0$

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