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HINTS & SOLUTIONS

Physics

1. (b) If \((b - a) \geq r\)
   
   \((r = \text{radius of circular path of particle})\)
   
   The particle cannot enter the region \(x > b\)
   
   So, to enter in the region \(x > b\)
   
   \(r > (b - a)\)
   
   or \(\frac{mv}{Bq} > (b - a)\)
   
   or \(v > \frac{q(b-a)E}{m}\)

2. (c) is the correct option.

   The angular momentum \(L\) of the particle is given by \(L = mr^2\omega\) where \(\omega = 2\pi n\).

   \[\therefore \quad \text{Frequency } n = \frac{\omega}{2\pi}; \quad \text{Further } i = q \times n = \frac{q\omega}{2\pi}\]

   Magnetic moment, \(M = iA = \frac{q\omega}{2\pi} \times \pi r^2; \quad \therefore M = \frac{q\omega r^2}{2}\)

   So,
   
   \[\frac{M}{L} = \frac{q\omega r^2}{2mr^2\omega} = \frac{q}{2m}\]

3. (b) Case of positively charged particle: Two forces are acting on the positively charged particle (a) due to electric field in the positive \(x\) direction.
   
   Force due to magnetic field.
   
   \[\vec{F} = q(\vec{v} \times \vec{B})\]

   \[\therefore \vec{F} = q(V\hat{i} \times B\hat{k})\]

   \[\therefore \vec{F} = qVB(\hat{i} \times \hat{k})\]

   \[\therefore \vec{F} = qVB(-\hat{j})\]

   This force will move the positively charged particle towards \(Y\)-axis

   Case of negatively charged particle:
   
   Two forces are acting on the negatively charged particle
   
   (i) Due to electric field in the negative \(X\)-direction
   
   (ii) due to magnetic field

   \[\vec{F} = -q(\vec{v} \times \vec{B})\]

   \[\vec{F} = -q(v(-\hat{i}) \times B\hat{k})\]

   \[\vec{F} = qVB(\hat{i} \times \hat{k})\]

   \[\vec{F} = qVB(-\hat{j})\]

   Same direction as that of positive charge

4. (c) Force between two straight parallel conductors

   \[\frac{\vec{F}}{I} = \frac{\mu_0}{2\pi} \frac{i_1 i_2}{d} = \frac{\mu_0}{2\pi} (i^2)\]

   \[\therefore i^2 = \left(\frac{30 \times 10^{-7}}{2 \times 10^{-7}}\right)\left(15 \times 10^{-2}\right) = \frac{1}{4}\]

   \[\therefore i = \frac{1}{2} = 0.5 \text{ Amp}\]
5. (a) \( V = \frac{E}{B} \)

Where \( E \) = Electric field strength

\( B \) = Magnetic field induction

\( \therefore V = \frac{3000}{4 \times 10^{-4}} = 7.5 \times 10^8 \) m / sec

6. (b) \( ig = \left( \frac{S}{G + S} \right) i \)

\( \Rightarrow 0.01 = \left( \frac{S}{50 + S} \right) (5) \)

\( \therefore S = \frac{50}{499} = 0.1 \) \( \Omega \) nearly

\( \therefore 0.1 \Omega \) resistance is to be connected in parallel to convert it into an ammeter.

7. (b) We know \( \frac{q}{m} \propto \frac{1}{r} \)

\( \therefore \frac{r_{\text{ele}}}{r_p} \times \frac{m_{\text{ele}}}{m_p} = \frac{q_{\text{ele}}}{q} = \frac{4}{1} \times \frac{q}{2q} \)

\( \therefore \frac{r_p}{2} = \frac{r}{2} \)

8. (b) \( r = 0.5 \times 10^{-10} \) m

frequency = \( 5 \times 10^{-15} \) cps

\( \therefore \) electric current \( i = (1.6 \times 10^{-19}) (5 \times 10^{15}) = 8 \times 10^{-4} \) amp = 0.8 mA

9. (c) Resistance \( R = \frac{V}{i} - G \)

\( = \frac{6}{6 \times 10^{-1}} - 25 = 975 \Omega \)

\( \therefore 975 \Omega \) Resistance is connected is series.

10. (a) \( \frac{q}{m} = (10^8 \text{Ckg}^{-1}) \)

\( v = 3 \times 10^5 \text{ms}^{-1}, \varnothing = 30^\circ \)

\( v \sin \varnothing = q \frac{r}{m} \)

\( \Rightarrow 3 \times 10^5 \times \frac{1}{2} = 10^8 \times 3x \)

\( \Rightarrow r = \frac{3 \times 10^5 \times \frac{1}{2}}{10^8 \times 3} = 0.5 \times 10^{-5} \text{m} = 0.5 \text{cm} \)

11: (a) \( E = nA Vt = nA \frac{m}{d} l \)

\( = \frac{50 \times 250 \times 10 \times 3600}{7.5 \times 10^3} = 6 \times 10^4 \) Joule

12: (b) \( H = ni \therefore \frac{H}{n} = \frac{100}{50} = 2 \text{A} \)

13: (a) \( M = iA = i \pi r^2 \) But \( 2\pi r = l \therefore M = \frac{1}{4\pi} \frac{l^2}{4\pi} = \frac{il^2}{4\pi} \)

14: (d) \( B = \mu_0 (I + H) = \mu_0 \left( \frac{M}{V} + H \right) \)
= 4 \times 3.14 \times 10^{-7} \times \left[ \frac{5}{10^4} + 5000 \right] = 6.28 \text{ Tesla}.

15: (c) For paramagnetic materials, \( X \propto \frac{1}{T} \)
\[
\therefore \frac{X_2}{X_1} = \frac{T_1}{T_2} \quad \text{or} \quad X_2 = \frac{0.0075 \times 200}{100} = 0.15
\]

16: (a) \( B = \sqrt{B^2 + B^2_{\text{ref}}} = \sqrt{B^2_{\text{ref}} \tan^2 45^\circ + B^2_{\text{ref}}} = B_{\text{ref}} \sqrt{2} \)
\[
= 5\sqrt{2} \times 10^{-3} \text{ Wb/m}^2
\]

17: (a) Total intensity of magnetic field remains constant
\[
\therefore \frac{B_x}{B_y} = 1:1
\]

18: (a) \( T = 2\pi \sqrt{\frac{1}{MB}} = 2\pi \sqrt{\frac{m^2}{12 \times m / B}} = 4 \text{ sec} \)

19: (c) \( M' = m \cdot \frac{1}{2} = \frac{M}{2} \)

20: (a) \( T \propto \frac{1}{\sqrt{H}} \quad \therefore \quad T_2 = T_1 \sqrt{\frac{H_1}{H_2}} = 6 \times \frac{0.33}{0.62} = 4.38 \text{ s} \)

21: (d)
\[ V = \left[ V_R^2 + (V_L - V_C)^2 \right]^{1/2}. \]

22: (a)
Ideal choke is a wattless device. Because the phase angle between the current and efmis is \( \frac{\pi}{2} \). This gives power factor \( \cos \phi = \cos \frac{\pi}{2} = 0. \)

23: (a)
\[ E \propto nABo. \quad \text{Therefore} \quad \frac{E_1}{E_2} = \frac{n_1 \omega_1}{n_2 \omega_2} = \frac{50 \times 50}{100 \times 100}. \]

24: (c)
\[ I_{\text{wattless}} = I_{\text{rms}} \sin \phi \]
Hence \( \sin \phi = \frac{\sqrt{3}}{2} \Rightarrow \phi = 60^\circ \)
Therefore \( \cos \phi = \frac{1}{2}. \)

25: (a) (i) L, R
The coil is broken into two identical coils.
\[ \text{Leq} = \frac{L/2 \times L/2}{L/2 + L/2} = \frac{L}{4} = 0.45 \times 10^{-4} \text{ H}, \]
\[ \text{Req} = \frac{R/2 \times R/2}{R/2 + R/2} = \frac{R}{4} = 1.5 \Omega \]
Time constant = $\frac{\text{Leq.}}{\text{Req.}} = \frac{0.45 \times 10^{-4}}{1.5} = 0.3 \times 10^{-4} \text{s}$

Steady current $I = \frac{E}{R} = \frac{12}{1.5} = 8 \text{A.}$

26: (a)

\[ V_B + e - 15 + I \times 1 = V_A \]

\[ \Rightarrow \quad V_B - V_A = 15 - e - I \]

Here, \( I = 5 \text{A,} \)

\[ e = \frac{\text{d}\phi}{\text{d}t} = L \left[ -\frac{\text{d}I}{\text{d}t} \right] = -5 \times 10^{-3} \times 10^3 = -5 \text{V} \]

\[ V_B - V_A = 15 \text{V} \]

27: (c)

For \( \omega < \omega_0, \quad X_L < X_C. \) So, the circuit is capacitive.

28: (d)

\[ \cos \theta \times \frac{1}{Z} \]

\[ \frac{Z_1}{Z_2} = \frac{\cos \theta_1}{\cos \theta_2} = \frac{1/4}{1/2} = \frac{1}{2} \]

\[ Z_2 = 2Z_1 \]

Percentage change = \( \frac{2Z_1 - Z_2}{Z_1} \times 100 = 100 \% \).

29: (d)

\[ E = V - I \times R = 200 - 3 \times 7 = 179 \text{ V.} \]

30: (c)

The number of turns has become twice and area has gone up four times. Therefore self inductance is \( 4 \times 2 = 8 \) times. \( X_L = \omega L = 2\pi vL \) with iron core \( X_L \) increases. Since \( I = \frac{E}{X_L} \), \( I \) decreases.

31: (b)

\[ \phi = (5t^2 + 10t + 5) \times 10^{-3} \text{Wb} \] \[ \text{as } e = \frac{\text{d}\phi}{\text{d}t} \text{ (in magnitude)} \]

\[ \frac{\text{d}}{\text{d}t} (5t^2 + 10t + 5) \times 10^{-3} \text{Wb sec}^{-1} \]

\[ = (10t + 10) \times 10^{-3} \text{ volt} \]

\[ \therefore \quad e = (10 \times 5 + 10) \times 10^{-3} = 0.06 \text{ volt} \]

32: (a)

\[ e = Blv = 30 \times 2 \times 8 \times 10^{-5} \]

\[ = 0.0048 \text{ V} \]

33: (d)

Here \( np = 220 \text{ V, } ns = 22 \text{ V, } Is = 0.1 \text{ amp.} \) and \( Ip = ? \)

\[ \frac{E_p}{E_r} = \frac{I_p}{I_s} \]
34: (b)

Peak value of current, \( I_0 = \sqrt{2} \) A

35: (d) According to the problem, the e.m.f. induced in an elementary ring of radius \( r \) and width \( d\theta r \) is \( \pi r^2 \beta \). The conductance of this ring is \( d\left( \frac{1}{R} \right) = \left( \frac{h \, dr}{2p} \right) \)

thus, the current induced is \( dI = h \beta (r^2 - a^2) / 2p \). Upon integration we get the total current

\[
I = \frac{h \beta}{2p} \left( b^2 \alpha - a^2 \right)
\]

36. (c) \( I_D = \frac{dq}{dt} = \frac{d}{dq} \sin 2\pi nt = 2\pi nq_0 \cos 2\pi q_0 \cos 2\pi nt \)

37. (d) \( B = \frac{\mu_0 E_{\text{ext}}}{2} \frac{dE}{dt} = \frac{1}{2} \times 9 \times 10^9 \times 10^6 = 5.56 \times 10^{-8} \text{T} \)

38. (b)

39. (a)

40. (c) \( I_D = \frac{dq}{dt} = C \frac{dv}{dt} \) or \( \frac{dv}{dt} = \frac{\frac{I_D}{C}}{10^6} = 10^6 \text{ V/s} \)

41. (a) A moving charge experiences a force in magnetic field. It is because of interaction of two magnetic fields, one which is produced due to the motion of charge and other in which charge is moving.

42. (a) In the absence of the electric current, the free electrons in a conductor are in a state of random motion, like molecules in a gas. Their average velocity is zero, i.e. they do not have any net velocity in a direction. As a result, there is no net magnetic force on the free electrons in the magnetic field. On passing the current, the free electrons acquire drift velocity in a definite direction, hence magnetic force acts on them, unless the field has no perpendicular component.

43. (b) In tangent galvanometer the current through the coil is given by \( I = \frac{2r}{n \mu_0} \tan \theta \) \( \Rightarrow \tan \theta \propto n/r \) i.e. by reducing its radius or by increasing number of turns of coil we can increase the sensitivity of tangent galvanometer.

44. (b) Like direct current, an alternating current also produces magnetic field. But the magnitude and direction of the field goes on changing continuously with time.

45. (d) The power of an ac circuit is given by \( P = EI \cos \phi \) where \( \cos \phi \) is power factor and \( \phi \) is phase angle. In case of circuit containing resistance only, phase angle is zero and power factor is equal to one. Therefore power is maximum in case of circuit containing resistor only.

### Chemistry

46. (a)

In (a) ‘H’ s are same hence mono substitution.

47. (b)

48. (a)

\[ \therefore \text{of –ve charge on nitrogen of} \ -N(CH_3)_3. \]

49. (b)

50. (b)

\[ \text{DBE} = 4 - 2 = 2 \text{ so, } H_2C = C = CH_2 \text{ and } \triangle \text{ and } H_2C - C = CH \]
51. (d)

52. (b)

53. (d)

54. (d)

55. (c)

56. (b)

57. (b)

58. (d)

\[ \text{H}_2\text{C} - \text{CH} = \text{C} - \text{CH}_3 \xrightarrow{\text{O/Zn}} \text{propanone} \]

59. (a)

Reduction of 2-butyne with \( \text{H}_2 \) is presence of Lindlar’s catalyst (\( \text{Pd-BaSO}_4 \)) gives cis-2-buten while with \( \text{Na/liqu. NH}_3 \) (Birch Reduction) gives trans-2-butene.

60. (c)

Due to + I-effect of \( \text{CH}_3 \) group, toluene (2) has higher electron density than benzene (1). Out of Cl and NO\(_2\), NO\(_2\) has a strong –I effect and –M-effect while Cl has a weak –I-effect, therefore, nitrobenzene will be least. Thus, the overall reactivity order is: 2 > 1 > 3 > 4, i.e., option (c) is correct.

61. (c)

The rate of nitration of benzene and hexadeuterobenzene are the same, therefore, option (c) is false

62. (a)

Due to steric hindrance, nitration occurs at o-position w.r.t the smaller \( \text{CH}_3 \) group.

63. (d)

64. (b)

\[ \text{CaC}_2 \xrightarrow{\text{H}_2\text{O}} \text{HC} = \text{CH} \xrightarrow{\text{Red hot iron tube}} \text{Benzene} \]

65. (b)

\( \sigma - p \) conjugation.

66. (c)

67. (b)

68. (b)
69. (c)
70. (b)
71. (b)
Numbering of carbon atoms is done from Cl than from I since ‘C’ of chlorine comes before ‘I’ of iodine.

![Image of 2-Bromo-1-chloro-3-iodo-5-fluorobenzene]

72. (c)
73. (d)
Reason due to H-bonding
74. (b)
It being a symmetrical diene, therefore it has only three geometrical isomers, i.e., cis-cis; cis trans = trans-cis; and trans –trans.
75. (d)
Options (a), (b) and (c) are correct while (d) is wrong. Maleic acid being cis-isomer is less closely packed in the crystal lattice as compared to fumaric acid (trans-isomer) and hence is more soluble in water than fumaric acid.
76. (b)
\[ \text{CH}_3\text{C} = \text{C} \text{CH}_2\text{CH}_3 \]
\[ \text{(1)} \]
\[ \text{H} \]
\[ \text{C} = \text{C} \text{CH}_3 \]
\[ \text{(2)} \]
is the Z-isomer since the substituents of higher priority, i.e., CH$_3$ and CH$_2$CH$_3$ are on the same side of the double bond.
77.

\[ \text{CH}_2\text{H} \]
\[ \text{N}(\text{CH}_3)_3 \]
\[ \Delta \text{OH}^- \]
\[ + (\text{CH}_3)_3\text{N} \]

78. Here in the given problem, carbocation (b) is stabilized most, as the CH$_3$ (e$^-$ releasing group) group is attached to the carbon bearing positive charge.
79. In IV lone pair is involved in resonance.
80. (c)
Hyper conjugation is dominating.
81. (d)
Due to +R effect of –OCH$_3$ and – Reflect $\text{O} - \text{C-CH}_3$.
82. (a)
CH$_3$MgC will pick up acidic hydrogen promalkyne.
83. (a)
Markovnikov’s Addition
84. (a)
–NO$_2$ is deactivating and hence mets direction
85.  (d) Only option (d) has different substituent’s on each carbon atom of the double bond.

86.  (b) 

87.  (b) 

88.  (a) 

89.  (a) 

90.  (a) 

**Botany**

91.  Transcription occurs in the nucleus only and hence all RNA polymerases I, II & III must be present in the nucleus of a eukaryotic cell.

92.  Many codons code for the same amino acid. Thus there are more codons than amino acids. This is called degeneracy of the genetic code.

93.  Synthesis always occurs in a 5’-3’ direction. RNA primers provide the reactive 3’OH required for DNA replication.

94.  Catabolic repressors (eg. Lac operon repressor protein) binds to the operator, while restriction endonucleases search for their 6bp recognition sequence. The TATA box of the promoter is required for the binding of RNA polymerase to DNA to initiate transcription.

95.  In prokaryotes, control of the rate of transcriptional initiation is the predominant site for control of gene expression. However it is not the only method for control of gene expression. Bacteria do not contain noncoding mRNAs (intron sequences) and thus do not require to be processed by cleavage to form functional molecules.

96.  The probability of each pair of parents to have a child who dies i.e a child suffering from sickle cell anaemia (dead) is 1/4. The probability of both children dying is \( \frac{1}{4} \times \frac{1}{4} \times 100 = 6.25\% \).

97.  d

98.  b


100.  Dee-geo-woo-gen is the dwarfing gene of rice and Norin-10 gene is the dwarf gene of wheat

101.  Jaya and Ratna were better yielding semi-dwarf varieties developed in India.

102.  b

103.  b

104.  RNA can both code genetic information and act as a catalyst

105.  

\[
\begin{align*}
5' & \text{ AUG } & \text{ AUG } & \text{ AUG } & \text{ GUG } & \text{ GUG } & \text{ UAA } 3' \\
\text{tRNA}_{\text{met}} & \text{ tRNA}_{\text{met}} & \text{ tRNA}_{\text{met}} & \text{ tRNA}_{\text{val}} & \text{ tRNA}_{\text{val}} & & \\
\end{align*}
\]

The first codon AUG requires a special tRNA i.e. tRNA\textsubscript{met} which is used only during the initiation process and thus cannot be reused during elongation. The second and third codons though coding for the same amino acid will required two tRNA\textsubscript{met} of the same kind as both codons will be involved during an elongation step. Likewise with the fourth and fifth codon. UAA being a stop codon does not require a tRNA. Thus 5 tRNAs are required.

106.  The anticodon is 5’AUG3’. Thus due to antiparallel nature and complementary property of nucleic acids the codon will be 3’UAC5’ i.e 5’CAU3’.

107.  An epistatic gene is similar to dominance involving factors that lie on different loci and thus forms an intergenic suppression
Inhibitory gene is a non-lethal gene

108. d
109. d

110. Housekeeping genes are those that are constitutively expressed. Structural gene Z of the Lac operon is expressed only when lactose breakdown is required i.e lactose is the source of nutrition in the nutrient medium.

111. DNA from every tissue of the same individual will show the same degrees of polymorphism because of which any tissue can be used as an identification tool in forensic applications. Polymorphisms are inheritable from parents to children and they can change by mutation.

112. Zea mays-10; Drosophila melanogaster-4

113. Distance between two genes= recombination frequency= \[\frac{\text{no. of recombinants} \times 100}{\text{Total no. of progeny}}\]

No. of recombinants= Aabb(46) +aaBb(54)
No. of recombinants= Aacc(380) + AaCc(520)
Distance between A-C=90cM

Distance between A-B= 10cM

114. b
115. d

116. Cystic Fibrosis- Autosomal recessive disorder
    Patau-Trisomy
    Tay Sach’s Disease- Error in fat metabolism

117. 44+XXY=47 +1 Barr Body

118. Association of 30S-mRNA with formyl met-tRNA

119. C

120. 

HEAT

Non-radioactive medium (Replication 1)

Non-radioactive medium (Replication 2)

Non-radioactive medium (Replication 3)
122. one gene one enzyme hypothesis- Beadle and Tatum

125. A non-sense mutation occurring in the repressor gene of an system results in continuous expression of the repressible system as well as continuous expression of the inducible inducible and repressible system.

126. Mung bean has been made disease resistant to yellow mosaic virus and powdery mildew only by mutation breeding. Atlas-66 is a wheat variety which has been biofortified with high proteins only. *Pusa swarnim* is a Brassica variety which is resistant to White rust while *Pusa Gaurav* is the Brassica variety which is resistant to insect pest aphids.

127. The farmer will choose a variety with a thick stem, long internodes, high sugar content and disease resistance.

128. Shakti Rattan and Protina are varieties of millets and rich in lysine

129. i) Wheat varieties PV-18 and Huw-468 were produced using pure line selection technique.

ii) ICAR evaluates the breeding of many plants in some of the 10 agroclimatic zones simultaneously for three consecutive years. (maximum 8 and minimum 2 based on the climate and soil)

### Zoology

136. (b)
137. (d)
138. (d)
139. (d)
140. (c)
141. (d)
142. (b)
143. (c)
144. (b)
145. (b)
146. (d)
147. (d)
148. (d)
149. (c)
150. (b)
151. (c)
152. (d)
153. (b)
154. (b)
155. (b)
156. (c)
157. (c)
158. (c)
159. (b)

It is enlargement of prostate gland in male, in female it is enlargement of clitoris and abnormal menstrual cycle.

160. (d)
161. (d)
162. (b)

Heroin is commonly called smack and is obtained by acetylation of morphine.
163. (b)
164. (b)
   Sporozoite attacks the liver cells.
165. (b)
166. (b)
167. (d)
168. (d)
169. (c)
170. (a)
171. (d)
172. (a)
173. (d)
174. (d)
175. (d)
176. (a)
177. (c)
178. (b)
179. (a)
180. (a)