## Answer Key

<table>
<thead>
<tr>
<th>PHYSICS</th>
<th>CHEMISTRY</th>
<th>BOTANY</th>
<th>ZOOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. (a)</td>
<td>46. (b)</td>
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<td>50. (d)</td>
<td>95. (d)</td>
<td>140. (b)</td>
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<td>51. (b)</td>
<td>96. (d)</td>
<td>141. (b)</td>
</tr>
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<td>52. (b)</td>
<td>97. (b)</td>
<td>142. (c)</td>
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<td>146. (c)</td>
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<td>103. (b)</td>
<td>148. (d)</td>
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<td>14. (c)</td>
<td>59. (b)</td>
<td>104. (c)</td>
<td>149. (a)</td>
</tr>
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<td>105. (d)</td>
<td>150. (b)</td>
</tr>
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<td>61. (c)</td>
<td>106. (d)</td>
<td>151. (d)</td>
</tr>
<tr>
<td>17. (b)</td>
<td>62. (c)</td>
<td>107. (a)</td>
<td>152. (a)</td>
</tr>
<tr>
<td>18. (Bonus)</td>
<td>63. (a,d)</td>
<td>108. (b)</td>
<td>153. (c)</td>
</tr>
<tr>
<td>19. (b)</td>
<td>64. (a)</td>
<td>109. (d)</td>
<td>154. (d)</td>
</tr>
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<td>110. (c)</td>
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<td>177. (b)</td>
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<td>179. (c)</td>
</tr>
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<td>45. (a)</td>
<td>90. (a)</td>
<td>135. (c)</td>
<td>180. (b)</td>
</tr>
</tbody>
</table>
Hints & Solutions

1. (a) Induced current is given by
   \[ i = \frac{e}{R} = \frac{N \left( \frac{d\phi}{dt} \right)}{R} = \frac{-N \left( \frac{d\phi}{dt} \right)}{R} \]
   \[ = \frac{10 \times 10^4 \times 10^{-4} \times 10}{20} = 5 \text{A} \]

2. (c) According to Lenz’s law, the induced current will be in such a direction, so that it opposes the change due to which it is produced.

3. (d) B, v and L should be mutually perpendicular.

4. (d) Current lags the voltage by \( \frac{\pi}{2} \).

5. (d)

6. (a)

7. (d)

8. (a) Frequency of \( \gamma \)-rays is greater than frequency of X-rays, and frequency of X-rays is greater than ultraviolet rays.

9. (b)

10. (a) Image formed in real, inverted and same in size because object is at the centre of curvature of the mirror.

11. (c) Total energy contained in cylinder
    \[ u_{av} \times \text{volume} = \left( \frac{1}{2} \varepsilon_0 E_0^2 \right) \times (AI) \]
    \[ = \frac{1}{2} \times (8.85 \times 10^{-12}) \times (50)^2 \times (10 \times 10^{-4}) \times (0.50) \text{J} \]
    \[ = 5.5 \times 10^{-12} \text{J} \]

12. (c) Here, \( v = nu \frac{1}{v} + \frac{1}{u} = \frac{1}{u} \)
    \[ : -1 \frac{1}{u} = \frac{1}{f} \text{ or } u = \frac{(n + 1)f}{n} \]

13. (a) Here, \( u = f + x_1, v = f + x_2 \)
    Use \( f = \frac{uv}{u+v} \) and solve to get \( f = \sqrt{x_1 x_2} \)

14. (c) Let mirror be placed at a distance \( x \) meter from a wall, figure.

\[ \therefore u = PO = -(x - 3) \]
15. (d)
For a convex mirror, 
\( u \) and \( v \) are related to \( f \) as 
\[
\frac{1}{v} + \frac{1}{u} = \frac{1}{f}
\]
At \( u = \infty \), \( v = f \)
i.e., when object is at infinity, image is at focus and at \( u = 0 \), \( v = 0 \), i.e., when object is at pole, image too is at pole.
Both these conditions are satisfied in graph (d)

16. (a)
Here, \( u = 20 \text{ cm}, f = 20 \text{ cm}, v = ? \)
\[
\frac{1}{v} + \frac{1}{20} = \frac{1}{20} = 0, \quad v = \infty
\]

17. (b)
As incident ray and reflected ray are parallel to each other is means, deviation 
\( \delta = 180^\circ \)
\[
\therefore \quad \delta = 360^\circ - 20
\]
\[
\therefore \quad 180^\circ = 360^\circ - 20
\]
\[
\Rightarrow \quad \theta = 90^\circ
\]

18. Bonus

19. (b)
The intensity of plane electromagnetic wave is
\[
I = \frac{1}{2} E_0^2 c \text{ or } E_0 = \frac{21}{\sqrt{\varepsilon_0 c}}
\]
\[
\therefore \quad E_0 = \sqrt{\frac{2 \times 8}{(8.86 \times 10^{-12}) \times (3 \times 10^8)}}
\]
\[
= 77.58 \text{ N/C}
\]

20. (c)
voltage drop across \( R \) will be maximum, when \( V_L = V_C \)
i.e., \( X_L = X_C \)
\[
\frac{\omega L}{\omega C} \text{ or } \omega = \frac{1}{\sqrt{LC}}
\]
or
\[
\omega = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi \sqrt{\frac{1 \times 10^{-3}}{\pi}}}
\]
\[
= \frac{1000}{2} = 500 \text{ Hz}
\]

21. (d)
\( I_1 = 3 \text{ A}, I_2 = 4\sqrt{2} \sin \omega t \)
Reading of the hot wire ammeter is \( I_v \), where
\[
I_v^2 R = I_1^2 R + \left( \frac{4\sqrt{2}}{\sqrt{2}} \right)^2 R
\]
or
\[
I_v^2 R = (3^2 + 4^2) R
\]
\[
= 25 \text{ A}
\]

22. (d)
P = E, I, cos 0° = \( \frac{100}{\sqrt{2}} \left( \frac{100}{\sqrt{2}} \times 10^{-3} \right) \times 1 \)
= 5 watt

23. (b)

The phase angle between \( I_1 \sin \omega t \) and \( I_2 \cos \omega t \) is 90°. Therefore,

\[ I_0 = \sqrt{I_1^2 + I_2^2}; \quad I_{\text{rms}} = I_0 = \sqrt{\frac{I_1^2 + I_2^2}{2}} \]

24. (d)

At resonance, \( X_L = X_C \), i.e., \( \omega L = \frac{1}{\omega C} \)

\[ Z = R \]

25. (a)

In series \( LR \) circuit,

power factor, \( \cos \theta = \frac{R}{Z} = \frac{R}{\sqrt{R^2 + X_L^2}} \)

\[ = \frac{R}{\sqrt{R^2 + 9R^2}} = \frac{R}{R\sqrt{10}} = \frac{1}{\sqrt{10}} \]

When capacitor with \( X_C = R \) is added in series, new power factor,

\[ \cos \theta_2 = \frac{R}{\sqrt{R^2 + (X_L - X_C)^2}} \]

\[ = \frac{R}{\sqrt{R^2 + (3R - R)^2}} = \frac{R}{R\sqrt{5}} \]

\[ \therefore \frac{\cos \theta_2}{\cos \theta_1} = \frac{\sqrt{10}}{1} = \sqrt{2} \]

26. (a)

27. (b)

Magnetic flux through the loop is upwards and it is increasing due to increasing current along \( AB \).
Current induced in the loop should have magnetic flux in the downward direction so as to oppose the increase in flux. Therefore, current induced in the loop is clockwise.

28. (b)

As \( e = e_0 \sin \theta \), therefore, \( e \) would be max., when \( \theta = 90^\circ \), i.e., normal to plane of coil is perpendicular to the field or plane of coil is parallel to magnetic field.

Ans. (a)

As \( \phi = MI \Rightarrow M = \frac{\phi}{I} = \frac{2 \times 10^{-2}}{0.01} = 2 \text{H} \)

30. (c)

From \( e = -\frac{L}{dt} \); \( 5 = -L \left( \frac{2 - 3}{10^3} \right) \); \( L = 5 \times 10^{-3} \text{ H} \)

31. (d)

Here, area \( A = 500(10/100)^2 = 5 \text{ m}^2 \)

\[ \frac{dB}{dt} = 1 \text{T/s} \]

\[ e = \frac{\partial \phi}{\partial t} = \frac{\text{AdB}}{\text{dt}} = 5 \times 1 = 5 \text{ volt} \]

32. (b)
Power dissipated in circuit
\[ P = \frac{V_{rms}^2}{R} = \frac{(30)^2}{10} = 90 \text{W} \]

33. (c)
At point A, \( X_C > X_L \)
at point B, \( X_C = X_L \)
at point C, \( X_C < X_L \)
So at C, circuit is inductive.

34. (c)

35. (c)
Current in inductance \( I_L \) lags behind, current in resistance \( I_R \) is in phase with voltage, while current in capacitance \( I_C \) leads by a phase of \( \pi/2 \).

36. (d)
37. (d)
38. (c)
39. (c)
40. (a)
On immersing a mirror in water, focal length of the mirror remains unchanged.

41. (d)
For virtual object (\( u = \) positive)
\[ \frac{1}{v} + \frac{1}{u} = \frac{1}{f} \]
\[ \therefore \frac{1}{v} = \frac{1}{f} \frac{1}{u} \]
If \( u < f, v = ve \), i.e., image may be real.

42. Bonus
43. (b)
\[ \phi = BA \cos \omega t \]
At \( \tau = 0 \), \( \phi = \) maximum
\[ |e| \left| \frac{d\phi}{dt} \right| = B\omega A \sin \omega t \]

\[ |e|_{\text{max}} \text{ when } \omega t = 90^\circ, \text{i.e, loop is rotated } 90^\circ, \text{or is parallel to magnetic field. At this instant } \phi = 0. \]

44. (a)
45. (a)
Chemistry
46. (b)

46. \[ \text{Br} - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{Br} \xrightarrow{Zn} \text{CH}_2 - \text{CH}_2 + \text{ZnBr}_2 \]
Cyclopropane

47. (c)

47. Most stable carbocation formation by halide shows more reactivity for \( S_N^+ \) reactions.

\[ \text{CH}_3 \]
\[ \text{C}_6\text{H}_5 \xrightarrow{\text{Br}} \text{C}_6\text{H}_5 \xrightarrow{\Theta} \text{C}_6\text{H}_5 \]

48. (d)
49. (b)

49. Electron withdrawing nature or - I. Effect increases the activation of ring more effectively, however resonance opposes inductive effect for attachment at O - and P - position and hence makes less deactivation for O - and P
50. (d) H-bonding in molecule give rise to higher boiling point.
51. (b) Quinones show highly conjugated system and thus, do not exhibit tautomerism.
52. (b) The Riemer - Tiemann reaction is followed by dichloro carbene mechanism.
53. (b) \( \text{Cl} \rightleftharpoons \text{CH}_2 \rightleftharpoons \text{CH}_2 \rightleftharpoons \text{O}^- + \text{H}^+ \); Negative charge on oxygen is dispersed and thus, ion is more stable.
54. (a) The presence of m-directing groups in benzene nucleus simply decreases electron density at o- and p-, whereas no change in electron density at m-position is noticed.
55. (a) Some heterocyclic compounds (hetero aromatics) possess aromatic nature. Follow Hückel rule.
56. (b) \(-\text{NH} \quad \text{and} \quad \text{O}^- \quad \text{group are o- and para directing (activating) and m-directing groups (deactivating) respectively. In such case o-(minor) and p- isomers (major) predominates.}
57. (a) In the presence of acid, the cleavage of cyclic unsymmetrical ethers occurs by \( \text{S}_2 \) pathway with some \( \text{S}_1 \) characters in the transition state. So, the attack of nucleophile (I\(^-\)) occurs on more hindered carbon.
58. (c) \( \boxed{\text{HC}_2 - \text{CH}_2 + \text{RMgI} \rightarrow \text{CH}_2 - \text{CH}_2 - \text{R} \xrightarrow{\text{H}_2\text{O}} \text{MgI(OH)} + \text{R} - \text{CH}_2 - \text{CH}_2 - \text{OH}} \)
59. (c) \( \text{CH}_3 - \text{CH} = \text{CH}_2 + \text{B}_2\text{H}_6 \xrightarrow{\text{H}_2\text{O}_2, \text{NaOH}} \text{CH}_3 - \text{CH}_2 - \text{CH}_2\text{OH} \)
60. (a,d) (a) (d) (iii) is most reactive because benzyl carbocation is resonance stabilized. (i) is more reactive than (ii) because C—Br bond is weaker than C—Cl bond. (iv) is least reactive because —OCH\(_3\) group is electron releasing and makes nucleophilic attack difficult. Thus the correct order of decreasing reactivity.
61. (d) The bond dissociation enthalpy C—X (where X is halogen) C—Cl > C—Br > C—I
62. (a) The reaction is
69. (d)

Vinyl chloride is least reactive because C—Cl bond is stronger and shorter. Allyl chloride is more reactive than propyl chloride because Allyl carbocation formed is more stable (due to resonance) than the propyl carbocation.

70. (b)

Williamson synthesis involves reaction of alkyl halides with sodium alkoxides.

71. (d)

Williamson synthesis involves reaction of alkyl halides with sodium alkoxides.

72. (d)

73. (a)

74. (c)

74. (d)

75. (b)

Weaker the base, better is the leaving group. Hence, basicities decrease in the order

\[
\text{OMe (II)} > \text{O-S-Me (III)} > \text{O-S-F (IV))}
\]

Therefore, the order of leaving group ability decreases in the reverse order (IV) > (III) > (I) > (II).

76. (d)

In S_N2 reaction, inversion of configuration occurs. Since the reactant and the product are not enantiomers, the sign of optical rotation may or may not change, hence single stereoisomer is obtained.

77. (b)

– NO_2 group increases the reactivity in nucleophilic substitution on benzene ring due to –R and –I effect.

78. (d)

Cl is o, p-directing and hence on further chlorination will give a mixture of o- and p-dichlorobenzene.

79. (a)

80. (a)
As more stable carbonium ion is formed.

(a)

NH group is an activating group and determines the position of incoming electrophile. The NH group is O, P-directing but orthoposition is blocked so Br comes at para w.r.t. to NH.

(c)

(c)

(a)

(c)

(d)

(d)

The ease of dehydration of alcohols can be explained on the basis of stability of the intermediate carbocation. Greater the stability of the carbonation formed, greater will be the rate of reaction. The order of stability of carbocation formed is:

\[
\begin{align*}
\text{CH}_3 & \quad \text{CH}_3 & \quad \text{H} \\
\text{CH}_3 - \text{C}^+ & \quad \text{H}_2\text{C} - \text{C}^+ & \quad \text{CH}_3 - \text{C}^+ \\
\text{CH}_3 & \quad \text{H} & \quad \text{H}
\end{align*}
\]

This is due to the electron releasing (+I) effect of the alkyl group. Therefore the ease of dehydration of alcohols follows the order:

Tertiary > secondary > primary alcohol.