## ANSWERKEY

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PHYSICS

1. (c)  
\[ x^2 = 4ay \]
Differentiating w.r.t. \( y \), we get
\[ \frac{dy}{dx} = \frac{x}{2a} \]
\[ \therefore \quad \text{At } (2a, a), \frac{dy}{dx} = 1 \Rightarrow \text{ hence } \theta = 45^\circ \]
the component of weight along tangential direction is \( mg \sin \theta \).

hence tangential acceleration is \( g \sin \theta = \frac{g}{\sqrt{2}} \)

2. (d)  
\[ H = \frac{v^2 \sin^2 \theta}{2g} = \frac{v^2}{4g} \]
\[ R = \frac{u^2 \sin^2 \theta}{g} = \frac{v^2}{4} = 4H = R \]

3. (d)  
\[ P_1 = \sqrt{40 \times 96 \times 2} \]
\[ P_1 = \sqrt{2 \times 2 \times 10 \times 2 \times 2 \times 48} \]
\[ P_1 = 4\sqrt{10 \times 48} \]
\[ P_1 = 4\sqrt{480} \]
\[ P_2 = -4\sqrt{480} \]
\[ \sqrt{2m_1E_2} = P_2 \quad \text{m}_2 = 20 \]
\[ E_2 = \frac{P_2^2}{2m} \]
\[ = \frac{16 \times 480}{2 \times 20} = 192 \]

4. (b)  
Conserving the angular momentum of (bullet + disc) system about O.
\[ Mv_0 2R = mv(2R) + I_0 \omega \]
\[ v = \omega 2R ; \quad I_0 = \frac{3}{2} MR^2 \]
\[ v = \frac{8mu}{8m + 3M} \]

5. (b)  
\[ T = I_{C.O.M} \omega^2 \]
\[ = \frac{ML_1^2}{12} + M \left( \frac{L_2}{2} \right)^2 \]

\[ \frac{ML^2}{12} + M\left(\frac{L}{6}\right)^2 \]

\[ = \frac{ML^2}{12} + \frac{ML^2}{36} = \frac{4ML^2}{36} = \frac{ML^2}{9} \]

6. (a)

\[ h_n = h e^{\alpha n} = 32\left(\frac{1}{2}\right)^4 = \frac{32}{16} = 2m \]

(here \( n = 2, \ e = 1/2 \))

7. (b)
8. (a)
9. (c)

\[ T = \frac{mv^2}{\ell} \]

\[ V = \sqrt{50} \] m/sec

10. (b)

Pressure at bottom of the lake = \( P_0 + h \rho g \)

Pressure at half the depth of a lake = \( P_0 + \frac{h}{2} \rho g \)

According to given condition

\[ P_0 + \frac{1}{2} h \rho g = \frac{2}{3} (P_0 + h \rho g) \Rightarrow \frac{1}{3} P_0 = \frac{1}{6} h \rho g \Rightarrow h = \frac{2P_0}{\rho g} = \frac{2 \times 10^3}{10 \times 10} = 20m. \]

11. (b)

\[ F = P \times A = h \rho g A = 0.4 \times 900 \times 10 \times 2 \times 10^{-3} = 7.2N \]

12. (d)

\[ h = \frac{P}{\rho g} \therefore h \propto \frac{1}{g} \] (If lift moves upward with some acceleration then effective \( g \) increases. So the value of \( h \) decreases i.e reading will be less than 76 cm.)

13. (d)

Pressure = \( h \rho g \) i.e pressure at the bottom is independent of the area of the bottom of the tank. It depends on the height of water upto which the tank is filled with water. As in both the tanks, the levels of water are the same, pressure at the bottom is also the same.

14. (c)

If two different bodies A and B are floating in the same liquid then

\[ \frac{\rho_A}{\rho_B} = \frac{(f_m)_A}{(f_m)_B} = \frac{1/2}{2/3} = \frac{3}{4} \]

15. (b)

There will be no change in the level, because volume of water displaced will be same in both case to balance its weight.

16. (b)

\[ P_0 + \rho_1 gh_1 = P_0 + \rho_2 gh_2 \]

\[ \Rightarrow \frac{h_1}{h_2} = \frac{\rho_2}{\rho_1} = 3. \]

17. (a)

Tension in both string shall be same which can be observed by making FBD of string in figure (1)

18. (a)

\[ Y = \frac{FL}{\pi^2 \ell} \]

\[ \therefore \frac{\ell}{\pi^2} = \frac{FL}{\pi^2 Y} \Rightarrow \ell \propto \frac{L}{r^2} \]
19. (c) 
20. (a) 
21. (a) 
   Side of the cube 
   \[ a = 60 \text{ mm} = 60 \times 10^{-3} \text{ m} \] 
   Change in the pressure 
   \[ \Delta P = 2.5 \times 10^7 \text{ N/m}^2 \] 
   Bulk modulus \( B = 1.25 \times 10^{11} \text{ N/m}^2 \) 
   The volume of cube is 
   \[ V = (60 \times 10^{-3})^3 \] 
   The change in volume is 
   \[ \Delta V = \frac{\Delta PV}{B} = \frac{(2.5 \times 10^7) \times (60 \times 10^{-3})^3}{(1.25 \times 10^{11})} \] 
   \[ = 43.2 \times 10^{-9} \text{ m}^3 \] 
   \[ = 43.2 \text{ mm}^3 \] 
22. (a) 
   (A) \( \Delta \lambda = \frac{F \Delta \ell}{AY} \) 
   \[ \frac{\ell}{y} = \frac{(4-2) \times 10^{-1}}{4000 \times 10^3} \] 
   Given \( l = 1 \text{ m} \rightarrow \) 
   \[ y = \frac{4000 \times 10^3}{2 \times 10^{-3}} = 2 \times 10^9 \text{ N/m}^2 \] 
23. (b) 
   \[ U = \frac{1}{2} \text{(stress)}^2 \] 
   Stress = \( \frac{\text{Tension}}{\text{area}} \) 
   \[ \frac{v_1}{v_2} = \frac{(r)^2}{(2r)^2} = 4 \] 
   \[ \therefore \text{Ans. (b)} \] 
24. (d) 
   Stress \( \text{strain} = Y = \text{slope of graph} \) 
   \[ \therefore \frac{Y_A}{Y_B} = \frac{\tan 60}{\tan 30} = 3 \] 
   \[ \therefore Y_A = 3Y_B \] 
25. (b) 
26. (b) 
27. (a) 
   \[ B = -\frac{\Delta P}{\Delta V/V} = -\frac{V \Delta P}{\Delta V} = -\frac{1.5 \times 140 \times 10^3}{-0.2 \times 10^{-3}} = 1.05 \times 10^9 \text{ Pa} \] 
   \[ \text{Ans. } 1.05 \times 10^9 \text{ Pa} \] 
28. (b) 
   \[ 1.15 \times 10^8 = \frac{900(10 + a)}{\left( \frac{\pi d^2}{4} \right)} \] 
   \[ \Rightarrow d = \frac{6}{\sqrt{10\pi}} \text{ cm} = \frac{0.06}{\sqrt{10\pi}} \text{ m} = \frac{6 \times 10^{-2}}{\sqrt{10\pi}} \text{ m} \] 
   \[ \text{Ans. } 6 \times 10^{-2} \text{ m} \] 
29. (a) 
   Viscous force = \( mg \sin \theta \)
\[ \eta A \frac{v}{t} = mg \sin \theta \]

or \[ \eta a^2 \frac{v}{t} = a^3 \rho g \sin \theta \]

\[ \eta = \frac{\tan \sin \theta a}{v} \]

30. (d)

Let \( v \) be the velocity of the movable plate and \( F \) is equal to viscous force

\[ F = \left[ \eta_1 \frac{v}{h_1} + \eta_2 \frac{v}{h - h_1} \right] A \]

\[ \Rightarrow \frac{dF}{dh_1} = 0 \quad \therefore h_1 = \frac{h}{3} \]

31. (c)

The coefficient of viscosity is the ratio of tangential stress on top surface of film (exerted by block) to that of velocity gradient (vertically downwards) of film. Since mass \( m \) moves with constant velocity, the string exerts a force equal to \( mg \) on plate towards right. Hence oil shall exert tangential force \( mg \) on plate towards left.

\[ \therefore \eta = \frac{F/A}{(v-0)/\Delta x} = \frac{125 \times 1000/10 \times 20}{(5-0)/.02} = 2.5 \text{ dyne-s/cm}^2 \]

32. (b)

Shear force \( F = T = mg = 0.020 \times 10 = 0.2 \text{ N} \)

Shear stress on the fluid = \( \frac{F}{A} = \frac{0.2}{0.1} = 2 \)

Strain rate = \( \frac{\nu}{\ell} = \frac{0.090}{0.30 \times 10^{-3}} \)

\[ \eta = \frac{\text{stress}}{\text{strain rate}} = \frac{2(0.30 \times 10^{-3})}{(0.090)} \]

\[ = \frac{20}{3} \times 10^{-3} \text{ Pa s} \]

33. (c)

When two drops of radius \( r \) each combine to form a big drop, the radius of big drop will be given by

\[ \frac{4}{3} \pi R^3 = \frac{4}{3} \pi r^3 + \frac{4}{3} \pi r^3 \]

or \( R^3 = 2r^3 \) or \( R = 2^{1/3} r \)

Now \( \frac{V_R}{V_r} = \left( \frac{R}{r} \right)^2 = 2^2 = 4^2 \)

\[ \therefore V_R = 5 \times 4^{1/3} \text{ cm/s} \]

34. (b)

Initially the terminal velocity \( V \) of sphere of radius \( a \) is

\[ W_{\text{eff}} = 6\pi \eta a V \quad \ldots (1) \quad (W_{\text{eff}} = \text{weight - Bouyant force}) \]

As the radius is doubled, mass is increased to 8 times and new terminal velocity will be

\[ 8W_{\text{eff}} = 6\pi \eta 2a V' \quad \ldots (2) \]

from 1 and 2 \( V' = 4V \)

35. (b)

At equilibrium

\[ mg = 6\pi \eta rv \]

or \( \rho \frac{4\pi}{3} r^3 g = 6\pi \eta rv \)

\[ \therefore \frac{v_1}{v_{2r}} = \left( \frac{r}{2r} \right)^2 \]

or \( v_{2r} = (v_r) \times 4 = 4 \text{ cm/s} \).

36. (a)
When the ball is just released, the net force on ball is $W_{\text{eff}} (= mg – \text{buoyant force})$

The terminal velocity $v_f$ of the ball is attained when net force on the ball is zero.

$\therefore$ Viscous force $6\pi r v_f = W_{\text{eff}}$

When the ball acquires $\frac{2}{3}$ rd of its maximum velocity $v_f$ the viscous force is $= \frac{2}{3} W_{\text{eff}}$.

Hence net force is $W_{\text{eff}} - \frac{2}{3} W_{\text{eff}} = \frac{1}{3} W_{\text{eff}}$

$\therefore$ required acceleration is $= \frac{a}{3}$

37. (b) Relative to liquid, the velocity of sphere is $2v_0$ upwards.

$\therefore$ viscous force on sphere $= 6\pi \eta r 2v_0$ downward$= 12\pi \eta r v_0$ downward

38. (a) Viscous force $= 6\pi \eta rv = 6\pi \times 18 \times 10^{-5} \times 0.03 \times 100 = 101.73 \times 10^{-4}$ dyne.

39. (c) $Mg - f_B = F_V \Rightarrow \frac{4}{3}\pi r^3(\rho_m - \rho)g = F_V$

40. (d) The speed increases and become constant. Therefore the graph that best represents the velocity as function of time is

41. (b)

42. (a)

43. (c)

44. (d)

45. (d)

CHEMISTRY

46. (a) $K_p = \frac{(P_{SO_2})^2}{(P_{SO_3}) P_{O_2}} = \frac{1}{P_{O_2}}$

Because the number of moles of SO$_3$ and SO$_2$ are same, thus their partial pressures are also same at equilibrium.

$P_{O_2} = \frac{1}{K_p} = \frac{1}{3.5} = 0.285$

47. (a) $\Delta H = \Delta E + \Delta n_g RT$. Here $\Delta n_g = 12 - 15 = -3$. 
Thus, $\Delta H - \Delta E = -3 \times 8.314 \times 298 = -7.43$ kJ.

48. (b)

Circumference of 3rd orbit = $2\pi r_3$

According to Bohr, angular momentum of electron in 3rd orbit is

$$mrv_3 = \frac{h}{2\pi} \quad \text{or} \quad \frac{h}{mv} = \frac{2\pi r_3}{3}$$

by De-Broglie equation

$$\lambda = \frac{h}{mv} \quad \therefore \lambda = \frac{2\pi r_3}{3} \quad \therefore 2\pi r_3 = 3\lambda.$$

i.e. circumference of 3rd orbit is three times the wavelength of electron or number of waves made by Bohr electron in one complete revolution in 3rd orbit is three.

49. (d)

The compound must contain at least one oxygen atom

So, a minimum of 1 g atom of oxygen will be present in 1 g molecule i.e., 1 mole of the compound.

If $M$ is the mol. wt. of the compound then since 16 is the atomic mass of oxygen so minimum of 16 g of oxygen will be present in $M$ g of the compound

Thus, $\% \text{ of oxygen} = \frac{16}{M} 	imes 100$ or $3.2 = \frac{16 \times 100}{M}$ or $M = 500$

50. (d)

HgCl$_2$ is sp hybridized and linear

51. (b)

H$_2$ and Cl$_2$ reacts to form HCl; Dalton’s law of partial pressure is valid only for the gases which don’t react at ordinary conditions

52. (a)

We look for the case where the ionic product exceeds the $K_{sp}$.

(A) $[Ag^+] [Cl^-] = \left( \frac{1}{2} \times 10^{-4} \right)^2 = 2.5 \times 10^{-8}$ [As the dilution factor for Ag$^+$ and Cl$^-$ is 2]

53. (a)

Since, rate of effusion $(r) = \frac{n}{\sqrt{M}}$ from a mixture.

$$\frac{r(\text{He})}{r(\text{CH}_4)} = \frac{n(\text{He})}{n(\text{CH}_4)} \sqrt{\frac{16}{4}} = 1.0 \quad \Rightarrow \quad n_{\text{CH}_4} : n_{\text{He}} = 2 : 1$$

54. (b)

4 alcoholic isomers and three ethers

$$\text{CH}_3 \quad \text{CH}_2 \quad \text{CH}_2 \quad \text{CH}_2 \quad \text{CH}_3 \quad \text{O} \quad \text{CH}_2 \quad \text{CH}_2 \quad \text{CH}_3 \quad \text{H}_3\text{C} \longrightarrow \text{C} \longrightarrow \text{CH}_2 \longrightarrow \text{OH} \quad \text{CH}_3$$

$$\text{H}_3\text{C} \longrightarrow \text{O} \longrightarrow \text{HC} \longrightarrow \text{CH}_3 \quad \text{CH}_3 \quad \text{CH}_3$$

$$\text{H}_3\text{C} \longrightarrow \text{CH} \longrightarrow \text{O} \quad \text{H}_3\text{C} \longrightarrow \text{CH}_2 \longrightarrow \text{O} \quad \text{CH}_2 \longrightarrow \text{CH}_3$$

$$\text{H}_3\text{C} \longrightarrow \text{CH}_2 \longrightarrow \text{CH} \longrightarrow \text{OH} \quad \text{CH}_3$$

$$\text{H}_3\text{C} \longrightarrow \text{CH}_2 \longrightarrow \text{CH} \longrightarrow \text{OH} \quad \text{CH}_3$$

55. (d)

The order of nucleophilicity depends on

(i) Nature of alkyl group on which the nucleophile attacks.

56. (d)
HCl is a covalent compound and in gaseous state, it does not conduct current. In water, however it reacts to form ions, $\text{HCl} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{Cl}^-$ and thus conducts current.

Conc. solution of Na in liquid NH$_3$ will produce sodium amide and hydrogen gas instantaneously. These are metastable and when catalyse give hydrogen and amide.

**BOTANICAL**

**91.** Ans. (d)

Etiolation is a process in flowering plants grown in partial or complete absence of light. It is
characterized by long, weak stems; smaller leaves due to longer internodes; and a pale yellow color.

92. (b)
93. (c)
94. (b)
95. (c)
96. (a)
97. Ans.(c)
 Frankia is a member of actinomycetes and thus its association with higher plants is called actinorhiza.

98. (d)
99. (d)
100. Ans.(d)
 Fe is a micronutrient while all other given here are macronutrients.

101. (a)
102. (a)
103. Ans.(a)
 Continuity of water column is maintained by cohesion and adhesion

104. Ans.(a)
 Osmotic potential of guard cells decreases as stomata open, resulting rise in potassium levels in guard cells. Hence movement of water from neighbouring cells into guard cells takes place.

105. Ans.(b)
 Wilting refers to the loss of rigidity of non-woody parts of plants. This occurs when the turgor pressure in non-lignified plant cells falls towards zero, as a result of diminished water in the cells.

106. Ans.(a)
 Boehm (1809) proposed that ascent of sap was because of capillary nature of vessels and tracheids of xylem in root. This theory is based on physical forces (non-living cells) that are responsible for ascent of sap. According to this theory, Water is first taken in, due to force of adhesion between water and the thin walls of xylem vessels. As the water flows upwards along the wall, strong cohesion forces between water molecules help to pull water in upward direction. The upward pull of water continues till adhesive and cohesive forces (of water molecule) are balanced by downward gravitational force. The rise in water always depends upon capillary size of tracheids.

107. Ans.(c)
 Pieces of beet root do not lose their colour in cold water, but do so in boiling water because the plasma membrane gets killed in boiling water and becomes permeable.

108. (b)
109. (c)
110. (d)
111. Ans.(a)
 DPD = OP-TP; water flows from lower DPD to higher DPD.

112. (b)
113. (a)
114. Ans.(b)
115. (b)
116. (c)
 Wind speed up to 20-30 km/hr will increase the transpiration rate but further increase in it will cause mechanical closing of stomata decreasing the rate of transpiration.

117. (d)
118. (c)
119. (b)
120. (b)
121. (b)
122. (d)
123. Ans.(a)
Endosperm of gymnosperm is haploid.

124. (c)
125. (b)
126. (c)
127. (c)
128. (c)
129. (a)
130. (d)
131. Ans. (a)

when a legume plant dies in the field, for example following the harvest, all of its remaining nitrogen, incorporated into amino acids inside the remaining plant parts, is released back into the soil. In the soil, the amino acids are converted to nitrate (NO₃⁻), making the nitrogen available to other plants, thereby serving as fertilizer for future crops.

132. (d)
133. (a)
134. (a)
135. (c)

**ZOOLOGY**

136. (b) Salivary amylase acts at a slightly acidic pH of 6.8.

137. (c) For safe blood transfusion recipient’s serum antibodies should not correspond with donar’s RBC antigens otherwise it shall result in clumping of RBCs.

138. (d) Bowman’s capsule + glomerulus = Malpighian corpuscle/ renal corpuscle

139. (b) Locomotion is due to striated muscles that are voluntary and hence controlled by CNS.

140. (c)

141. (a) During contraction thin filaments slide over thick filaments to reduce length of sarcomere without affecting A – band width

142. (b) Podocytes are modified squamous epithelium of visceral layer of Bowman’s capsule to increase its porosity.

143. (d)

144. (b) Glucose being a high threshold substance is completely reabsorbed in PCT and hence not in DCT.

145. (b)

146. (c)

147. (c) Fresh water bony fishes are ammonotelic

148. (c) Net filtration pressure = 55 – (30+15)
    
    = 55 – 45
    
    = 10 mm Hg
149. (b)

150. (b) Inside the kidney the cortical region extends in between medullary pyramids as column of Bertini

151. (d) Fast oxidative skeletal muscles must show ideal characteristics of aerobic respiration

152. (d)

153. (c)

154. (b)

155. (d)

156. (b) Glycine being the simplest amino acid lack α - carbon and hence is optically inactive

157. (c)

158. (c) ER of muscle cells is modified to store Ca and hence called as sarcoplasmic reticulum

159. (c)

160. (b) Ornithine cycle or urea cycle takes place in liver,

\[ 2\text{NH}_3 + \text{CO}_2 \rightarrow \text{Urea} \]

161. (b)

162. (c)

163. (a) ADH or vasopressin is released to increase permeability of DCT, collecting ducts to facilitate reabsorption of water when intake of water is less, GFR is low or when body loses lot of water during summer.

164. (c) Chloride ions gets passively reabsorbed when sodium ions are actively reabsorbed.

165. (a)

166. (c)

167. (c) Sycon belongs to phylum Porifera

168. (b)

169. (a)

170. (c) Muscles relax when Ca from sarcoplasm is pumped back in sarcoplasmic reticulum. In absence of this, muscles shall continue to contract.

171. (b) Red fibres are rich in myoglobin and mitochondria and hence aerobic while white fibres comparatively has less myoglobin and mitochondria.

172. (a)
173. (b)

174. (a) TV = 500 ml

175. (d)

176. (d) Brunner's glands are sub-mucosal gland present in duodenum that secretes intestinal juice devoid of enzymes

177. (c) Uric acid is insoluble in water

178. (a)

179. (c) Radius in fore arm is towards thumb and ulna is towards little finger

180. (c) White muscle fibres have less mitochondria