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<td>45. (c)</td>
<td>90. (a)</td>
<td>135. (c)</td>
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</table>
HINTS & SOLUTIONS

PHYSICS

1. \[ \frac{1}{2} (100) \left( \frac{5}{100} \right)^2 = \frac{1}{2} mv^2 \Rightarrow v = \sqrt{\frac{5}{2}} \; ; \quad x = v \sqrt{\frac{2h}{g}} = 1 \text{ m} \]

2. By constant relation
\[ V_B = 3V_A = 30 \text{ m/sec} \]

3. Let x be the extension in the spring when 2 kg block leaves the contact with ground. Then,
\[ kx = 2g \]
\[ or \quad x = \frac{2g}{k} = \frac{2 \times 10}{40} = \frac{1}{2} \text{ m} \]

Now, from conservation of mechanical energy
\[ mgx = \frac{1}{2} kx^2 + \frac{1}{2} mv^2 \quad (m = 5 \text{ kg}) \]
\[ or \quad v = \sqrt{2gx - \frac{kx^2}{m}} \]

Substituting the values
\[ v = \sqrt{2 \times 10 \times \frac{1}{2} - \frac{(40)}{4 \times 5}} = 2\sqrt{2} \text{ m/s} \]

4. \[ \frac{1}{2} k \left( \frac{h}{4} \right)^2 = mg \left( h + \frac{h}{4} \right), k = \frac{32mg \left( \frac{5}{4} \right)}{h} = \frac{40mg}{h} \]

5. For maximum speed acceleration should be zero.

6. For equilibrium of M block
\[ 2T \cos \theta = Mg, T = Mg \]

7. Work done
\[ W = F \times s = ma \times \frac{1}{2} at^2 \quad \left[ \text{from } s = ut + \frac{1}{2} at^2 \right] \]
\[ \therefore W = \frac{1}{2} ma^2 t^2 = \frac{1}{2} m \left( \frac{v}{t_f} \right)^2 t^2 \quad \left[ \text{As } a = \frac{v}{t_f} \right] \]

9. Area = change in momentum
\[ \frac{1}{2} t_o F_0 = 2mV \]
\[ F_0 = \frac{4mV}{t_o} \]

10. \[ h = \frac{1}{2} gt^2 = \frac{1}{2} \times 10 \times 16 = 80 \text{ m} \]
\[ |\Delta U| = mgh = 1 \times 10 \times 80 = 800 \text{ J} \]

11. Because the efficiency of machine is 80%.

Hence potential energy gained by mass
\[ = \frac{80}{100} \times \text{energy spent} = \frac{80}{100} \times 5000 \text{ J} = 4000 \text{ J} \]

When the mass is released now, gain in KE on reaching the ground = KE on hitting the ground
= loss of potential energy = 4500 J

12. \[ F = \frac{\text{d}U}{\text{d}r} \]

13. Kinetic energy for first condition = \( \frac{1}{2} m (v^2_1 - v^2) = \frac{1}{2} m (20^2 - 0^2) = 150 \text{ mJ} \)

K.E. for second condition = \( \frac{1}{2} m (10^2 - 0^2) = 50 \text{ mJ} \)

\[ \therefore \frac{(\text{K.E.})_I}{(\text{K.E.})_II} = \frac{150 \text{ mJ}}{50 \text{ mJ}} = 3 \]

14. Maximum frictional force possible on lower block = \( \mu \times 2g = 10 \text{ N} \).

Maximum possible acceleration of lower block = \( \frac{10}{3} \text{ m/s}^2 \)

For no slipping between two blocks, maximum acceleration of the system = \( \frac{10}{3} \text{ m/s}^2 \)

Therefore maximum force on upper block for no slipping between two blocks = \( (3 + 2) \frac{10}{3} N = \frac{50}{3} \text{ N} \).

15. \[ p = \sqrt{2mK} \]

16. Wedge is at rest hence no force acts on wedge.

17. \[ \tan \theta = \frac{v^2}{Rg} \]

19. Momentum of both parts will be equal and opposite

\[ K = \frac{P^2}{2m} \quad K \propto \frac{1}{m} \]

20. Here limiting friction force between block A and surface is \( f = \mu (m_A + m_B)g = 15N > m_Ag \)

Hence system will be stationary and tension in string between A and B is zero and friction force between the block is also zero.

21. F.B.D. of block is as shown

\[ \begin{align*}
Ma & \quad N \\
Mg & \quad a \\
Ma & \quad Mg \\
\end{align*} \]

\[ a = \frac{g}{4} \]

23. \[ a = \frac{Mg \sin \theta}{2M} \quad \text{and} \quad T = Ma \]

24. Reading reduces when the lift starts accelerating downwards and then original value is restored as lift moves with constant velocity.

Apparent weight = \( m(g \pm a) \), where \( a \) is acceleration of lift.

25. For no slipping \( f_{\text{max}} \geq \frac{mv^2}{R} \).

So \( \mu mg \geq \frac{mv^2}{R} \)

26. The inclined plane exerts a force of \( mg \cos \theta \) perpendicular to inclination and \( mg \sin \theta \) along inclination.
27. \[ t_1 = 2t_2 \]

\[
\frac{2s}{\sqrt{g (\sin \theta - \mu \cos \theta)}} = 2 \frac{2s}{\sqrt{g \sin \theta}}
\]

28. Thrust on the block \( F = \frac{dm}{dt} = 5 \) N

Acceleration of the block \( \frac{F}{M} = 5 \) ms\(^{-2}\)

29. \( \Sigma F_y = 0, R = ma \)

Mg = \( \mu R = \mu ma \)

\( \mu = \frac{\frac{g}{a}}{0.5} \)

30. \( T - mg = ma \)

T = mg + ma

Kx = m(g + a)

\[ x = \frac{m(g + a)}{K} \]

31. \( T = \frac{\sqrt{2h}}{g + a} \)

(w. r. t. elevator)

32. \( F = -\frac{dU}{dx} = -5(2x - 4) \) at mean position \( F = 0 \Rightarrow x = 2 \) m,

\[ U_{\text{min}} = -20 \text{ J}. \]

33. \( K \propto \frac{1}{1}, K_1 = K, K_2 = \frac{K}{2} \)

\[ U = \frac{1}{2} Kx^2 = \frac{1}{2} K \times \frac{F^2}{K^2} \]

\[ U = \frac{1}{2} K, U \propto \frac{1}{K} \]

\[ U_1 = K_2 = \frac{1}{K_1} = \frac{1}{2} \]

35. \( T = \frac{mv^2}{1} = \frac{m(\sqrt{3gl})^2}{1} = 3mg \)

36. \( \frac{v^2}{3} = 12t^2 \)

\( v = 6t \)
37. Let x% of the length L over hang
\[ \therefore \mu \left( \frac{100-x}{100} \right) Mg = \frac{x}{100} Mg \]
\[ \Rightarrow 0.25(100-x) = x \]
x = 20%

38. Force on a particle moving on a circular path = Centripetal force = \( \frac{mv^2}{R} \)
\[ = \left( \frac{1}{2}mv^2 \right) \frac{2}{R} = \frac{2K}{R} = \frac{2aS}{R} \]

39. If acceleration of wedge is \( g \cot\theta \) then block starts falling freely.

40. \[ R^2 = \frac{\left( \alpha t R \right)^2}{R} = \alpha^2 t^2 R \]
\[ t = \sqrt{\frac{1}{\alpha}} \]

41.
\[ f = mg \sin \theta \quad \cdots \text{(i)} \]
\[ M = mg \cos \theta \quad \cdots \text{(ii)} \]
\[ R = \sqrt{N^2 + f^2} = mg . \]

43. At the highest point of vertical circle tension is zero not velocity.

44. \[ O = m_1 v_1 - m_2 v_2 \]
and \( K_1 + K_2 = E \) the energy released in explosion.
\[ \therefore \frac{K_1}{K_2} = \frac{m_2}{m_1} \]
and \( P = \sqrt{2mE} \).

CHEMISTRY

46. The mole diffused per unit area in first case \( \propto \pi r^2 \)
The mole diffused per unit area in second case \( \propto r^2 \)
Thus \( \frac{r_1}{r_2} = \frac{a_1 \times t_1}{a_2 \times t_2} = \pi \quad (t_1 = t_2) \)

47. A gas can be liquefied only if its temperature is lower than its critical temperature

48. Intermolecular forces of attraction between molecules

49. \( H_2 \) and He shows \( PV > RT \)
and rest all shows \( PV < RT \)

50. \[ n_1 T_1 = n_2 T_2 \]
\[ 1 \times 350 = \frac{7}{12} \times T_2 \]
\[ T_2 = \frac{12 \times 350}{7} = 600 \text{ K} = 327^\circ \text{C} \]
52. From Boyle’s law
\[ PV = \text{constant} \]
\[ P \, dV + V \, dP = 0 \]
\[ \left( \frac{dP}{dV} \right)_T = -\frac{P}{V} = -\frac{K}{V^2} \]
\[ (PV = K) \]

54. Volume of the container = 750 ml
\[ P_{\text{dry nitrogen}} + P_{\text{H}_2\text{O}(s)} = 740 \text{ mm} \]
\[ P_{\text{H}_2\text{O}(s)} = 24 \text{ mm} \]
\[ \therefore P_{\text{dry nitrogen}} = 740 - 24 = 716 \text{ mm} \]

Now, for dry nitrogen gas \( PV = nRT \)
\[ \frac{716}{760} \times \frac{750}{1000} = n \times 0.0821 \times (25 + 273) \]
\[ n = 0.0288 \text{ moles} \]
\[ n = 28.8 \text{ m mol} \]

55. Let the number of moles of \( \text{C}_2\text{H}_4 \) and \( \text{C}_3\text{H}_8 \) be \( x \) and \( y \) respectively.

Using the formula
\[ PV = nRT \]
\[ 1 \text{ atm} \times 0.820 \text{ L} = (x + y) \text{ mol} \times 0.082 \text{ L atm K}^{-1} \text{ mol}^{-1} \times 300 \text{ K} \]
\[ \text{or } x + y = \frac{1}{30} \quad (a) \]

Again, \( 28x + 44y = 0.613 \quad (b) \)

Solving, we get \( \frac{y}{x} = 1.54 \).

56. \( \text{OF} \) has \( \sigma 1s^1\sigma^* 1s^1, \sigma 2s^2\sigma^* 2s^2, \sigma 2p_x^2, \pi 2p_y^2 = \pi 2p_z^2, \pi^* 2p_y^2 = \pi^* 2p_z^2 \)
(3 antibonding \( \epsilon^* \) in \( \pi^* 2p \) and is more stable)

\( \text{F}_2 \) has \( \sigma 1s^1\sigma^* 1s^1, \sigma 2s^2\sigma^* 2s^2, \sigma 2p_x^2, \pi 2p_y^2 = \pi 2p_z^2, \pi^* 2p_y^2 = \pi^* 2p_z^2 \)
(4 antibonding \( \epsilon^* \) in \( \pi^* 2p \), so less stable)

57. In the hydrides of group 15 and group 16 (except \( \text{NH}_3 \) and \( \text{H}_2\text{O} \)) the energy difference between 3s and 3p orbitals is quite high. Hybridization increase the energy of 3s orbital so much that lone pair rather prefers to occupy unhybridized s orbital. For example in \( \text{PH}_3 \), 600 kJ mol\(^{-1}\) of energy is required to hybridize the central atom. So to avoid such energy demanding hybridization P forms bonds with unhybridized p orbitals leaving the lone pair in the spherical s orbital which leads to a bond angle close to 90°.

58. Hybridisation in \( \text{PO}_4^{3-} \) is sp\(^3\)
\[ \text{i.e. } = \frac{1}{2} [5 + 0 + 3 - 0] = 4 \]

In \( \pi \)-bonding only d-orbital of P, p-orbital of O can be involved.
Since hybrid atomic orbitals do not form \( \pi \)-bond.
60. \( p'_{N_2} = p_M \times \text{mole fraction} \) (or) \( \frac{25}{10} = 100 \times \text{m.f.} \)

(or) percent m.f. = \( \frac{25}{10} \times 100 = 2.5 \%

61. \( u = \sqrt{\frac{3RT}{M}} \) if \( T = 2T \) & \( M = \frac{M}{2} \)

then \( u_1 = \sqrt{\frac{3R \times 2T}{M}} \)

\[ \therefore \frac{u_1}{u} = \sqrt{4} = 2 \]

62. Ammonia molecule is more basic than nitrogen trifluoride and Boron trifluoride because ammonia molecule easily gives lone pair of electron.

63. (i) density of a gas \( (\rho) = \frac{PM}{RT} \)

Since \( \frac{M_B}{T_B} = \frac{M_A}{T_A} \), \( \therefore \) at the same pressure \( \rho_A = \rho_B \).

But if pressure is different then \( \rho_A \neq \rho_B \).

(ii) Pressure of the gases would be equal if their densities are equal other wise not.

KE per mol = \( \frac{3}{2}RT \)

\( \therefore \) It will be different for the two gases.

(iii) \( V_{rms} = \sqrt{\frac{3RT}{M}} \), since \( \frac{T_A}{M_A} = \frac{T_B}{M_B} \); \( V_{rms} \) of A = \( V_{rms} \) of B

64. \( \text{KO}_2 \rightarrow K^+ + \text{O}_2^- \)

\( \text{O}_2^- \) contain one unpaired electron (MOT)

65. \( \frac{P_1V_1}{P_2V_2} = \frac{n_1RT_1}{n_2RT_2} = \frac{n_1T_1}{n_2T_2} \)

As, \( V_1 = V_2 \) & \( T_1 = T_2 \)

\( \frac{P_1}{P_2} = \frac{n_1}{n_2} \)

\( \frac{P_{\text{H}_2\text{S}}}{P_{\text{CO}_2}} = \frac{n_{\text{H}_2\text{S}}}{n_{\text{CO}_2}} \)

\( \frac{P_{\text{H}_2\text{S}}}{1} = \frac{44/2}{44} = 22 \text{ atm} \)

67. \% ionic character = \( \frac{\mu_{\text{observed}}}{\mu_{\text{calculated}}} \times 100 \)

68. Both \( \text{H}_2\text{Se} \) and \( \text{H}_2\text{S} \) are polar but the former has higher dispersion forces due to its higher molecular weight and hence the higher boiling point

69. Polarisibility directly proportional to size of anion.

70. Except (A), all others are linear plots.
Hence, (B,C) and (D) are the correct answer.

76. The \( \mu \)'s 2Cl and 5Cl are vectorically cancelled.
\[
\begin{align*}
\mu^2 &= \mu_1^2 + \mu_2^2 + 2\mu_1\mu_2 \cos \theta \\
&= (1.5)^2 + (1.5)^2 + 2 \times 1.5 \times 1.5 \cos 120^\circ \\
\therefore \quad \mu &= 1.5 \text{ D}
\end{align*}
\]

77. Because of larger size of Cl atm.
OCl\(_2\) have largest bond angle.

78. Because of larger size of Cl atm.

79. SO\(_4^{2-}\) and BF\(_4^-\)

80. Let x mole of N\(_2\) present into vessel II and P is final pressure of N\(_2\).
\[
P(2V) = xR(T_2/3) \quad \text{and} \quad P(V) = (0.1 - x)RT_2
\]
\[
\Rightarrow 2 = \frac{x}{3(0.1 - x)}
\]
\[
\Rightarrow x = 0.6/7 \text{ mole}
\]
\[
\frac{0.6}{7} \times 28 = 2.4 \text{ g N}_2
\]

II has 2.4 g N\(_2\) and I has 0.4 g of N\(_2\)
\[
\frac{W_I}{W_{II}} = \frac{0.4}{2.4} \Rightarrow 1:6
\]

81. Hydrogen bonding is facilitated by the high electronegativity and small size of the atoms concerned, so H-bonding is exhibited by molecules in which hydrogen is bonded to F, O or N.

82. According to Fagan's rule
So, LiCl < BeCl₂ < BC₁₃ < CCl₄.

83. \[
\frac{r_{O_2}}{r_{CH_4}} = \frac{n_{O_2}}{n_{CH_4}} \sqrt{\frac{M_{CH_4}}{M_{O_2}}} = \frac{3}{2} \times \frac{16}{32} \times \sqrt{\frac{16}{32}} = \frac{3}{4\sqrt{2}}
\]

84. A low ionization energy helps the formation of cations and a high electron affinity that of anions.

85. \[400 \times 100 = Z \times 100 \times 0.0821 \times 200\]
\[z = 2/0.0821 > 1\]

Repulsive forces will dominate

89. \[
\frac{r_1}{r_2} = \frac{P_1}{P_2} \sqrt{\frac{M_2}{M_1}}
\]
\[\therefore (P \propto n)\]
\[
\frac{r_{CO}}{r_{N_2}} = \frac{1}{2} \times \sqrt{\frac{28}{28}} \Rightarrow r_{CO} = \frac{1}{2} \times r_{N_2}
\]

**BOTANY**

91. Salvinia is a heterosporous pteridophyte
96. These are adventitus roots for food storage
102. The endosperm is formed before fertilisation and is haploid
109. Anthers are fused and filaments are free
111. Yathium inflorescence is seen in Euphorbiaceae
115. Tuberous root for food storage
120. Xerophytic adaptation as seen in Opuntia
131. Deposition is of calcium carbonate
134. Fern plant is sporophyte
135. The figure shows pneumatophores

**ZOOLOGY**

137. Hint: Carbon, Oxygen, Nitrogen, Hydrogen and Sulphur have greater percentage weight in the human body.

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<th>% weight in human body</th>
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<td>Oxygen</td>
<td>46.6</td>
<td>65</td>
</tr>
<tr>
<td>3.</td>
<td>Nitrogen</td>
<td>Very little</td>
<td>3.3</td>
</tr>
<tr>
<td>4.</td>
<td>Sulphur</td>
<td>0.03</td>
<td>0.3</td>
</tr>
</tbody>
</table>
5. Hydrogen | 0.14 | 0.5
6. Sodium  | 2.8  | 0.2
7. Calcium | 3.6  | 1.5
8. Magnesium | 2.1  | 0.1
9. Silicon  | 27.7 | negligible

138. Parotid gland, the largest salivary gland produces salivary amylase and contributes to about 20% of saliva. Sub-lingual glands contribute to about 5% of saliva.

141. Ptyalin which is salivary amylase breaks down only cooked starch at pH 6.8 while Amylopsin which is pancreatic breaks down cooked as well as uncooked starch at pH 7.8.


143. The sugar in DNA is 2’ deoxyribose which is a pentose sugar. There are two types of purine nucleotides in DNA namely Adenyllic acid and Guanylic acid. DNA has two strands which are antiparallel, complementary and have a clockwise helical structure.

144. Chyle in small intestine is basic, bolus in mouth is acidic and chyme in stomach is acidic.

145. Only the anterior 2/3 rd of the tongue has taste buds while the posterior 1/3 rd doesn't. Only circumvallate and fungiform papillae of tongue have taste buds within them. Lower portion of tongue is attached to hyoid bone.

148. The part C is mucosa while in duodenum Brunner’s glands are present in submucosa. Part E has longitudinal muscles while Part D has circular muscles which help in peristaltic movements of the alimentary canal. Part B is made up of loose connective tissue containing nerves, blood and lymph vessels.

150. P- pepsin produced by stomach as pepsinogen. Q- trypsin or chymotrypsin produced by pancreas as trypsinogen or chymotrypsinogen. R- Aminopeptidase produced intestine in an active form. R could also be carboxypeptidase produced by pancreas as procarboxypeptidase. S is dipeptidase produced by intestine in an active form.

157. 4 is premolar- They are always monophyodont. 6 is molar- They are 8 in number in a 15 year old boy. 3 is canine- Their number in children is same as that in adult. 1 is incisor- They are 8 in number and used for cutting.

160. Neutral fats are triglycerides.

161. Mucus cells of gastric cells are near the neck.

163. Gastrin is excitatory to the gastric glands. Cholecystokinin is excitatory to the gall bladder as well as pancreas. Pancreozymin is excitatory to pancreas but has no effect on gall bladder.
