MT - 01 – (2019 Aspirants)

SOLUTION

31.

) $|\vec{a}_1| = 1, \quad |\vec{a}_2| = 1$

$|\vec{a}_1 + \vec{a}_2| = \sqrt{3}$

$\Rightarrow a_1^2 + a_2^2 + 2a_1 a_2 \cos\theta = 3$

$1 + 1 + 2(1)(1)\cos\theta = 3$

$\cos\theta = \frac{1}{2} \longrightarrow (1)$

$(\vec{a}_1 - \vec{a}_2)\cdot(2\vec{a}_1 + \vec{a}_2) = 2(\vec{a}_1 \cdot \vec{a}_1) + (\vec{a}_1 \cdot \vec{a}_2) - 2(\vec{a}_1 \cdot \vec{a}_2) - (\vec{a}_2 \cdot \vec{a}_2)$

$= 2a_1^2 - (\vec{a}_1 \cdot \vec{a}_2) - a_2^2$

$= 2a_1^2 - (a_1 a_2 \cos\theta) - a_2^2$

$= (2)(1) - (1)(1)\left(\frac{1}{2}\right) - 1$

$= \frac{1}{2}$

correct option is (3)

(32) $\frac{P+V}{P-V} = \frac{3}{1} \Rightarrow P + V = 3P - 3V$

$2P = 4V$

$P = 2V$

correct option is (1)

(33) $\frac{\Delta A}{A} = 2\frac{\Delta a}{a} + 3\frac{\Delta b}{b} + \frac{\Delta c}{c} + \frac{1}{2}\frac{\Delta d}{d}$

$= 2(1) + 3(3) + 2 + \frac{1}{2}(2)$

$= 2 + 9 + 2 + 1$

$= 14\%$

correct option is (3)

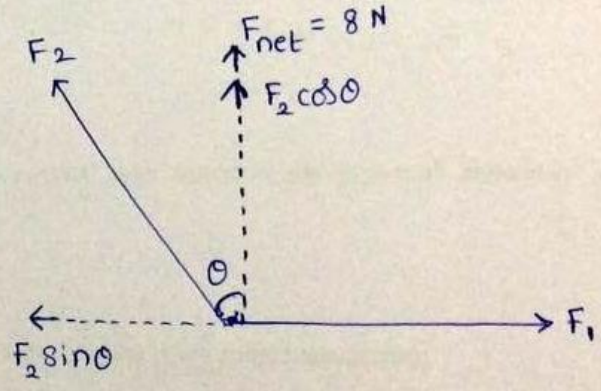
(34)

In addition or subtraction, the final result should retain as many as decimal places as are there in the number with the least decimal places.

In multiplication or division, the final result should retain as many significant figures as are there in the number with the least significant figures.

According to above rules, option (1) is correct.

(35) $F_1 + F_2 = 16$, consider F_1 is smaller force



From figure,

$F_2\cos\theta = 8 \longrightarrow (1)$

$F_2\sin\theta = F_1 \longrightarrow (2)$

$(1)^2 + (2)^2 \Rightarrow$

$F_2^2 = 8^2 + F_1^2$

$(16 - F_1)^2 = 64 + F_1^2$

$256 + F_1^2 - 32F_1 = 64 + F_1^2$

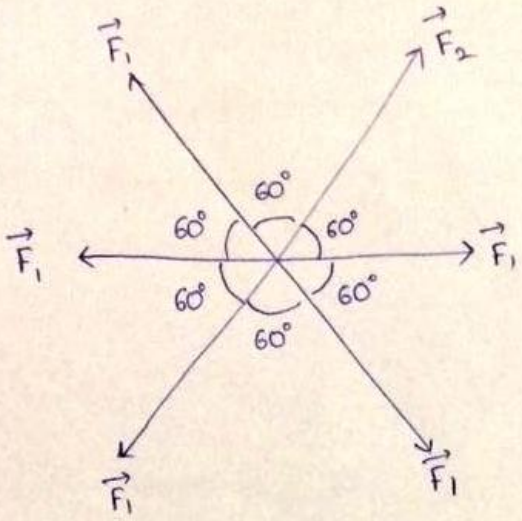
$32F_1 = 192 \Rightarrow \boxed{F_1 = 6\ N}$

$F_1 + F_2 = 16$

$6 + F_2 = 16 \Rightarrow \boxed{F_2 = 10\ N}$

correct option is (1).

36)



$F_{net} = |F_1 - F_2|$

correct option is (3)

37) $\vec{a} \cdot \vec{b} = |\vec{a} \times \vec{b}|$

$ab\cos\theta = ab\sin\theta$

$\theta = 45°$

$$\left|\frac{\vec{a}+\vec{b}}{\vec{a}-\vec{b}}\right| = \frac{\sqrt{a^2+b^2+2ab\cos\theta}}{\sqrt{a^2+b^2-2ab\cos\theta}} = \sqrt{\frac{4+8+2(2)(2\sqrt{2})\frac{1}{\sqrt{2}}}{4+8-2(2)(2\sqrt{2})\frac{1}{\sqrt{2}}}}$$

$$= \sqrt{\frac{20}{4}} = \sqrt{5}$$

correct option is (2)

38) $(\vec{a}-\vec{b}) \perp \vec{b} \Rightarrow (\vec{a}-\vec{b}) \cdot \vec{b} = 0$

$(\vec{a} \cdot \vec{b}) - (\vec{b} \cdot \vec{b}) = 0$

$ab\cos\theta = b^2$

$a\cos\theta = b \longrightarrow (1)$

$|\vec{a}-\vec{b}| = \frac{1}{2}|\vec{a}|$

Squaring on both sides

$|\vec{a}-\vec{b}|^2 = \frac{1}{4}|\vec{a}|^2$

$a^2+b^2-2ab\cos\theta = \frac{1}{4}a^2$

$a^2+b^2-2b(b) = \frac{1}{4}a^2$

$b^2 = \frac{3}{4}a^2 \Rightarrow b = \frac{\sqrt{3}}{2}a$

$\therefore$ From eqn (1),

$a\cos\theta = \frac{\sqrt{3}}{2}a$

$\cos\theta = \frac{\sqrt{3}}{2}$

$\theta = \frac{\pi}{6}$

correct option is (1)

39) $(\vec{a}+\vec{b}) \perp \vec{a}$

$\Rightarrow (\vec{a}+\vec{b}) \cdot \vec{a} = 0$

$\Rightarrow (\vec{a} \cdot \vec{a}) + (\vec{b} \cdot \vec{a}) = 0$

$a^2 + abc\cos\theta = 0$

$abc\cos\theta = -a^2$

$\cos\theta = -\frac{a}{b}$

$\theta = \cos^{-1}\left(-\frac{a}{b}\right)$

correct option is (2)

40) consider $\vec{a} = a\hat{i}$, $\vec{b} = b\hat{j}$, $\vec{c} = c\hat{k}$

clearly options (a), (c), (d) are true.

Now, $\frac{\vec{a} \times \vec{b}}{|\vec{a} \times \vec{b}|} = \frac{(ab\sin 90^\circ)\hat{k}}{ab\sin 90^\circ} = \hat{k}$, whereas $\vec{c} = c\hat{k}$

$\therefore$ only option (2) is wrong.

41) $x = \frac{V_0}{a}(1 - e^{-at})$

Dimensions of $a = [T^{-1}]$

$\frac{V_0}{a}$ has dimensions of x.

$x = \frac{V_0}{a} \Rightarrow V_0 = ax$

$\Rightarrow V_0 = [LT^{-1}]$

correct option is (2)

42) $\frac{hc}{G} = \frac{[ML^2T^{-1}][LT^{-1}]}{[M^{-1}L^3T^{-2}]} = [M^2] = kg^2$

correct option is (1)

43) Pressure $P = \frac{a - t^2}{bx}$, here a and t^2 have same dimensions.

$\therefore \quad P \neq x^2$

i. Dimensionally $P = \frac{a}{bx} \Rightarrow \frac{a}{b} = Px$

$$\Rightarrow \frac{a}{b} = [ML^{-1}T^{-2}][L]$$

$$\frac{a}{b} = [ML^0T^{-2}]$$

correct option is (2)

44) $K = \frac{P^2}{2m} \Rightarrow K \propto P^2$

$$\Rightarrow \frac{K_2 - K_1}{K_1} = \left(\frac{P_2}{P_1}\right)^2 - 1$$

$$\Rightarrow \frac{\Delta K}{K} \times 100\% = \left[\left(\frac{P_2}{P_1}\right)^2 - 1\right] \times 100\%$$

$$= \left[\left(\frac{120}{100}\right)^2 - 1\right] \times 100\%$$

$$= 44\%$$

correct option is (3)

45) Force $F \propto A^x V^y D^z$

$$[MLT^{-2}] \propto [L^2]^x [LT^{-1}]^y [ML^{-3}]^z$$

$$[MLT^{-2}] \propto [M^z L^{2x+y-3z} T^{-y}]$$

On comparing the powers of M on both sides, $\boxed{z = 1}$

On comparing the powers of T on both sides, $-2 = -y \Rightarrow \boxed{y = 2}$

" " " " L " " ,

$$2x + y - 3z = 1$$

$$2x + 2 - 3 = 1$$

$$2x = 2 \Rightarrow \boxed{x = 1}$$

$\therefore F \propto AV^2D$ correct option is (1).

46. (1)

Weight ratio, $H_2 : O_2 = 1:4$

Mole ratio, $H_2 : O_2 = \frac{1}{2} : \frac{4}{32} = \frac{1}{2} : \frac{1}{8} = 4:1$

47. (3)

Molar mass of mixture of CO and $CO_2 = 2 \times V.D = 2 \times 20 = 40$

If mass of CO in 100 g is x,

$$\frac{100}{40} = \frac{x}{28} + \frac{100-x}{44} \Rightarrow x = 17.5\,g$$

Moles of $CO = \frac{17.5}{28} = 0.625$

48. (2)

If atomic weight of metal M is A, for M_3O_4

$$\frac{16 \times 4}{16 \times 4 + 3A} \times 100 = 27.6 \Rightarrow A = 56$$

2nd oxide:

Moles of $M = \frac{70}{56} = 1.25$, Moles of $O = \frac{30}{16} = 1.875$

$M : O = 1.25 : 1.875 = 1:1.5 = 2:3$

Formula if M_2O_3

49. (4)

$CaCO_3$ (molar mass = 100g) in impure sample $= 20 \times \frac{75}{100} = 15g = \frac{15}{100}\,mol$

$$CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$$

1 mole $H_2SO_4 \equiv 1$ mole $CaCO_3$

50. (4)

Equal number of mole of $BaCl_2$ and Na_2SO_4 are reacting:

$$BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4 \downarrow + 2NaCl(aq)$$

It is NaCl that remains in solution.

51. (2)

$$\underset{65.5g}{Zn} + 2H^+ \rightarrow Zn^{2+} + \underset{22400\,mL}{H^2}$$

$22400\,mL\,H_2 \equiv 65.6\,g\,Zn$

$120\,mL\,H_2 = \frac{65.5 \times 120}{22400}\,g\,Zn$

$Zn\% = \frac{65.5 \times 120 \times 100}{22400} = 35\%$

52. (1)

$$\chi_{urea} = \frac{n_{urea}}{n_{urea} + n_{H_2O}}$$

$\chi_{urea} = 0.1 = n_{urea}$

$\chi_{H_2O} = 1 - 0.1 = 0.9 = n_{H_2O}$

$w_{H_2O} = 0.9 \times 18 g = \frac{0.9 \times 18}{1000} kg$

$\text{Molality} = \frac{n_{urea}}{w_{H_2O}(kg)} = \frac{0.1}{\left(\frac{0.9 \times 18}{1000}\right)} = \frac{1000}{9 \times 18}$

Alternatively:

$\chi_{urea} = 0.1,\ \chi_{H_2O} = 1 - 0.1 = 0.9$

$m = \frac{\chi_B}{\chi_A} \times \frac{1000}{M_A} = \frac{0.1}{0.9} \times \frac{1000}{18} = \frac{1000}{9 \times 18}$

53. (3)

Let the volume of CO_2 in the original mixture be x L.

Volume of $CO = (100 - x) L$

$\underset{x\,L}{CO_2} + C \rightarrow \underset{2x\,L}{2CO}$

Total volume, i.e., volume of CO after reaction $= (100 - x) + 2x = 100 + x$

$100 + x = 120 \Rightarrow x = 20$

54. (2)

$\text{Molality} = \frac{1000M}{1000d - M \times M_B} = \frac{1000 \times 2.05}{1000 \times 1.02 - 2.05 \times 60}$

$= \frac{2050}{1020 - 123} = \frac{2050}{897} = 2.285 \text{ mol kg}^{-1}$

Alternatively,

$2.05 M \Rightarrow n = 2.05, V = 1000 mL$

Weight of 1000 mL solution = Vd = 1000×1.02 g = 1020g

Weight of 2.05 mol $CH_3COOH = 2.05 \times 60 = 123 g$

Weight of solvent = 1020 – 123 = 897 g

$\text{Molality} = \frac{n_B}{w_{solvent(kg)}} = \frac{2.05}{(897/1000)} = 2.285 \text{ mol kg}^{-1}$

55. (1)

$C\% = \frac{2.48}{6.2} \times 100 = 40\%$

$(H_2O)\% = 100 - 40 = 60\%$

Ratio of moles of $C : (H_2O) = \frac{40}{12} : \frac{60}{18} = \frac{10}{3} : \frac{10}{3} = 1:1$

Empirical formula $= CH_2O$

56. (2)

$0.04 = \frac{n_{C_2H_2OH}}{n_{C_2H_5OH} + n_{H_2O} \text{ in } 1L}$

$0.04 = \frac{n_{C_2H_2OH}}{n_{C_2H_5OH} + 55.55}$

$n_{C_2H_5OH}$ in 1 L aqueous solution = 2.31moles

Molarity = 2.31 M

57. (3)

Container $I: P_2V_2 = P_1V_1$

$$P_2 = \frac{6\times10}{30} = 2\,\text{atm}$$

container $II: P_2 = \frac{10\times20}{30} = 6.67\,\text{atm}$

Total pressure = 2 + 6.67 = 8.67 atm

58. (3)

Let 32 g of each of H_2, He and O_2 are mixed. (LCM of molar masses)

$$\text{Mole fraction of } O_2 = \frac{\frac{32}{32}}{\frac{32}{2}+\frac{32}{4}+\frac{32}{32}} = \frac{1}{25}$$

Partial pressure of O_2 = Mole fraction of $O_2 \times P_{total} = \frac{1}{25}\times7.5 = 0.3\,\text{atm}$

59. (3)

$$\frac{\bar{v}}{\alpha} = \frac{\sqrt{\frac{8RT}{\pi M}}}{\sqrt{\frac{2RT}{M}}} = \sqrt{\frac{4}{\pi}} = \frac{2}{\sqrt{\pi}}$$

60. (3)

Higher the critical temperature, easier is the liquefaction of the gas.

61. (4)

CO and N_2 both have equal molecular mass and so equal rates of diffusion.

62. (3)

Because the flask is open to the atmosphere,

$$P_1V_1\left(\text{at } 27^\circ C\right) = P_2V_2\left(\text{at } 477^\circ C\right)$$

$$\Rightarrow \quad n_1RT_1 = n_2\left(\text{left}\right)RT_2$$

For $n_1 = 100$

$$100\times\left(27+273\right) = n_2\left(477+273\right)$$

$$n_2 = \frac{100\times300}{750} = 40$$

Percentage of air expelled = 100 – 40 = 60%

63. (2)

$$r_u = \frac{1}{3}r_{He} \qquad \Rightarrow \qquad \frac{r_u}{r_{He}} = \frac{1}{3}$$

$$\sqrt{\frac{M_u}{M_{He}}} = \frac{r_{He}}{r_u} \Rightarrow M_u = M_{He}\times\left(\frac{r_{He}}{r_u}\right)^2 = 4\times9 = 36$$

64. (3)

$$\mu = \sqrt{\frac{3RT}{M}}, E = \frac{3}{2}RT \Rightarrow RT = \frac{2}{3}E$$

$$\mu = \sqrt{\frac{3\times\frac{2}{3}E}{M}} = \sqrt{\frac{2E}{M}}$$

65. (3)

$$n_A = \frac{1}{M_A}; n_B = \frac{2}{M_B}; \frac{n_A}{n_B} = \frac{M_B}{2M_A} \quad \ldots(i)$$

$$P_A = 2\,\text{bar}; P_A + P_B = 3\,\text{bar}; P_B = 3-2 = 1\,\text{bar}$$

$$\frac{P_A V_A}{P_B V_B} = \frac{n_A RT}{n_B RT} \Rightarrow \frac{n_A}{n_B} = \frac{P_A}{P_B} = 2 \quad \ldots(ii)$$

From equations (i) and (ii) $\frac{M_B}{2M_A} = 2 \Rightarrow M_B = 4M_A$

66. (1)

At low pressure, the co-volume 'b' is neglected.

$$\left(P + \frac{a}{V^2}\right)(V) = RT$$

$$PV + \frac{a}{V} = RT$$

$$\frac{PV}{RT} + \frac{a}{VRT} = 1$$

$$Z = 1 - \frac{a}{VRT}$$

67. (4)

$$\text{Angular momentum} = \sqrt{l(l+1)}\times\frac{h}{2\pi} = \sqrt{l(l+1)}\times\hbar$$

$$= \sqrt{2(2+1)}\hbar = \sqrt{6}\times\hbar$$

68. (4)

$$Cr(Z=24): 1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$$

Total electrons in $l = 1$, i.e., p-subshell = 6 + 6 = 12

Total electrons in l =2, i.e., d-subshell = 5.

69. (3)

$$\frac{\text{Sp. charge of } \alpha-\text{particle}}{\text{Sp. charge of proton}} = \frac{\left(\frac{e}{m}\right)\alpha-\text{particle}}{\left(\frac{e}{m}\right)\text{proton}} = \frac{\left(\frac{2}{4}\right)}{\left(\frac{1}{1}\right)} = \frac{\left(\frac{1}{2}\right)}{1} = \frac{1}{2}:1 \text{ or } 1:2$$

70. (4)

$$F(Z=9): 1s^2 2s^2 2p_x^2 2p_y^2 2p^1{}_z$$

9th electron is $2p^1{}_z$, which has n = 2, l = 1, m $= \pm 1, 0$

$s = +\frac{1}{2}$ or $-\frac{1}{2}$.

71. (1)

$Ti^{2+}(Z=22), V^{3+}(Z=23), Cr^{4+}(Z=24)$ and $Mn^{5+}(Z=25)$ have same electronic configuration $[At]3d^2$. They have the same number of 3d-electrons, i.e., 2.

72. (3)

73. (3)

$$\frac{(\Delta x \cdot m \cdot \Delta v)_e}{(\Delta x \cdot m \cdot \Delta v)_p} = \frac{h/4\pi}{h/4\pi} = 1$$

$$\frac{m_e \cdot \Delta v_e}{m_p \cdot \Delta v_p} = 1$$

$$\frac{\Delta v_e}{\Delta v_p} = \frac{m_p}{m_e} = 1836:1$$

74. (3)

$$\frac{KE_1}{KE_2} = \frac{h(v_1 - v_0)}{h(v_2 - v_0)}; \frac{KE_1}{KE_2} = \frac{1}{x} \text{ (given)}$$

$$\Rightarrow \quad \frac{v_1 - v_0}{v_2 - v_0} = \frac{1}{x} \qquad \Rightarrow xv_1 - xv_0 = v_2 - v_0$$

$$\Rightarrow \quad xv_1 - v_2 = xv_0 - v_0 \Rightarrow v_0 = \frac{xv_1 - v_2}{x-1}$$

75. (3)

$$\frac{1}{\lambda_{1(\text{emitted})}} + \frac{1}{\lambda_{2(\text{emitted})}} = \frac{1}{\lambda_{(\text{absorbed})}}$$

$$\frac{1}{\lambda_{2(\text{emitted})}} = \frac{1}{2400} - \frac{1}{6000} = \frac{6000-2400}{2400\times 6000} = \frac{3600}{2400\times 6000} = \frac{1}{4000}$$

$$\Rightarrow \quad \lambda_2 = 4000\,\text{Å}.$$

76. (3)

$$\text{Velocity} \propto \frac{Z}{n}$$

77. (2)

78. (1)

According to Lavoisier Laplace law:

$$Na \rightarrow Na^+ + e^-; \Delta H = +5.1 \text{ eV}$$

$$Na^+ + \bar{e} \rightarrow Na; \Delta H = -5.1 \text{eV}$$

79. (1)

For isoelectronic atom and ions, higher the atomic number, smaller is the size. O^{2-}, F^-, Na^+ and Mg^{2+} all have 10 electrons.

80. (3)

Ionisation energy of Be (Z = 4, electronic configuration $1s^2 2s^2$) is greater than that of B (Z = 5, EC $1s^2 2s^2 2p^1$). IE of N (Z = 7, EC $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$) is greater than that of $O\left(Z=8, EC 1s^2 2s^2 2p_x^2 2p_y^1 2p_z^1\right)$.

81. (3)

82. (1)

$Be: 1s^2 2s^2$ has no tendency to take electron.

83. (2)

In 'a' set all have 32 electrons.
In 'c' set all have 14 electrons.
In 'd' set all have 50 electrons.

84. (2)

First IE on N-atom is actually higher than that of O-atom because of $2p_x^1 2p_y^1 2p_z^1$ half filled stable electronic configuration.

85. (3)

86. (2)

87. (1)

88. (2)

89. (4)

90. (4)

91 (4) NCERT XI: Pg. no. 23,24

92 (3) NCERT XI: Pg. no.132

93 (2) Wildlife sanctuaries, Botanical garden and Zoological Park help in conservation of species while other are methods of preservation or recording descriptions

94 (1) NCERT XI: Pg. no.30, 36,38

95 (2) NCERT XI: Pg. no.136

96 (3) Vascular sporophytes are Pteridophytes that alternates with autotrophic short lived prothallus which is gametophyte. *Adiantum* and *Dryopteris* are Pteridophytes while *Funaria* is a Bryophyte. *Ectocarpus* is brown algae and *Chara* is green algae. NCERT XI: Pg. no.33,35,38

97 (3) Cell wall is composed of peptidoglycan which retains the Gram stain.

98 (1) NCERT XI: Pg. no.132

99 (3) NCERT XI: Pg. no.38

100 (3) Dinomitosis differs from mitosis in the retention of nuclear membrane during cell division

101 (2) Viruses is made up of nucleic acids and proteins only and hence are referred to as nucleoprotein particles

102 (1) NCERT XI: Pg. no. 11

103 (1) NCERT XI: Pg. no.131,132

104 (1) Indusium is a part of sporophyte hence diploid, prothallus is gametophye hence haploid while spore mother cells is diploid.

105 (3) Mesosomes are infoldings of cell membrane. Lateral mesosomes contains respiratory enzymes

106 (2) NCERT XI: Pg. no.30

107 (1) (2) Class-opsidaorae (3) Family-aceae or idea (4) Tribe-eae

108 (2) NCERT XI: Pg. no139

109 (2) NCERT XI: Pg. no.43

110 (1) A 23s rRNA and 5s rRNA are the components of 50s subunit of 70s RNA

111 (4) NCERT XI: Pg. no. 23

112 (3) *Adiantum* is also called as Walking fern because of it can propagate vegetatively in all directions

113 (4) NCERT XI: Pg. no. 5

114 (4) NCERT XI: Pg. no. 21,22

115 (1) Asexual reproduction in liverworts takes place by fragmentation or by formation of gemmae.

116 (2) NCERT XI: Pg. no.133

117 (1) Lichens can be used as bioindicator of SO2 pollution NCERT XI: Pg.no. 27

118 (3) NCERT XI: Pg. no.35

119 (1) NCERT XI: Pg. no132,133

120 (1) NCERT XI: Pg. no. 10,11

121 (2) NCERT XI: Pg. no.126

122 (3) NCERT XI: Pg. no.38

123 (3) NCERT XI: Pg. no.137 Only *Paramoecium* and *Euglena* are eukaryotes

124 (3) Acellular slime moulds produce flagellated swarm cells after the germination of spores

125 (1) NCERT XI: Pg. no. 19

126 (3) 41 x 29 cm

127 (2) NCERT XI: Pg. no. 19

128 (3) NCERT XI: Pg. no.41

129 (2) NCERT XI: Pg. no.135

130 (3) NCERT XI: Pg. no.33

131 (4) . Sexual reproduction of *Rhizopus* involves gametangial copulation that leads to the formation of dark, thick walled resting spore called zygospore. It undergoes a period of dormancy for months.

132 (1) NCERT XI: Pg. no.137

133 (4) NCERT XI: Pg. no.137,138

134 (4) NCERT XI: Pg. no.30

135. (1) NCERT XI: Pg. no.19. *Rhodospirillum* is a chemosynthetic autotrophic bacterium thus does not perform oxygenic photosynthesis unlike the other three which are photoautotrophs.