BITSAT

Solved Paper 2011

Instructions

1. There are 150 questions in all. The number of questions in each part is as follows

Subjects	No. of Questions
Part I (Physics)	1–40
Part II (Chemistry)	41–80
Part III	
(a) English Proficiency	81–95
(b) Logical Reasoning	96–105
Part IV (Mathematics)	106-150

2. All questions are multiple choice questions with four options, only one being correct.
3. Each correct answer fetches 3 marks while incorrect answer fetches –1 mark.

Part I

Physics

1. Suppose the gravitational force varies inversely as the nth power of distance. Then the time period of a planet in circular orbit of radius R around the sun will be proportional to
   (a) $R^{(n+1)/2}$ (b) $R^{(n-1)/2}$
   (c) R^n (d) $R^{(n-2)/2}$
2. Two wires are made of the same material and have the same volume. However wire 1 has cross-sectional area A and wire 2 has cross-sectional area $3A$. If length of wire 1 increased by Δx on applying force F, how much force is needed to stretch wire 2 by the same amount?
   (a) $4F$ (b) $6F$
   (c) $9F$ (d) F
3. The satellite of mass m revolving in a circular orbit of radius r around the earth has kinetic energy E. Then its angular momentum will be
   (a) $\sqrt{\frac{E}{mr^2}}$ (b) $\frac{E}{2mr^2}$
   (c) $\sqrt{2Emr^2}$ (d) $\sqrt{2Emr}$
4. A galvanometer of resistance 100Ω gives full scale deflection with 0.01 A current. How much resistance should be connected in parallel to convert it into an ammeter of range 10 A?
   (a) 0.100Ω (b) 1.00Ω
   (c) 10.00Ω (d) 100.00Ω
5. A car is moving on a circular road of diameter 50 m with a speed of 5 m/s. It is suddenly accelerated at a rate of 1 m/s^2. If the mass of the car is 500 kg, then the net force acting on the car is
   (a) 5 N (b) 1000 N
   (c) $500\sqrt{2}$ N (d) $\frac{500}{\sqrt{2}}$ N

6. Hard X-rays for the study of fractures in bones should have a minimum wavelength of 10^{-11}m. The accelerating voltage for electrons in X-ray machine should be
   (a) < 124 kV
   (b) > 124 kV
   (c) between 60 kV and 70 kV
   (d) $= 100$ kV

7. Natural length of a spring is 60 cm and its spring constant is 4000 N/m. A mass of 20 kg is hung from it. The extension produced in the spring is (Take $g = 9.8\ m/s^2$)
   (a) 4.9 cm (b) 0.49 cm
   (c) 9.4 cm (d) 0.94 cm

8. A point source of light is placed 4 m below the surface of water of refractive index $\frac{5}{3}$. The minimum diameter of a disc, which should be placed over the source, on the surface of water to cut-off all right coming out of water is
   (a) infinite (b) 6 m
   (c) 4 m (d) 3 m

9. What is the maximum acceleration of the particle doing the SHM?
   $y = 2\sin\left[\frac{\pi t}{2} + \phi\right]$, where 2 is in cm
   (a) $\frac{\pi}{2}$ cm/s^2 (b) $\frac{\pi^2}{2}$ cm/s^2
   (a) 10 days (b) 20 days
   (c) 40 days (d) None of these

13. The velocity of efflux of a liquid through an orific in the bottom of the tank does not depend upon
   (a) size of orific
   (b) height of liquid
   (c) acceleration due to gravity
   (d) density of liquid

14. A neutron with velocity v strikes a stationary deuterium atom, its KE changes by a factor of
   (a) $\frac{15}{16}$ (b) $\frac{1}{2}$
   (c) $\frac{2}{1}$ (d) None of these

15. The Poisson's ratio of a material is 0.5. If a force is applied to a wire of this material, there is a decrease in the cross-sectional area by 4%. The percentage increase in the length is
   (a) 1% (b) 2%
   (c) 2.5% (d) 4%

16. Lenz's law of electromagnetic induction corresponds to the
   (a) law of conservation of charge
   (b) law of conservation of energy
   (c) law of conservation of momentum
   (d) law of conservation of angular

19. The force constant of a spring gun is 50 N/m. If a ball of 20 g be shoot by the gun so, that its spring is compressed by 10 cm, the velocity of the ball is

(a) 5 m/s (b) 15 m/s
(c) 25 m/s (d) 20 m/s

20. 1 g of water (volume 1 cm^3) becomes 1671 cm^3 of steam when boiled at a pressure of 1 atm. The latent heat of vapourisation is 540 cal/g, then the external work done is
(1 atm = 1.013×10^5 N/m^2)

(a) 499.7 J (b) 40.3 J
(c) 169.2 J (d) 128.57 J

21. A cube has a side of length 1.2×10^{-2}m. Calculate its volume.

(a) $1.7 \times 10^{-6} m^3$ (b) $1.73 \times 10^{-6} m^3$
(c) $1.70 \times 10^{-6} m^3$ (d) $1.732 \times 10^{-6} m^3$

22. A ball is dropped from height h and another from $2h$. The ratio of time taken by the two balls to reach the ground is

(a) $1 : \sqrt{2}$ (b) $\sqrt{2} : 1$
(c) 2 : 1 (d) 1 : 2

23. The linear momentum p of a body moving in one dimension varies with time t according to the equation $p = a + bt^2$, where a and b are positive constant. The net force acting on the body is

(a) a constant
(b) proportional to t^2
(c) inversely proportional to t
(d) proportional to t

24. Which of the following is not an example of perfectly inelastic collision?

(a) A bullet fired into a block, if bullet gets embedded into block
(b) Capture of an electron by an atom
(c) A man jumping onto a moving boat
(d) A ball bearing striking another ball bearing

25. If a new planet is discovered rotating around sun with the orbital radius double that of the earth, then what will be its time period? (in earth's days)

(a) 1032 (b) 1023
(c) 1024 (d) 1043

26. If density of earth increases 4 times and its radius becomes half of what it is, our weight will

(a) be 4 times its present value
(b) be doubled
(c) remain same
(d) be halved

27. The magnitude of electric field intensity E, such that an electron placed in it would experience an electrical force equal to its weight, is given by

(a) mge (b) $\frac{mg}{e}$
(c) $\frac{e}{mg}$ (d) $\frac{e^2}{m^2}g$

28. The work done in placing a charge of 8×10^{-18} C on a capacitor of capacity 100 μF is

(a) 32×10^{-32} J (b) 16×10^{-32} J
(c) 3.1×10^{-26} J (d) 4×10^{-10} J

29. A steady current flow in a metallic conductor of non-uniform cross-section. The quantity/quantities remaining constant along the whole length of the conductor is/are

(a) current, electric field and drift speed
(b) drift speed only
(c) current and drift speed
(d) current only

30. A galvanometer of 50 Ω resistance has 25 divisions. A current of 4×10^{-4} A gives a deflection of one division. To convert this galvanometer into a voltmeter having a range of 25 V, it should be connected with a resistance of

(a) 2500 Ω as a shunt
(b) 2950 Ω as in shunt
(c) 2550 Ω in series
(d) 2450 Ω in series

31. The cyclotron frequency of an electron gyrating in a magnetic field of 1 T is approximately

(a) 28 MHz
(b) 280 MHz
(c) 2.8 GHz
(d) 28 GHz

32. If **M** is magnetic moment and **B** is the magnetic field, then the torque is given by
(a) $\mathbf{M} \cdot \mathbf{B}$ (b) $\frac{|\mathbf{M}|}{|\mathbf{B}|}$
(c) $\mathbf{M} \times \mathbf{B}$ (d) $|\mathbf{M}||\mathbf{B}|$

33. A coil of inductance L is carrying a steady current I what is the nature of its stored energy?
(a) Magnetic
(b) Electrical
(c) Both magnetic and electrical
(d) Heat

34. Energy conversion in a photoelectric cell takes place from
(a) chemical to electrical
(b) magnetic to electrical
(c) optical to electrical
(d) mechanical to electrical

35. If the ionisation potential of helium atom is 24.6 V, the energy required to ionise it will be
(a) 24.6 eV (b) 24.6 V
(c) 13.6 V (d) 13.6 V

36. Fast neutrons can easily be solved down by
(a) the use of lead shielding
(b) passing them through water
(c) elastic collision with heavy nuclei
(d) applying a strong electric field

37. A film projector magnifies a $100\ cm^2$ film strip on a screen. If the linear magnification is 4, the area of the magnified film on the screen is
(a) $1600\ cm^2$ (b) $400\ cm^2$
(c) $800\ cm^2$ (d) $6400\ cm^2$

38. If v_m is the speed of sound in moist air and v_d is the speed of sound in dry air under identical conditions of pressure and temperature, then
(a) $v_m > v_d$ (b) $v_m < v_d$
(c) $v_m = v_d$ (d) $v_m \cdot v_d = 1$

39. A hot and a cold body are kept in vacuum separated from each other. Which of the following cause decrease in temperature of the hot body?
(a) Radiation
(b) Convection
(c) Conduction
(d) Temperature remains unchanged

40. An ideal refrigerator has a freezer at a temperature of $-13°C$. The coefficient of performance of the engine is 5. The temperature of the air (to which heat is rejected) will be
(a) 325°C (b) 325 K
(c) 39°C (d) 320°C

Part II

Chemistry

41. The mutual heat of neutralisation of 40 g NaOH and 60 g CH_3COOH will be
(a) 57.1 kJ
(b) less than 57.1 kJ
(c) more than 57.1 kJ
(d) 13.7 kJ

42. Which has the smallest size?
(a) Al^{3+} (b) Mg^{2+}
(c) P^{5+} (d) Na^{+}

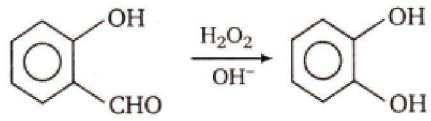
43. The treatment of benzene with *iso*-butene in the presence of sulphuric acid gives
(a) *iso*-butylbenzene (b) *tert*-butylbenzene
(c) *n*-butylbenzene (d) no reaction

44. Toluene on reaction with N-bromo-succinimide gives
(a) *p*-bromomethylbenzene
(b) *o*-bromomethylbenzene
(c) phenyl bromomethane
(d) *m*-bromomethylbenzene

45. Pinacolone is
(a) 2, 3-dimethyl-2, 3-butanediol
(b) 3, 3-dimethyl-2-butanone
(c) 1-phenyl-2-propanone
(d) 1, 1-diphenyl-1, 2-ethandiol

46. A synthetic rubber which is resistant to the action of oils, gasoline and other solvents is
(a) buna-S (b) polyisoprene
(c) neoprene (d) polystyrene

47. Ozone depletion over Antarctica is due to the
(a) formation of chlorine nitrate ($ClONO_2$)
(b) formation of HCl
(c) formation of HOCl and Cl_2 which are converted back into reactive Cl atoms
(d) None of the above

48. 

This reaction is called
(a) Reimer-Tiemann reaction
(b) Liebermann's nitroso reaction
(c) Dakin reaction
(d) Leader-Manase reaction

49. Which anion is the weakest base?
(a) $C_2H_5O^-$ (b) NO_3^-
(c) F^- (d) CH_3COO^-

50. K_b for water is 0.52 K/m. Then 0.1 m solution of NaCl will boil approximately at
(a) 100.52°C (b) 100.052°C
(c) 101.04°C (d) 100.104°C

51. One mole of P_2O_5 undergoes hydrolysis as

$$P_2O_5 + H_2O \longrightarrow H_3PO_4$$

The normality of the phosphoric acid formed is (The volume of solution is 1 L.)
(a) 2 (b) 12
(c) 24 (d) 4

52. 1 L of a gas is at a pressure of 10^{-6} mm of Hg at 25°C. How many molecules are present in the vessel?
(a) 3.2×10^6 (b) 3.2×10^{13}
(c) 3.2×10^{10} (d) 3×10^4

53. Which of the following has the largest de-Broglie wavelength, given that all have equal velocity?
(a) CO_2 molecule (b) NH_3 molecule
(c) Electron (d) Proton

54. 1 g of U–235 is converted into UF_6. The radioactivity of UF_6 thus obtained is
(a) zero
(b) less than that of 1 g of U–235
(c) more than that of 1 g of U–235
(d) same as that of 1 g of U–235

55. In which of the following molecules S atom does not assume sp^3 hybridisation?
(a) SO_4^{2-} (b) SF_4
(c) SF_2 (d) S_8

56. For the reaction,

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

the units of K are
(a) L mol^{-1} (b) L^2 mol^{-2}
(c) mol L^{-1} (d) No units

57. A sulphuric acid solution has pH = 3. Its normality is
(a) 1/1000 (b) 1/200
(c) 1/2000 (d) 1/100

58. The oxidation number of N and Cl in $NOClO_4$ respectively are
(a) + 2 and + 7 (b) + 3 and + 7
(c) – 3 and + 5 (d) + 2 and – 7

59. Pyrolusite is a/an
(a) oxide ore (b) sulphide ore
(c) carbide ore (d) Not an ore

60. When potassium ferrocyanide crystals are heated with conc. H_2SO_4, the gas evolved is
(a) SO_2 (b) NH_3
(c) CO_2 (d) CO

61. The product/s of the reaction,

$$Na_2CO_3 + CO_2 + H_2O \longrightarrow \text{ is/are}$$

(a) $2NaOH + CO_2$ (b) $Na_2CO_3 + H_2CO_3$
(c) $2NaHCO_3$ (d) None of these

62. Which among the following is likely to show geometrical isomerism?
(a) $CH_3CH{=}NOH$
(b) $CH_3CH{=}CH_2$
(c) $CH_2{=}CH{-}CH{=}CCl_2$
(d) $CH_3C(Cl){=}C(CH_3)_2$

63. A fuel has the same knocking property as a mixture of 70% *iso*-octane (2, 2, 4-trimethylpentane) and 30% *n*-heptane by volume. The octane number of the fuel is
(a) 100 (b) 70
(c) 50 (d) 40

64. Sodium carbonate reacts with SO_2 in aqueous medium to give
(a) $NaHSO_3$ (b) $Na_2S_2O_3$
(c) $NaHSO_4$ (d) Na_2SO_4

65. For a given reaction $t_{1/2} = 1/ka$. The order of this reaction is

(a) 0 (b) 1
(c) 2 (d) 3

66. Which of the following compounds will react with two moles of CH_3MgBr?

(a) C_2H_5COOH (b) CH_3COOH
(c) $CH_3C \equiv CCH_3$ (d) $HC \equiv C—CH_2OH$

67. The number of polypeptide chains present in a molecule of haemoglobin is

(a) four (b) one
(c) two (d) three

68. *The pentose sugar in DNA and RNA has the*

(a) open chain structure
(b) pyranose structure
(c) furanose structure
(d) All of the above

69. Which of the following is an artificial edible colour?

(a) Saffron (b) Carotene
(c) Tetrazine (d) Melamine

70. The number of unpaired electrons in nickel carbonyl is

(a) zero (b) one
(c) four (d) five

71. The time taken for 90% of a first order reaction to complete is approximately

(a) 1.1 times that of half-life
(b) 2.2 times that of half-life
(c) 3.3 times that of half-life
(d) 4.4 times that of half-life

72. The pH of a 0.01 M HCN solution for which pK_a is 4 is

(a) 0.47 (b) 1.2
(c) 3.0 (d) 4.0

73. Which of the following does not contain any coordinate bond?

(a) H_3O^+ (b) BF_4^-
(c) HF_2^- (d) NH_4^+

74. If E is the energy of the combining atomic orbitals, E_1 and E_2 are the energies of the bonding and anti-bonding molecular orbitals formed, then

(a) $E - E_1 > E_2 - E$
(b) $E - E_1 < E_2 - E$
(c) $E - E_1 = E_2 - E$
(d) Any one of the above is possible

75. The equilibrium constant (K) for the reaction $Cu(s) + 2Ag^+(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$

will be [Given, $E^\circ_{cell} = 0.46$ V]

(a) K_c = Antilog 15.6 (b) K_c = Antilog 2.5
(c) K_c = Antilog 1.5 (d) K_c = Antilog 12.2

76. E° for Fe/Fe^{2+} is +0.44 V and E° for Cu/Cu^{2+} is – 0.32 V. Then, in the cell

(a) Cu oxidises Fe^{2+} ion
(b) Cu^{2+} oxidises iron
(c) Cu reduces Fe^{2+} ion
(d) Cu^{2+} ion reduces Fe

77. Which of the following carbon atoms is most electronegative?

$$\overset{III}{CH_3}—\overset{II}{CH_2}—\overset{I}{C}\equiv CH$$

(a) I
(b) II
(c) III
(d) All are equally electronegative

78. The reaction/method that does not give an alkane is

(a) catalytic hydrogenation of alkenes
(b) hydrolysis of alkylmagnesium bromide
(c) Kolbe's electrolytic method
(d) dehydrohalogenation of an alkyl halide

79. Which of the following will yield a mixture of 2-chlorobutene and 3-chlorobutene on treatment with HCl?

(a) $CH_2=C=CH—CH_3$
(b) $H_2C=C(CH_3)—CH=CH_2$
(c) $CH_2=CH—CH=CH_2$
(d) $HC \equiv C—CH=CH_2$

80. The well known urinary antiseptic urotropine is formed when formaldehyde reacts with

(a) NH_2OH (b) NH_3
(c) $NH_2 \cdot NH_2$ (d) $C_6H_5NH \cdot NH_2$

96. Which one number is wrong in the given series?

5, 10, 17, 24, 37

(a) 10 (b) 17
(c) 24 (d) 37

97. Find the next two letters in the given series.

E F H K O ?

(a) T, Z (b) Z, T
(c) S, Z (d) T, Y

98. If MONKEY is coded as NNOJFX, what will be the code for TARGET?

(a) ZUSFFS (b) SFFSZU
(c) UZSFSF (d) UZSFFS

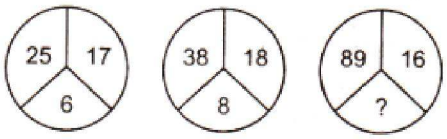
99. Among six friends L, M, N, P, Q and S, each having a different height, N is shorter than Q and P but taller than M. S is shorter than only L. Which of the following represents the tallest among six friends?

(a) P
(b) Q
(c) L
(d) Cannot be determined

100. Manick is fourteenth from the right end in a row of 40 boys. What is his position from the left end?

(a) 24^{th} (b) 25^{th}
(c) 26^{th} (d) 27^{th}

101. The missing number in the given figure is



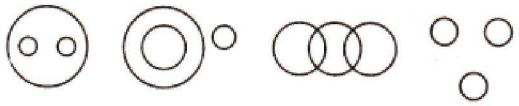
(a) 13 (b) 15
(c) 17 (d) 19

102. Select the combination of numbers so that the letters arranged will form a meaningful word.

H N R C A B
1 2 3 4 5 6

(a) 2, 5, 3, 4, 1, 6 (b) 3, 5, 6, 4, 1, 2
(c) 4, 1, 5, 6, 2, 3 (d) 6, 3, 5, 2, 4, 1

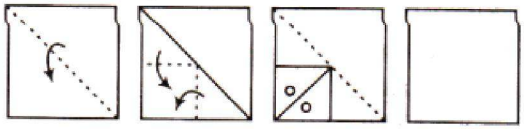
103. Which of the given Venn diagrams out of (a), (b), (c) or (d) correctly represents the relationship among the following classes?
Rose, Flower, Lotus



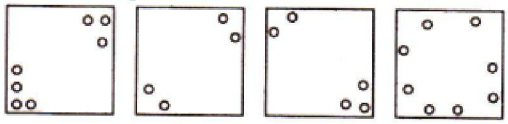
(a) (b) (c) (d)

104. A piece of paper is folded and a cut is made as shown below. From the given responses indicate how it will appear when opened?

Question figures



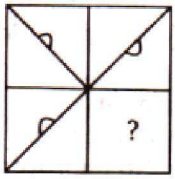
Answer figures



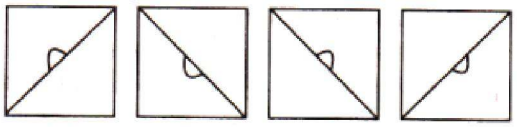
(a) (b) (c) (d)

105. Which answer figure will complete the question figure?

Question figure



Answer figures



(a) (b) (c) (d)

Part IV

Mathematics

106. The equation of the normal to the circle $x^2 + y^2 = a^2$ at point (x', y') will be

(a) $x'y - xy' = 0$ (b) $xx' - yy' = 0$
(c) $x'y + xy' = 0$ (d) $xx' + yy' = 0$

107. Equation of the bisector of the acute angle between lines $3x + 4y + 5 = 0$ and $12x - 5y - 7 = 0$ is

(a) $21x + 77y + 100 = 0$
(b) $99x - 27y + 30 = 0$
(c) $99x + 27y + 30 = 0$
(d) $21x - 77y - 100 = 0$

108. If $z = \cos\theta + i \sin\theta$, then the value of $z^n + \frac{1}{z^n}$ will be

(a) $\sin 2n\theta$ (b) $2\sin n\theta$
(c) $2\cos n\theta$ (d) $\cos 2n\theta$

109. If α and β are the roots of the equation $x^2 - 2x + 4 = 0$, then the value of $\alpha^n + \beta^n$ will be

(a) $i2^{n+1}\sin(n\pi/3)$ (b) $2^{n+1}\cos(n\pi/3)$
(c) $i2^{n-1}\sin(n\pi/3)$ (d) $2^{n-1}\cos(n\pi/3)$

110. If $A = \begin{bmatrix} 3 & 1 \\ -1 & 2 \end{bmatrix}$ and $I = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, then the correct statement is

(a) $A^2 + 5A - 7I = O$
(b) $-A^2 + 5A + 7I = O$
(c) $A^2 - 5A + 7I = O$
(d) $A^2 + 5A + 7I = O$

111. The value of the determinant $\begin{vmatrix} a-b-c & 2a & 2a \\ 2b & b-c-a & 2b \\ 2c & 2c & c-a-b \end{vmatrix}$ will be

(a) $(a-b-c)(a^2+b^2+c^2)$
(b) $(a+b+c)^3$
(c) $(a+b+c)(ab+bc+ca)$
(d) None of the above

112. If $(1+x)^n = C_0 + C_1x + C_2x^2 + \ldots + C_nx^n$, then $C_0 - C_1 + C_2 - C_3 + \ldots + (-1)^n \cdot C_n$ is equal to

(a) 3^n (b) 2^n
(c) 1 (d) 0

113. If AM and HM between two numbers are 27 and 12 respectively, then their GM is

(a) 9 (b) 18
(c) 24 (d) 36

114. For any two events A and B, if $P(A \cup B) = 5/6$, $P(A \cap B) = 1/3$, $P(B) = 1/2$, then $P(A)$ is

(a) 1/2 (b) 2/3
(c) 1/3 (d) None of these

115. A bag contains 3 white and 5 black balls. One ball is drawn at random. Then, the probability that it is white, is

(a) $\frac{1}{8}$ (b) $\frac{3}{8}$
(c) $\frac{5}{8}$ (d) $\frac{3}{5}$

116. $\mathbf{a} \cdot (\mathbf{b} \times \mathbf{c}) = 0$, then the correct statement is

(a) out of $\mathbf{a}$, $\mathbf{b}$, $\mathbf{c}$ any two vectors are parallel
(b) $\mathbf{a}$, $\mathbf{b}$, $\mathbf{c}$ are coplanar
(c) any two are equal $\mathbf{a}$, $\mathbf{b}$, $\mathbf{c}$
(d) at least one above statement is correct

117. If $2\mathbf{i} + \mathbf{j} - \mathbf{k}$ and $\mathbf{i} - 4\mathbf{j} + \lambda\mathbf{k}$ are perpendicular to each other, then λ is equal to

(a) -3 (b) -2
(c) -1 (d) 0

118. If $\frac{d}{dx}(\phi(x)) = f(x)$, then $\int_1^2 f(x)\,dx$ is equal to

(a) $f(1) - f(2)$ (b) $\phi(1) - \phi(2)$
(c) $f(2) - f(1)$ (d) $\phi(2) - \phi(1)$

119. $\int_0^2 |1 - x|\,dx$ is equal to

(a) 0 (b) 1
(c) $\frac{3}{2}$ (d) $\frac{1}{2}$

120. $\int \frac{\sin 2x}{\sin^4 x + \cos^4 x}\,dx$ is equal to

(a) $2\tan^{-1}(\tan^2 x) + C$
(b) $\tan^{-1}(x\tan^2 x) + C$
(c) $\tan^{-1}(\tan^2 x) + C$
(d) None of the above

121. The function $\sin x + \cos x$ is maximum when x is equal to

(a) $\frac{\pi}{6}$ (b) $\frac{\pi}{4}$

(c) $\frac{\pi}{3}$ (d) $\frac{\pi}{2}$

122. $\frac{d}{dx}(x^x)$ is equal to

(a) $x^x \log(e/x)$ (b) $x^x \log ex$

(c) $\log ex$ (d) $x^x \log x$

123. $\lim_{x \to 0} \frac{\sin x}{x}$ is equal to

(a) 2 (b) -1

(c) 1 (d) 0

124. The set $A = \{x : x \in R, x^2 = 16 \text{ and } 2x = 6\}$ equals

(a) ϕ (b) {14, 3, 4}

(c) {3} (d) {4}

125. In how many ways can 5 prizes be distributed among four students when every student can take one or more prizes?

(a) 1024 (b) 625

(c) 120 (d) 600

126. The value of $(\sqrt{5}+1)^5 - (\sqrt{5}-1)^5$ is

(a) 252 (b) 352

(c) 452 (d) 552

127. The value of $7\log\left(\frac{16}{15}\right) + 5\log\left(\frac{25}{24}\right) + 3\log\left(\frac{81}{80}\right)$ is equal to

(a) log 2 (b) 3

(c) 5 (d) 7

128. The value of $\frac{2}{1!} + \frac{2+4}{2!} + \frac{2+4+6}{3!} + \ldots \infty$ is

(a) e (b) $2e$

(c) $3e$ (d) None of these

129. The sum of the series $\log_4 2 - \log_8 2 + \log_{16} 2 - \ldots$ is

(a) e^2 (b) $\log_e 2$

(c) $\log_e 3 - 2$ (d) $1 - \log_e 2$

130. If the domain of the function $f(x) = x^2 - 6x + 7$ is $(-\infty, \infty)$, then the range of function is

(a) $(-\infty, \infty)$ (b) $[-2, \infty)$

(c) $(-2, 3)$ (d) $(-\infty, -2)$

131. $\lim_{x \to 0} \frac{\cos(\sin x) - 1}{x^2}$ is equal to

(a) 1 (b) -1

(c) $\frac{1}{2}$ (d) $-\frac{1}{2}$

132. In order that the function $f(x) = (x+1)^{1/x}$ is continuous at $x = 0$, $f(0)$ must be defined as

(a) $f(0) = 0$ (b) $f(0) = e$

(c) $f(0) = \frac{1}{e}$ (d) $f(0) = 1$

133. The function $f(x) = |x|$ at $x = 0$ is

(a) continuous but non-differentiable

(b) discontinuous and differentiable

(c) discontinuous and non-differentiable

(d) continuous and differentiable

134. The point (0, 5) is closer to the curve $x^2 = 2y$ at

(a) $(2\sqrt{2}, 0)$ (b) (0, 0)

(c) (2, 2) (d) None of these

135. The function $f(x) = x^{1/x}$ is

(a) increasing in $(1, \infty)$

(b) decreasing in $(1, \infty)$

(c) increasing in $(1, e)$, decreasing in (e, ∞)

(d) decreasing in $(1, e)$, increasing in (e, ∞)

136. The area bounded by the x-axis and the curve $y = \sin x$ and $x = 0$, $x = \pi$ is

(a) 1 sq unit (b) 2 sq units

(c) 0 (d) 4 sq units

137. The order and degree of the differential equation $\sqrt{\frac{dy}{dx}} - 4\frac{dy}{dx} - 7x = 0$ are

(a) 1 and $\frac{1}{2}$ (b) 2 and 1

(c) 1 and 1 (d) 1 and 2

138. The line $x + y = 4$ divides the line joining the points $(-1, 1)$ and $(5, 7)$ in the ratio

(a) 2 : 1 (b) 1 : 2

(c) 1 : 2 externally (d) None of these

139. The angle between the pair of lines given by equation $x^2 + 2xy - y^2 = 0$, is

(a) $\frac{\pi}{3}$ (b) $\frac{\pi}{6}$

(c) $\frac{\pi}{2}$ (d) 0

140. The length of tangent from point (5, 1) to the circle $x^2 + y^2 + 6x - 4y - 3 = 0$ is

(a) 81 (b) 29

(c) 7 (d) 21

141. The length of the latusrectum of the parabola $169\{(x-1)^2 + (y-3)^2\} = (5x - 12y + 17)^2$ is

(a) $\frac{14}{13}$ (b) $\frac{12}{13}$

(c) $\frac{28}{13}$ (d) None of these

142. The angle of intersection between the curves $x^2 = 8y$ and $y^2 = 8x$ at (0, 0) is

(a) $\frac{\pi}{4}$ (b) $\frac{\pi}{3}$

(c) $\frac{\pi}{6}$ (d) $\frac{\pi}{2}$

143. If the centre, one of the foci and semi-major axis of an ellipse be (0, 0), (0, 3) and 5, then its equation is

(a) $\frac{x^2}{16} + \frac{y^2}{25} = 1$ (b) $\frac{x^2}{25} + \frac{y^2}{16} = 1$

(c) $\frac{x^2}{9} + \frac{y^2}{25} = 1$ (d) None of these

144. The radius of the director circle of the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ is

(a) $a - b$ (b) $\sqrt{a - b}$

(c) $\sqrt{a^2 - b^2}$ (d) $\sqrt{a^2 + b^2}$

145. If projection of any line on coordinate axes 3, 4 and 5, then its length is

(a) 12 (b) 50

(c) $5\sqrt{2}$ (d) $3\sqrt{2}$

146. If $\tan\theta = \frac{1}{2}$ and $\tan\phi = \frac{1}{3}$, then the value of $\theta + \phi$ is

(a) $\frac{\pi}{6}$ (b) π

(c) 0 (d) $\frac{\pi}{4}$

147. If $\sin\theta = \frac{1}{2}$, $\tan\theta = \frac{1}{\sqrt{3}}$, $\forall\, n \in I$, then most general values of θ is

(a) $2n\pi + \frac{\pi}{6}, \forall\, n \in I$ (b) $2n\pi + \frac{\pi}{4}, \forall\, n \in I$

(c) $2n\pi + \frac{\pi}{3}, \forall\, n \in I$ (d) $2n\pi + \frac{\pi}{3}, \forall\, n \in I$

148. The principal value of $\sin^{-1}\left(-\frac{\sqrt{3}}{2}\right)$ is

(a) $-\frac{2\pi}{3}$ (b) $-\frac{\pi}{3}$

(c) $\frac{4\pi}{3}$ (d) $\frac{5\pi}{3}$

149. A ladder rests against a wall so that its top touches the roof of the house. If the ladder makes an angle of 60° with the horizontal and height of the house be $6\sqrt{3}$ m, then the length of the ladder is

(a) $12\sqrt{3}$ m (b) 12 m

(c) $\frac{12}{\sqrt{3}}$ m (d) None of these

150. If angles A, B and C are in AP, then $\frac{a+c}{b}$ is equal to

(a) $2\sin\left(\frac{A-C}{2}\right)$ (b) $2\cos\left(\frac{A-C}{2}\right)$

(c) $\cos\left(\frac{A-C}{2}\right)$ (d) $\sin\left(\frac{A-C}{2}\right)$

Answers

Physics

1. (a)	2. (c)	3. (c)	4. (a)	5. (c)	6. (a)	7. (a)	8. (b)	9. (b)	10. (d)
11. (a)	12. (a)	13. (a)	14. (d)	15. (d)	16. (b)	17. (a)	18. (c)	19. (a)	20. (c)
21. (a)	22. (a)	23. (d)	24. (d)	25. (a)	26. (b)	27. (b)	28. (a)	29. (d)	30. (d)
31. (d)	32. (c)	33. (a)	34. (c)	35. (a)	36. (b)	37. (a)	38. (a)	39. (a)	40. (c)

Chemistry

41. (b)	42. (c)	43. (b)	44. (c)	45. (b)	46. (c)	47. (c)	48. (c)	49. (b)	50. (d)
51. (b)	52. (b)	53. (c)	54. (d)	55. (b)	56. (b)	57. (a)	58. (b)	59. (a)	60. (d)
61. (c)	62. (a)	63. (b)	64. (a)	65. (c)	66. (d)	67. (a)	68. (c)	69. (c)	70. (a)
71. (c)	72. (c)	73. (c)	74. (b)	75. (a)	76. (b)	77. (a)	78. (d)	79. (a)	80. (b)

(a) English Proficiency

81. (b)	82. (d)	83. (a)	84. (d)	85. (d)	86. (a)	87. (b)	88. (c)	89. (c)	90. (b)
91. (c)	92. (b)	93. (b)	94. (c)	95. (c)					

(b) Logical Reasoning

96. (c)	97. (a)	98. (d)	99. (c)	100. (d)	101. (b)	102. (d)	103. (a)	104. (d)	105. (b)

Mathematics

106. (a)	107. (c)	108. (c)	109. (b)	110. (c)	111. (b)	112. (d)	113. (b)	114. (b)	115. (b)
116. (b)	117. (b)	118. (d)	119. (b)	120. (d)	121. (b)	122. (b)	123. (c)	124. (a)	125. (a)
126. (b)	127. (a)	128. (c)	129. (d)	130. (b)	131. (d)	132. (b)	133. (a)	134. (d)	135. (c)
136. (b)	137. (d)	138. (c)	139. (c)	140. (c)	141. (c)	142. (d)	143. (a)	144. (c)	145. (c)
146. (d)	147. (a)	148. (b)	149. (b)	150. (b)					

Hints & Solutions

Physics

1. The necessary centripetal force required for a planet to move round the sun

= gravitational force exerted on it

$$\frac{mv^2}{R} = \frac{GM_e m}{R^n}$$

or $$v = \left(\frac{GM}{R^{n-1}}\right)^{1/2}$$

as $$T = \frac{2\pi R}{v} = 2\pi R \times \left(\frac{R^{n-1}}{GM}\right)^{1/2}$$

$$T = 2\pi\left[\frac{R^{\frac{(n+1)}{2}}}{(GM_e)^{1/2}}\right]$$

$$\therefore \quad T \propto R^{(n+1)/2}$$

2. $$Y = \frac{FL}{A\Delta L}$$

or $$F = \frac{YA\Delta L}{L} = \frac{YA^2\Delta L}{AL}$$

$$= \frac{YA^2\Delta L}{V} = \frac{YA^2\Delta x}{V}$$

where $AL = V =$ Volume of wire, Young modulus in the same as both the wires are made of same material. It is given that both the wire have same volume and same extension in length

$$\therefore \quad \frac{F'}{F} = \frac{A'^2}{A^2} = \frac{(3A)^2}{A^2} = 9$$

$$F' = 9F$$

3. KE of a satellite

$$E = \frac{1}{2}mv^2$$

or $$mv = \sqrt{2Em}$$

Angular momentum

$$L = mvr = (\sqrt{2Em}) \times r$$

$$= \sqrt{2mEr^2}$$

4. Shunt is given by

$$S = \frac{I_g \times R_g}{I - I_g} = \frac{0.01 \times 100}{10 - 0.01}$$

$$= \frac{0.01 \times 100}{9.99} = 0.100\,\Omega$$

5. Given, $r = 25$ m, $v = 5$ m/s, $m = 500$ kg

$$a_t = 1\ \text{m/s}^2,\ a_r = \frac{v^2}{r} = \frac{5 \times 5}{25} = 1\ \text{m/s}^2$$

$$a_{net} = \sqrt{a_t^2 + a_r^2} = \sqrt{1^2 + 1^2} = \sqrt{2}\ \text{m/s}^2$$

$$F = ma_{net} = 500\sqrt{2}\ \text{N}$$

6. From conservation of energy the electron kinetic energy equals the maximum photon energy (we neglect the work function ϕ because it is normally so small compared to eV_0)

$$eV_0 = h\nu_{max}$$

$$eV_0 = \frac{hc}{\lambda_{min}}$$

$$V_0 = \frac{hc}{e\lambda_{min}}$$

$$V_0 = \frac{12400 \times 10^{-10}}{10^{-11}}$$

$$= 124\ \text{kV}$$

Hence, accelerating voltage for electrons is X-ray machine should be less than 124 kV.

7. Given $l = 60$ cm $= 60 \times 10^{-2}$ m

$$m = 20\ \text{kg}, \quad k = 400\ \text{N/m}$$

The weight hung from the spring

$$= mg = 20 \times 9.8 = 196\ \text{N}$$

Suppose x is the extension produced in spring

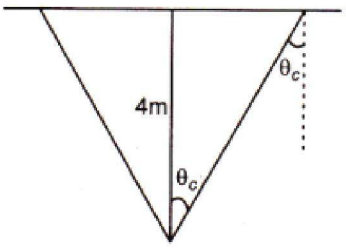
Now, force applied by the spring

= downward force on the spring

$$\therefore \quad kx = mg \Rightarrow x = \frac{mg}{k}$$

$$x = \frac{20 \times 9.8}{4000} = 0.049\ \text{m} = 4.9\ \text{cm}$$

8. $\sin\theta_c = \frac{1}{\mu} = \frac{3}{5}$



$$\frac{r}{4} = \tan\theta_c = \frac{3}{4}$$

Radius, r = radius = 3 m

Diameter, $d = 6$ m

9. $y = 2\sin\left(\frac{\pi t}{2} + \phi\right)$

Comparing the equation with the standard equation

$$y = A\sin(\omega t + \phi)$$

So $A = 2$ cm, $\omega = \frac{\pi}{2}$

Acceleration of particle is

$$a = \omega^2 x \quad \text{(numerically)}$$

at $x = +A$, $a = a_{max}$

$$\therefore \quad a_{max} = \omega^2 A$$

$$= \left(\frac{\pi}{2}\right)^2 \times 2$$

$$= 2 \times \frac{\pi^2}{4}$$

$$= \frac{\pi^2}{2} \text{ cm/s}^2$$

10. Apparent frequency heard will be

$$n' = n\left(\frac{v}{v - v_s}\right)$$

v = velocity of sound

v_s = velocity of source of sound

n = frequency

= 3 kHz

$$\therefore \quad n' = 3 \times \frac{v}{v - 0.5v}$$

$$= 3 \times \frac{v}{0.5v}$$

$$= 6 \text{ kHz}$$

11. Bernoulli's theorem is applicable only for tube flow of non-uniform cross-section.

12. From the formula

$$N = N_0\left(\frac{1}{2}\right)^n$$

$$\frac{N}{16} = N_0\left(\frac{1}{2}\right)^n$$

N_0 = original number of atom

$$\left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^n$$

$$\Rightarrow \quad n = 4$$

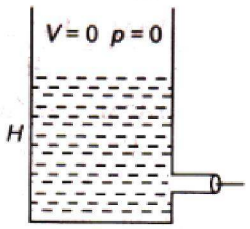
4 half lives

$$\therefore \quad 4T_{1/2} = 40$$

$$T_{1/2} = \frac{40}{4} = 10 \text{ days}$$

13. v = velocity of efflux through an orifice

$$= \sqrt{2gH}$$

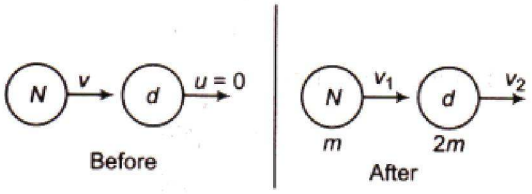


It is independent of the size of orifice.

14. Neutron velocity = v, mass = m

Deuteron contains 1 neutron and 1 proton

$$= 2m$$



In elastic collision, both momentum and KE are conserved

$$p_i = p_f$$

$$mv = m_1v_2 + m_2v_2$$

$$mv = mv_1 + 2mv_2$$

By kinetic energy

$$\frac{1}{2}mv^2 = \frac{1}{2}mv_1^2 + \frac{1}{2}(2m)v_2^2$$

By solving

$$v_1 = \frac{m_1 - m_2}{m_1 + m_2}v + \frac{2m_2}{(m_1 + m_2)}v$$

$$v_1 = \frac{m_1 - 2m}{3m}$$

$$v_1 = -\frac{v}{3}$$

$$K_i = \frac{1}{2}mv^2$$

$$K_f = \frac{1}{2}mv_1^2$$

$$\frac{K_i - K_f}{K_i} = 1 - \frac{v_1^2}{v^2}$$

$$= 1 - \frac{1}{9}$$

$$= \frac{8}{9} \text{ fractional change in KE}$$

15. Poisson's ratio = 0.5

Since, density is constant therefore change in volume is zero, we have

$$V = A \times l = \text{constant}$$

$$\log V = \log A + \log l$$

or

$$\frac{dA}{A} + \frac{dl}{l} = 0$$

$$\frac{dl}{l} = -\frac{dA}{A}$$

∴Percentage increase in length = 4%

16. Lenz's law of electromagnetic induction compounds to the law of conservation of energy.

17. Rotational kinetic energy $= \frac{1}{2}I\omega^2$

According to question

$$\frac{1}{2}I\omega^2 = 1500$$

$$\frac{1}{2}I(\alpha t)^2 = 1500$$

$$(1.2) \times (25)^2 \times t^2 = 3000$$

$$1.2 \times 625 \times t^2 = 3000$$

$$t^2 = \frac{3000}{1.2 \times 625} = 4$$

$$t = 2\,\text{s}$$

18. For a solenoid

$$B = \mu_0 ni$$

$$\because \quad n = \frac{N}{2\pi r}$$

$$\therefore \quad B = \frac{\mu_0 NI}{2\pi r}$$

Flux linked with the solenoid

$$\phi = NBA$$

$$\phi = \frac{\mu_0 N^2 IA}{2\pi r}$$

$$= \frac{4\pi \times 10^{-7} \times (1200)^2 \times 12 \times 10^{-4}}{2\pi \times 15 \times 10^{-2}}$$

$$L = 2.3 \times 10^{-3}\,\text{H}$$

$$= 2.3\,\text{mH}$$

19.

$$\frac{1}{2}mv^2 = \frac{1}{2}kx^2$$

$$v = \sqrt{\frac{R}{m}}x$$

$$= \sqrt{\frac{50}{20 \times 10^{-3}}}(10 \times 10^{-2})$$

$$= 50 \times 10^{-1}$$

$$= 5\,\text{m/s}$$

20. Work done, $W = p\Delta V$

$$= 1.013 \times 10^5 \times (1671 - 1) \times 10^{-6}$$

$$= 1.013 \times 10^5 \times 1670 \times 10^{-6}$$

$$= 169.2\,\text{J}$$

21. Volume, $V = l^3 = (1.2 \times 10^{-2}\,\text{m})^3$

$$= 1.728 \times 10^{-6}\,\text{m}^3$$

Since length (l) has two significant figure, the volume (V) will also have two significant figure.

Therefore, the correct answer is

$$V = 1.7 \times 10^{-6}\,\text{m}^3$$

22. $t = \sqrt{\frac{2h}{g}}$ and $t' = \sqrt{\frac{2(2h)}{g}}$

$$\therefore \quad \frac{t}{t'} = \frac{1}{\sqrt{2}}$$

23. Given, $P = a + bt^2$

$$\frac{dP}{dt} = 2bt$$

$$\because \quad F = \frac{dP}{dt}$$

$$\therefore \quad F = 2bt$$

or $F \propto t$

24. A ball bearing striking another ball bearing is not an example of perfectly inelastic collision.

25. By Kepler's third law, $T^2 \propto R^3$

$$\therefore \left(\frac{T_2}{365 \text{ days}}\right)^2 = \left(\frac{2r}{r}\right)^3$$

$$T_2 = 365 \times 2\sqrt{2} = 1032 \text{ days}$$

26. Weight, $w = mg = m\frac{4}{3}\pi GR\rho$

$$\therefore \quad \frac{w'}{w} = \frac{R'\rho'}{R\rho} = \left(\frac{1}{2}\right) \times 4 = 2$$

$$w' = 2w$$

27. Force on electron

$$|F| = qE = eE = mg$$

$$E = \frac{mg}{e}$$

28. Work done, $W = \frac{q^2}{2C}$

$$= \frac{(8 \times 10^{-18})^2}{2 \times 100 \times 10^{-6}}$$

$$= 32 \times 10^{-32} \text{J}$$

29. In a metallic conductor of non-uniform cross section, only the current remains constant along the entire length of the conductor.

30. Here, $I_g = 25 \times 4 \times 10^{-4} \text{A} = 10^{-2} \text{ A}$

To convert the galvanometer into a voltmeter we must join a series resistance of

$$R = \frac{V}{I_g} - G$$

$$= \frac{25}{10^{-2}} - 50 = 2500 - 50$$

$$= 2450\,\Omega$$

31. Cyclotron of frequency, $\nu = \frac{Bq}{2\pi m}$

$$= \frac{1 \times 1.6 \times 10^{-19}}{2\pi \times 9.1 \times 10^{-31}}$$

$$= 2.8 \times 10^{10} \text{ Hz}$$

$$= 28 \text{ GHz}$$

32. Torque, $\tau = \mathbf{M} \times \mathbf{B}$

33. Energy is stored in an inductor in the form of magnetic potential energy.

34. In a photoelectric cell, optical energy is being transformed into electrical energy because light photons are being absorbed and photoelectric current is being produced.

35. Ionisation energy $E = eV$

$$= 1.6 \times 10^{-19} \times 24.6 \text{ J}$$

$$= 24.6 \text{ eV}$$

36. Fast neutrons can easily be slowed down by passing them through water. Slowing down process is due to collision between neutron and hydrogen nucleus present in water.

37. As linear magnification $m = 4$,

hence, a real magnification $m_a = m^2$

$$= (4)^2 = 16$$

∴Surface area of film image on the screen

$$= 16 \times 100 = 1600 \text{ cm}^2$$

38. Under identical pressure and temperature condition, speed of sound in moist air is more than that in dry air, *i.e.*, $v_m > v_d$

39. Heat flow through vacuum is possible in radiation mode due to which temperature of hot body falls.

40. Given, $T_2 = -13°\text{C} = 260 \text{ K}$ and $\beta = 5$

$$\beta = \frac{T_2}{T_1 - T_2}$$

$$5 = \frac{260}{T_1 - 260}$$

$$T_1 = 312 \text{ K}$$

or $T_1 = 312 \text{ K} = 39°\text{C}$

41. $40\text{g NaOH} = \frac{40}{40} = 1 \text{ mol NaOH}$

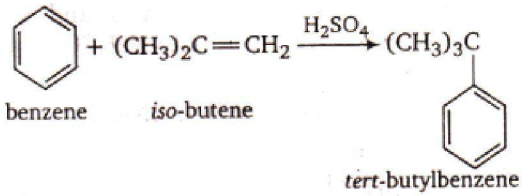
$60\text{g } CH_3COOH = \frac{60}{60} = 1 \text{ mol } CH_3COOH$

Since acetic acid is a weak acid, some of the heat is utilised to ionise it. So, enthalpy of neutralisation of 1 mol of NaOH by 1 mol CH_3COOH is less than 57.1 kJ.

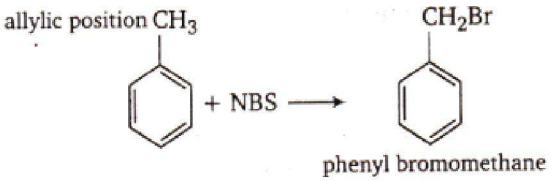
Enthalpy of neutralisation of a strong acid by a strong base is always 57.1 kJ.

42. Ionic size varies inversely with nuclear charge. Higher the nuclear charge, smaller the radii. Thus, P^{5+} because of the high nuclear charge, has the smallest size.

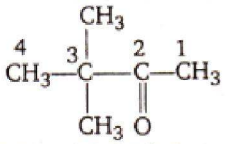
43.



44. NBS (N-bromosuccinimide) causes bromination at allylic position.

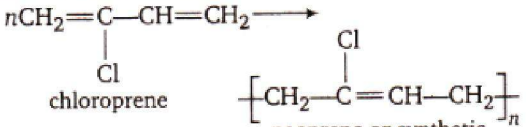


45. The structure of pinacolone is



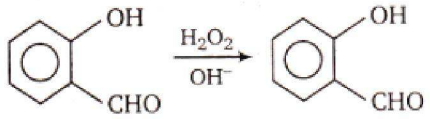
3,3-dimethyl-2-butanone

46. Neoprene is synthetic rubber. It is a polymer of chloroprene and is resistant to the action of oils, gasoline and other solvents.



47. HOCl and Cl_2 are formed over Antarctica. These are converted back into reactive Cl atoms which start the chain reaction with O_3 causing its depletion.

48. The reduction of —CHO group to —OH by H_2O_2/OH^- is called Dakin reaction.



Thus, the above reaction is Dakin reaction.

49. Conjugated base of a stronger acid is weak. The corresponding acids of the given conjugated bases are as (in order of acidity)

$$C_2H_5OH < CH_3COOH < HF < HNO_3$$

$\therefore$ The order of basicity is

$$C_2H_5O^- > CH_3COO^- > F^- > NO_3^-$$

Thus, NO_3^- is the weakest base among the given.

50. $\Delta T_b = ik_b \cdot m = 2 \times 0.52 \times 0.1 = 0.104°C$

$T_b = 100 + 0.104°C = 100.104°C$

51. $\underset{1 \text{ mol}}{P_2O_5} + 6H_2O \longrightarrow \underset{4 \text{ mol}}{4H_3PO_4}$

$\therefore$ 1 L solution contains 4 mol H_3PO_4.

$\therefore$ Molarity of $H_3PO_4 = 4$ M

Normality = Molarity × Basicity

$= 4 \times 3 \text{ N} = 12 \text{ N}$

52. $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$\Rightarrow \frac{10^{-6} \times 1000}{298} = \frac{760 \times V_2}{273}$

$V_2 = 1.2 \times 10^{-6}$ cc (at STP)

No. of molecules $= \frac{6.02 \times 10^{23}}{22400} \times 1.2 \times 10^{-6}$

$= 3.2 \times 10^{13}$

53. $\lambda = h / mv$

For same velocity $\lambda \propto 1/m$

Electron has the least mass, so its wavelength is maximum.

54. Radioactivity does not depend upon the state of combination so it remains unaffected.

55. In $SO_4^{2-} \Rightarrow bp = 4;\ lp = 0 \therefore$ hybridisation sp^3

In $SF_4 \Rightarrow bp = 4;\ lp = 1 \therefore$ hybridisation sp^3d

In $SF_2 \Rightarrow bp = 2;\ lp = 2 \therefore$ hybridisation sp^3

In $S_8 \Rightarrow bp = 2;\ lp = 2 \therefore$ hybridisation sp^3

Thus, only SF_4 does not have sp^3 hybridisation.

56. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

$$K = \frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{\left[\frac{\text{mol}}{\text{L}}\right]^2}{\left[\frac{\text{mol}}{\text{L}}\right]\left[\frac{\text{mol}}{\text{L}}\right]^3}$$

$$= \left[\frac{\text{mol}}{\text{L}}\right]^{-2} = \text{L}^2\text{mol}^{-2}$$

57. pH = 3

$$[H^+] = 1 \times 10^{-3}\ \text{mol/L}$$

$$H_2SO_4 \longrightarrow 2H^+ + SO_4^{2-}$$

$$[H_2SO_4] = \frac{1 \times 10^{-3}}{2} = \frac{1}{2000}\ \text{M}$$

$$N = 2\,\text{M} \qquad (\text{for } H_2SO_4)$$

$$\text{Normality} = \frac{2}{2000} = \frac{1}{1000}\ \text{N}$$

58. $NOClO_4$ is actually $NO^+ClO_4^-$.

Let the oxidation state of N in NO^+ is x.

NO^+ $\qquad x + (-2) = +1$

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

Let the oxidation state of Cl in ClO_4^- is y.

ClO_4^- $\qquad y + (-2) \times 4 = -1$

$$y - 8 = -1;\ y = +7$$

59. Pyrolusite is MnO_2. Thus, it is an oxide ore.

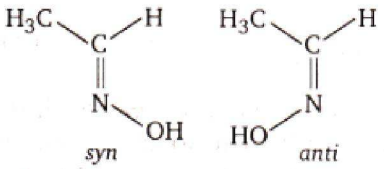
60. $K_4[Fe(CN)_6] + 6H_2SO_4 + 6H_2O \longrightarrow$

$$2K_2SO_4 + FeSO_4 + 3(NH_4)_2SO_4 + 6CO$$

61. When sodium carbonate is treated with CO_2 and H_2O, it gets converted into sodium bicarbonate.

$$Na_2CO_3 + CO_2 + H_2O \longrightarrow \underset{\substack{\text{sodium bicarbonate}\\ \text{or sodium hydrogen}\\ \text{carbonate}}}{2NaHCO_3}$$

62. Among the given only $CH_3CH{=}NOH$ (oxime) satisfy the conditions essential for exhibiting geometrical isomerism. So, it will exhibit *syn-anti* geometrical isomerism.



63. Octane number is defined as the percentage of *iso*-octane (by volume) in a mixture of *iso*-octane and *n*-heptane which has the same anti-knocking properties as the fuel under consideration.

Thus, the octane number of the given fuel is 70 as it contains 70% *iso*-octane.

64. When SO_2 is passed in the sodium carbonate solution, CO_2 gas is evolved and sodium carbonate is converted into $NaHSO_3$ (sodium bisulphite).

$$Na_2CO_3 + 2SO_2 + H_2O \rightarrow 2NaHSO_3 + CO_2$$

65. $t_{1/2} \propto \dfrac{1}{(a)^{n-1}}$

Given, $\qquad t_{1/2} \propto \dfrac{1}{a}$

On comparing, $\qquad a^{n-1} = a^1$

$$n - 1 = 1$$

$$n = 1 + 1 = 2$$

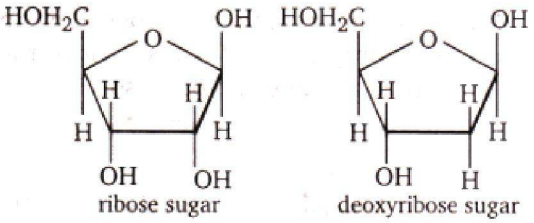
66. In $HC{\equiv}C{-}CH_2OH$ two active hydrogen atoms are present, hence it will react with two moles of CH_3MgBr (Grignard reagent).

$$HC{\equiv}C{-}CH_2OH + 2CH_3MgBr \longrightarrow$$

$$2CH_4 + BrMgC{\equiv}CCH_2OMgBr$$

67. Haemoglobin molecule contains four polypeptide chains.

68. The structure of sugar of DNA (*i.e.*, deoxyribose) and that of RNA (*i.e.*, ribose) is as



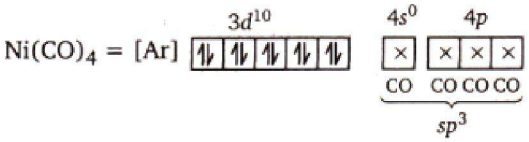
Thus, it is clear that these have furanose structure.

69. Tetrazine is an artificial edible colour.

70. In nickel carbonyl, $Ni(CO)_4$, Ni is present as Ni.

$Ni = [Ar]\ 3d^8 4s^2$

CO being strong field ligand, shifts electrons from 4s to 3d orbital.



Therefore, number of unpaired electrons in nickel carbonyl is 0.

71. For a first order reaction,

$$k = \frac{2.303}{t}\log\frac{a}{a-x}$$

$$t = \frac{2.303 \times t_{1/2}}{0.693}\log\frac{100}{(100-90)} \qquad \left[\because k = \frac{t_{1/2}}{0.693}\right]$$

$$= \frac{2.303 \times t_{1/2}}{0.693}\log 10$$

$$= 3.3\, t_{1/2}$$

= 3.3 times that of half-life

72. Given, $pK_a = 4$

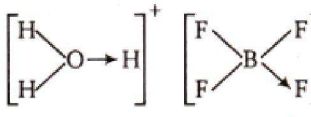
$\therefore \quad K_a = 1 \times 10^{-4}$

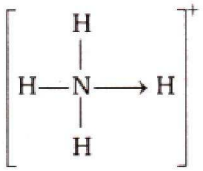
$$[H^+] = \sqrt{K_a \cdot C} = \sqrt{1 \times 10^{-4} \times 0.01}$$

$$= \sqrt{10^{-6}} = 10^{-3}\,M$$

$$pH = -\log[H^+] = -\log 10^{-3} = 3$$

73. Among the given, only HF_2^- has H-bonding $[F—H\ldots F]^-$. Rest all the molecules have coordinate bonds.





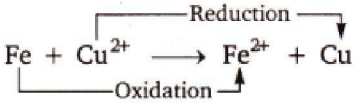
74. Anti-bonding molecular orbital is raised more in energy than the energy by which bonding molecular orbital is lowered.

75.
$$E^\circ = \frac{0.059}{n}\log K_c$$

$$0.46 = \frac{0.059}{2}\log K_c$$

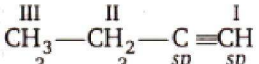
$$\log K_c = \frac{0.46 \times 2}{0.059} = 15.6$$

$$K_c = \text{antilog } 15.6$$

76.


$$E^\circ_{cell} = E^\circ_{Fe/Fe^{2+}} + E^\circ_{Cu^{2+}/Cu} = 0.44 + 0.32$$

$$= 0.76\ V$$

77.


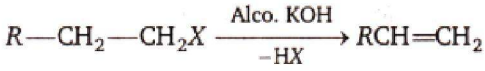
Electronegativity $\propto$ s-character.

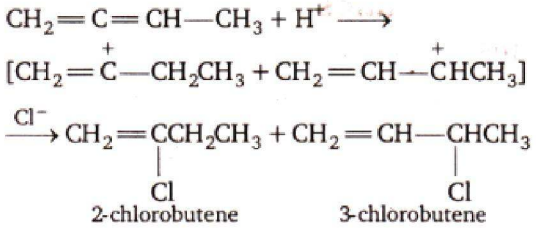
In sp hybrid orbitals, s character = 50%

and in sp^3 hybrid orbitals, s character = 33.3%

Thus, I is the most electronegative.

78. Dehydrohalogenation of alkyl halide gives alkenes but not alkane.



79.


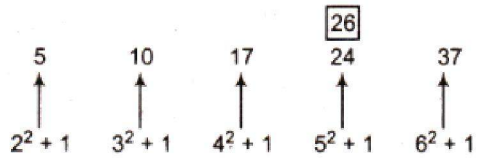
80. When formaldehyde reacts with ammonia, a well known urinary antiseptic urotropine (also called hexamethylene tetramine) is obtained.

$$6HCHO + 4NH_3 \rightarrow (CH_2)_6N_4 + 4H_2O$$

structure of urotropine

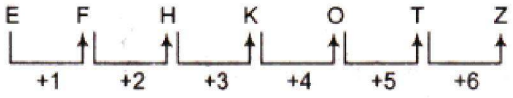
(b) Logical Reasoning

96. The pattern of the series is



Hence, 24 is the wrong number.

97. The pattern of the series is



98. As, M $\xrightarrow{+1}$ N Similarly, T $\xrightarrow{+1}$ U

O $\xrightarrow{-1}$ N A $\xrightarrow{-1}$ Z

N $\xrightarrow{+1}$ O R $\xrightarrow{+1}$ S

K $\xrightarrow{-1}$ J G $\xrightarrow{-1}$ F

E $\xrightarrow{+1}$ F E $\xrightarrow{+1}$ F

Y $\xrightarrow{-1}$ X T $\xrightarrow{-1}$ S

99. L > S > (P, Q) > N > M

Hence, L is the tallest among six friends.

100. Number of boys towards the left of Manick

$= (40 - 14) = 26$

So, Manick is 27th from the left end.

101. The sum of the two numbers in the upper part is seven times the number in the lower part.

$(25 + 17) \div 7 = 6$

$(38 + 18) \div 7 = 8$

So, missing term $= (89 + 16) \div 7$

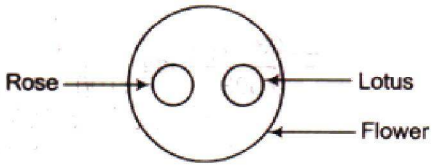
$= 105 \div 7$

$= 15$

102. Clearly, the given letters, when arranged in the order of '6, 3, 5, 2, 4, 1' form the word 'BRANCH'.

103. Rose and Lotus are different type of flowers.

Hence, the diagram will be



104. Answer figure (d) will appear when a piece of paper is folded and cut.

105. Answer figure (b) will complete the question figure.

Mathematics

106. Given, $x^2 + y^2 = a^2$

On differentiating w.r.t. x, we get

$$2x + 2y\frac{dy}{dx} = 0$$

$$\Rightarrow \quad \frac{dy}{dx} = -\frac{x}{y}$$

$$\Rightarrow \quad \left(\frac{dy}{dx}\right)_{(x', y')} = -\frac{x'}{y'}$$

$\therefore$ Equation of normal is

$$y - y' = \frac{y'}{x'}(x - x')$$

$$\Rightarrow \quad x'y - y'x' = xy' - y'x'$$

$$\Rightarrow \quad x'y - xy' = 0$$

107. Given equations are

$$3x + 4y + 5 = 0$$

and $$12x - 5y - 7 = 0$$

$$\therefore \quad a_1a_2 + b_1b_2 = 3 \times 12 + 4 \times (-5)$$

$$= 16 > 0$$

$\therefore$ For acute angle bisector

$$\frac{a_1x + b_1y + c_1}{\sqrt{a_1^2 + b_1^2}} = -\frac{(a_2x + b_2y + c_2)}{\sqrt{a_2^2 + b_2^2}}$$

$$\therefore \quad \frac{3x + 4y + 5}{\sqrt{9 + 16}} = -\frac{(12x - 5y - 7)}{\sqrt{12^2 + (-5)^2}}$$

$$\Rightarrow \quad \frac{3x + 4y + 5}{5} = -\frac{(12x - 5y - 7)}{13}$$

$$\Rightarrow 39x + 52y + 65 = -60x + 25y + 35$$

$$\Rightarrow \quad 99x + 27y + 30 = 0$$

108. Given, $z = \cos\theta + i\sin\theta$

$$\therefore z^n + \frac{1}{z^n} = (\cos\theta + i\sin\theta)^n + (\cos\theta + i\sin\theta)^{-n}$$

$$= \cos n\theta + i\sin n\theta + \cos n\theta - i\sin n\theta$$

$$= 2\cos n\theta$$

109. Since, α and β are the roots of $x^2 - 2x + 4 = 0$

$$\therefore \quad \alpha + \beta = 2 \text{ and } \alpha\beta = 4$$

Now, $$(\alpha - \beta) = \sqrt{(\alpha+\beta)^2 - 4\alpha\beta}$$

$$= \sqrt{4-16} = 2\sqrt{3}\,i$$

On solving, we get

$$2\alpha = 2 + 2\sqrt{3}\,i$$

$$\Rightarrow \quad \alpha = 2\left(\frac{1}{2} + \frac{\sqrt{3}}{2}i\right)$$

$$= 2\left(\cos\frac{\pi}{3} + i\sin\frac{\pi}{3}\right)$$

and $$\beta = \frac{2 - 2\sqrt{3}\,i}{2} = 2\left(\cos\frac{\pi}{3} - i\sin\frac{\pi}{3}\right)$$

$$\therefore \quad \alpha^n + \beta^n = \left[2\left(\cos\frac{\pi}{3} + i\sin\frac{\pi}{3}\right)\right]^n + \left[2\left(\cos\frac{\pi}{3} - i\sin\frac{\pi}{3}\right)\right]^n$$

$$= 2^n\left[2\cos\frac{n\pi}{3}\right] = 2^{n+1}\cos\frac{n\pi}{3}$$

110. Now, $$A^2 = \begin{bmatrix} 3 & 1 \\ -1 & 2 \end{bmatrix}\begin{bmatrix} 3 & 1 \\ -1 & 2 \end{bmatrix}$$

$$= \begin{bmatrix} 8 & 5 \\ -5 & 3 \end{bmatrix}$$

$$\therefore A^2 - 5A + 7I = \begin{bmatrix} 8 & 5 \\ -5 & 3 \end{bmatrix} - \begin{bmatrix} 15 & 5 \\ -5 & 10 \end{bmatrix} + \begin{bmatrix} 7 & 0 \\ 0 & 7 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

Hence, option (c) is the correct answer.

111. Applying $R_1 \to R_1 + R_2 + R_3$ and taking common from R_1, we get

$$\Delta = (a+b+c)\begin{vmatrix} 1 & 1 & 1 \\ 2b & b-c-a & 2b \\ 2c & 2c & c-a-b \end{vmatrix}$$

Applying $C_2 \to C_2 - C_1$ and $C_3 \to C_3 - C_1$

$$\Delta = (a+b+c)\begin{vmatrix} 1 & 0 & 0 \\ 2b & -(a+b+c) & 0 \\ 2c & 0 & -(a+ \end{vmatrix}$$

$$= (a+b+c)^3$$

112. Given,

$$(1+x)^n = C_0 + C_1x + C_2x^2 + \ldots + C_nx^n$$

Put $x = -1$, we get

$$C_0 - C_1 + C_2 - \ldots + (-1)^n \cdot C_n = 0$$

113. Let a and b be two numbers, then

$$\text{AM} = \frac{a+b}{2}$$

$$\Rightarrow \quad 27 = \frac{a+b}{2}$$

$$\Rightarrow \quad a + b = 54$$

and $$\text{HM} = \frac{2ab}{a+b}$$

$$\Rightarrow \quad 12 = \frac{2ab}{54}$$

$$\Rightarrow \quad ab = 324$$

$$\therefore \quad \text{GM} = \sqrt{ab} = \sqrt{324} = 18$$

114. Given, $P(A \cup B) = \frac{5}{6}$, $P(A \cap B) = \frac{1}{3}$,

$P(B) = \frac{1}{2}$,

$$\because \quad P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$\therefore \quad P(A) = \frac{5}{6} - \frac{1}{2} + \frac{1}{3}$$

$$= \frac{5-3+2}{6} = \frac{4}{6} = \frac{2}{3}$$

115. $\therefore$ Required probability $= \frac{{}^3C_1}{{}^8C_1} = \frac{3}{8}$

116. Since, scalar triple product is zero, then **a**, **b** and **c** are coplanar.

117. Since, given vectors are perpendicular.

$$\therefore (2\mathbf{i} + \mathbf{j} - \mathbf{k}) \cdot (\mathbf{i} - 4\mathbf{j} + \lambda\mathbf{k}) = 0$$

$\Rightarrow \quad 2 - 4 - \lambda = 0$

$\Rightarrow \quad \lambda = -2$

118. $\int_1^2 f(x)dx = \int_1^2 \frac{d}{dx}(\phi(x))dx$

$= [\phi(x)]_1^2 = \phi(2) - \phi(1)$

119. $\int_0^2 |1 - x|\, dx = \int_0^1 (1 - x)\, dx + \int_1^2 (x - 1)\, dx$

$= \left[x - \frac{x^2}{2}\right]_0^1 + \left[\frac{x^2}{2} - x\right]_1^2$

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

$= \frac{1}{2} + \frac{1}{2} = 1$

120. Let $I = \int \frac{\sin 2x}{\sin^4 x + \cos^4 x}\, dx$

$= \int \frac{\sin 2x}{(\sin^2 x + \cos^2 x)^2 - 2\sin^2 x \cos^2 x}\, dx$

$= \int \frac{\sin 2x}{1 - \frac{1}{2}(\sin 2x)^2}\, dx$

$= \int \frac{\sin 2x}{1 - \frac{1}{2}(1 - \cos^2 2x)}\, dx$

$= \int \frac{\sin 2x}{\frac{1}{2}(1 + \cos^2 2x)}\, dx$

Put $\cos 2x = t \Rightarrow -2\sin 2x\, dx = dt$

$\therefore \quad I = -\int \frac{dt}{1 + t^2} = -\tan^{-1} t + C$

$= -\tan^{-1}(\cos 2x) + C$

121. Let $y = \sin x + \cos x$

$= \sqrt{2}\left(\sin\left(\frac{\pi}{4} + x\right)\right)$

Here, y will be maximum when

$x = \frac{\pi}{4}$

122. Let $y = x^x$

$\Rightarrow \quad \log y = x \log x$

On differentiating w.r.t. x, we get

$\frac{1}{y}\frac{dy}{dx} = \frac{x}{x} + \log x$

$\Rightarrow \quad \frac{dy}{dx} = y(1 + \log x)$

$\Rightarrow \quad = x^x(\log e + \log x)$

$= x^x(\log ex)$

123. $\lim_{x \to 0} \frac{\sin x}{x} = \lim_{x \to 0} \frac{\cos x}{1}$

$= \cos 0 = 1$

124. Since, $x^2 = 16 \Rightarrow x = \pm 4$

and $2x = 6 \Rightarrow x = 3$

Hence, no value of x is satisfied.

$\therefore \quad A = \phi$

125. Required number of ways

$= 4^5 = 2^{10} = 1024$

126. Since, $(\sqrt{5} + 1)^5 - (\sqrt{5} - 1)^5$

$= 2\{{}^5C_1(\sqrt{5})^4 + {}^5C_3(\sqrt{5})^2 + {}^5C_5 \cdot 1\}$

$= 2\{5 \times 25 + 50 + 1\}$

$= 2(176) = 352$

127. $\therefore 7\log\left(\frac{16}{15}\right) + 5\log\left(\frac{25}{24}\right) + 3\log\left(\frac{81}{80}\right)$

$= \log\left[\left(\frac{16}{15}\right)^7 \cdot \left(\frac{25}{24}\right)^5 \cdot \left(\frac{81}{80}\right)^3\right]$

$= \log 2$

128. Here, $T_n = \frac{n(n+1)}{n!} = \frac{n - 1 + 2}{(n-1)!}$

$= \frac{1}{(n-2)!} + \frac{2}{(n-1)!}$

$\therefore \quad S = \sum_{n=1}^{\infty} T_n = \sum_{n=1}^{\infty} \frac{1}{(n-2)!} + 2\sum_{n=1}^{\infty} \frac{1}{(n-1)!}$

$= e + 2e = 3e$

129. $\log_4 2 - \log_8 2 + \log_{16} 2 - \ldots.$

$= \left(\frac{1}{2} - \frac{1}{3} + \frac{1}{4} - \ldots\right) - 1 + 1$

$= -\left(1 - \frac{1}{2} + \frac{1}{3} - \frac{1}{4} + \ldots\right) + 1$

$= 1 - \log(1 + 1) = 1 - \log_e 2$

130. Now, $x^2 - 6x + 7 = (x-3)^2 - 2$

It is obvious that minimum value is -2 and maximum value is ∞.

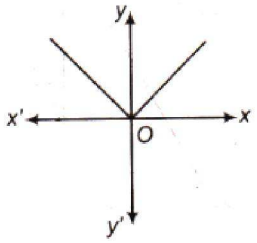
131. $\lim_{x \to 0} \frac{\cos(\sin x) - 1}{x^2} = \lim_{x \to 0} \frac{-2\sin^2\left(\frac{\sin x}{2}\right)}{x^2}$

$$= -2 \lim_{x \to 0} \frac{\sin^2\left(\frac{\sin x}{2}\right) \cdot \left(\frac{\sin x}{2}\right)^2}{\left(\frac{\sin x}{2}\right)^2 \times x^2}$$

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

132. $\lim_{x \to 0} f(x) = f(0) = \lim_{x \to 0} (1+x)^{1/x} = e$

133. Given, $f(x) = |x|$



It is clear from the graph, $f(x)$ is continuous but non-differentiable at $x = 0$.

134. Let any point on the curve be (h, k).

Then, $h^2 = 2k$

$\therefore$ Distance $D = \sqrt{h^2 + (k-5)^2}$

$\Rightarrow$ $D = \sqrt{2k + (k-5)^2}$

$\Rightarrow \frac{dD}{dk} = \frac{1}{2\sqrt{2k + (k-5)^2}} \times \{2 + 2(k-5)\} = 0$ (say)

$\therefore$ $k = 4$

Then, point will be $(\pm 2\sqrt{2}, 4)$.

135. Let $y = x^{\frac{1}{x}} \Rightarrow \log y = \frac{1}{x} \log x$

$\Rightarrow$ $\frac{1}{y}\frac{dy}{dx} = \frac{1}{x^2} - \frac{\log_e x}{x^2}$

$\Rightarrow$ $\frac{dy}{dx} = x^{1/x}\left(\frac{1 - \log_e x}{x^2}\right)$

For $1 < x < \infty$, $x^{1/x} > 0$

and $\frac{1 - \log_e x}{x^2} > 0$ in $(1, e)$

and $\frac{1 - \log_e x}{x^2} < 0$ in (e, ∞)

Hence, $f(x)$ is increasing in $(1, e)$ and decreasing in (e, ∞).

136. $\therefore$ Required area $= \int_0^{\pi} \sin x \, dx$

$= [-\cos x]_0^{\pi}$

$= [+1 + 1]$

$= 2$ sq units

137. Given, $\sqrt{\frac{dy}{dx}} - 4\frac{dy}{dx} - 7x = 0$

On squaring, we get

$$\frac{dy}{dx} = 16\left(\frac{dy}{dx}\right)^2 + 49x^2 + 56x\frac{dy}{dx}$$

Here, order is 1 and degree is 2.

138. $\therefore$ Required ratio $= -\frac{(-1+1-4)}{(5+7-4)} = \frac{1}{2}$

139. Here, $a + b = 1 - 1 = 0$

Hence, pair of lines are perpendicular.

140. Length of tangent $= \sqrt{S_1}$

$= \sqrt{5^2 + 1^2 + 30 - 4 - 3}$

$= \sqrt{49} = 7$

141. Given equation can be rewritten as

$$(x-1)^2 + (y-3)^2 = \left(\frac{5x - 12y + 17}{13}\right)^2$$

$\Rightarrow$ SP = PM

Here, focus is (1, 3), directrix

$5x - 12y + 17 = 0$

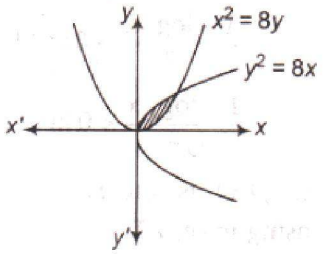
$\therefore$ The distance of the focus from the directrix

$$= \left|\frac{5 - 36 + 17}{\sqrt{25 + 144}}\right|$$

$$= \frac{14}{13} = 2a$$

$\therefore$ Latusrectum $= 2 \times \frac{14}{13} = \frac{28}{13}$

142. It is clear that angle between the curves



= angle between the x-axis and y-axis is $\frac{\pi}{2}$.

143. Given centre (0, 0), focus (0, 3), $b = 5$

$\Rightarrow be = 3 \Rightarrow e = \frac{3}{5}$

$\therefore \quad a = b\sqrt{1-e^2} = 5\sqrt{1-\frac{9}{25}} = 4$

Hence, required equation is

$$\frac{x^2}{16} + \frac{y^2}{25} = 1$$

144. The equation of director circle to the hyperbola is $x^2 + y^2 = a^2 - b^2$

$\therefore \quad$ Radius $= \sqrt{a^2 - b^2}$

145. Let d be the length of line, then projection on x-axis $= dl = 3$, projection of y-axis $= dm = 4$ and projection on z-axis $= dn = 5$

Now, $\quad d^2(l^2 + m^2 + n^2) = 50$

$\Rightarrow \quad d^2 = 50 \Rightarrow d = 5\sqrt{2}$

146. $\therefore \tan(\theta + \phi) = \frac{\tan\theta + \tan\phi}{1 - \tan\theta \cdot \tan\phi}$

$$= \left(\frac{1}{2} + \frac{1}{3}\right) \Big/ \left(1 - \frac{1}{2}\cdot\frac{1}{3}\right) = 1$$

$\Rightarrow \quad \theta + \phi = \frac{\pi}{4}$

147. $\because \sin\theta = \frac{1}{2} = \sin\frac{\pi}{6}$

$\Rightarrow \quad \theta = \frac{\pi}{6}, \pi - \frac{\pi}{6}$

and $\quad \tan\theta = \frac{1}{\sqrt{3}} = \tan\left(\frac{\pi}{6}\right)$

$\Rightarrow \quad \theta = \frac{\pi}{6}, \pi + \frac{\pi}{6}$

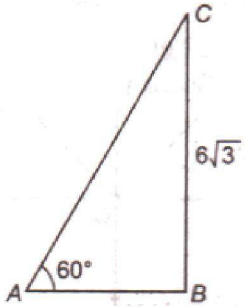
$\therefore$ Common value of θ is $\frac{\pi}{6}$.

$\therefore$ General value of θ is

$$2n\pi + \frac{\pi}{6}, \forall\, n \in I$$

148. $\therefore \sin^{-1}\left(-\frac{\sqrt{3}}{2}\right) = \sin^{-1}\left(\sin\left(-\frac{\pi}{3}\right)\right) = -\frac{\pi}{3}$

149. $\therefore$ Length of ladder, $AC = \frac{6\sqrt{3}}{\sin 60^\circ} = 12$ m



150. Since. $A + B + C = \pi$

But $\quad 2B = A + C$

$\therefore \quad 3B = \pi \Rightarrow B = \pi/3$

$$\frac{a+c}{b} = \frac{\sin A + \sin C}{\sin B}$$

$$= \frac{2\sin\left(\frac{A+C}{2}\right)\cos\left(\frac{(A-C)}{2}\right)}{\sin\frac{\pi}{3}}$$

$$= \frac{2\sin\frac{\pi}{3}\cos\left(\frac{A-C}{2}\right)}{\sin\frac{\pi}{3}}$$

$$= 2\cos\left(\frac{A-C}{2}\right)$$