RESEARCH METHODOLOGY-SCIENCE (2018)

1. What is the next term in the following sequence ?

7, 11, 13, 17, 19, 23, 29, ...

(A) 37 (B) 35

(C) 31 (D) 33

2. Which of the following numbers is a perfect square ?

(A) 1022121 (B) 2042122

(C) 3063126 (D) 4083128

3. If 42 $\rightarrow$ 26, 71 $\rightarrow$ 78, 33 $\rightarrow$ 16, then 62 $\rightarrow$

(A) 68 (B) 54

(C) 38 (D) 39

4. Approximately how much blood flows per day through a normal human heart beating 70 times per minute, having a relaxed volume of 110 cc and compressed volume of 70 cc ?

(A) 7150 litres (B) 4000 litres

(C) 28000 litres (D) 11100 litres

5. Find the missing word : A, AB, _____, ABBABAAB

(A) AABB (B) ABAB

(C) ABBA (D) BAAB

6. How many digits are there in 3^{16} when it is expressed in the decimal form ?

(A) Three (B) Six

(C) Seven (D) Eight

7. The sum of the first n natural numbers with one of them missed is 42. What is the number that was missed ?

(A) 1 (B) 2

(C) 3 (D) 4

8. If N, E and T are distinct positive integers such that N × E × T = 2013, then which of the following is the maximum possible sum of N, E and T ?

(A) 39 (B) 2015

(C) 671 (D) 675

9. Two plane mirrors facing each other are kept at 60º to each other. A point is located on the angle bisector. The number of images of the point is :

(A) 6 (B) 3

(C) 5 (D) infinite

10. A 3 m long car goes past a 4 m long truck at rest on the road. The speed of the car is 7 m/s. The time taken to go past is :

(A) 4/7 s (B) 1 s

(C) 7/4 s (D) 10/7 s

11. The dimensions of a floor are 18 × 24. What is the smallest number of identical square tiles that will pave the entire floor without the need to break any tile ?

(A) 6 (B) 24

(C) 12 (D) 8

12. I bought a shirt at l0% discount and sold it to a friend at a loss of l0%. If the friend paid me Rs. 729.00 for the shirt, what was the undiscounted price of the shirt ?

(A) Rs. 900 (B) Rs. 800

(C) Rs. 1000 (D) Rs. 911.25

13. How many non-negative integers less than 10,000 are there such that the sum of the digits of the number is divisible by three ?

(A) 1112 (B) 2213

(C) 2223 (D) 3334

14. 20 teachers of a school either teach mathematics or physics. 12 of them teach mathematics while 4 teach both the subjects. Then the number of teachers teaching physics only is :

(A) 8 (B) 12

(C) 16 (D) None of these

15. Let A, B be the ends of the longest diagonal of the unit cube. The length of the shortest path from A to B along the surface is :

(A) $\sqrt{3}$ (B) $1+\sqrt{2}$

(C) $\sqrt{5}$ (D) 3

16. In an examination, a student scores 4 marks for every correct answer and loses 1 mark for every wrong answer. If he attempts in all 60 questions and secures 130 marks, the number of questions he attempts correctly, is :

(A) 35 (B) 38

(C) 40 (D) 42

17. It takes 2 hours for Tiwari and Deo to do a job. Tiwari and Hari take 3 hours to do the same job. Deo and Hari take 6 hours to do the same job. Which of the following statements is *incorrect* ?

(A) Tiwari alone can do the job in 3 hours

(B) Deo alone can do the job in 6 hours

(C) Hari does not work at all

(D) Hari is the fastest worker

18. If you count 21 letters in the English alphabet from the end and 20 letters from the beginning, which letter will appear exactly in the middle of the sequence thus formed ?

(A) M (B) L

(C) K (D) N

19. A train running at 36 km/h crosses a mark on the platform in 8 sec and takes 20 sec to cross the platform. What is the length of the platform ?

(A) 120 m (B) 280 m

(C) 40 m (D) 160 m

20. Water is slowly dripping out of a tiny hole at the bottom of a hollow metallic sphere initially full of water. Ignoring the water that has flowed away, the centre of mass of the system :

(A) remains fixed at the centre of the sphere

(B) moves down steadily as the amount of water decreases

(C) moves down for some time but eventually returns to the centre of the sphere

(D) moves down until half of the water is lost and then moves up

21. The missing number is :

3	6	8
5	8	4
4	7	?

(A) 6 (B) 7

(C) 8 (D) 9

22. Reena is twice as old as Sunita. Three years ago, she was three times as old as Sunita. How old is Reena now ?

(A) 6 years

(B) 7 years

(C) 12 years

(D) 8 years

23. A bicycle tube has a mean circumference of 200 cm and a circular cross-section of diameter 6 cm. What is the approximate volume of water (in cc) required to completely fill the tube, assuming that it does not expand ?

(A) 600 π (B) 1200 π

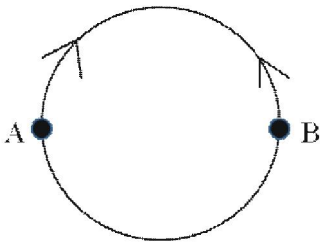
(C) 3600 π (D) 1800 π

24. Six persons P, Q, R, S, T and U are standing in a circle. Q is between S and R. P is between T and R. U is to the right of S. Who is between P and U ?

(A) Q (B) R

(C) T (D) S

25.



Two ants, initially at diametrically opposite points A and B on a circular ring of radius R, start crawling towards each other. The speed of the one at A is half of that of the one at B. The point at which they meet is at a straight line distance of :

(A) R from A

(B) $\frac{3R}{2}$ from A

(C) R from B

(D) $\frac{3R}{2}$ from B

26. A person completely under sea water tracks the Sun. Compared to an observer above water, which of the following observations would be made by the underwater observer ?

(A) Neither the time of sunrise or sunset nor the angular span of the horizon changes.

(B) Sunrise is delayed, sunset is advanced, but there is no change in the angular span of the horizon.

(C) Sunrise and sunset times remain unchanged, but the angular span of the horizon shrinks.

(D) The duration of the day and the angular span of the horizon, both decrease.

27. The number of boys in a class is three times the number of girls. Which one of the following numbers cannot represent the total number of children in the class ?

(A) 48

(B) 42

(C) 44

(D) 40

28. Two coconuts have spherical space inside their kernels, with the first having an inner diameter twice that of the other. The larger one is half filled with liquid, while the smaller is completely filled. Which of the following statements is *correct* ?

(A) The larger coconut contains 4 times the liquid in the smaller one.

(B) The larger coconut contains twice the liquid in the smaller one.

(C) The coconuts contain equal volumes of liquid.

(D) The smaller coconut contains twice the liquid in the larger one.

29. A tiger usually stalks its prey from a direction that is upwind of the prey. The reason for this is :

(A) the wind aids its final burst for killing the prey

(B) the wind carries the scent of the prey to the tiger and helps the tiger locate the prey easily

(C) the upwind area usually has denser vegetation and better camouflage

(D) the upwind location aids the tiger by not letting its smell reach the prey

30. A cellphone tower radiates 1W power while the handset transmitter radiates 0.1 mW power. The correct comparison of the radiation energy received by your head from a tower 100 m away (E_1) and that from a handset held to your ear (E_2) is :

(A) $E_1 >> E_2$

(B) $E_2 >> E_1$

(C) $E_1 = E_2$ for communication to be established

(D) insufficient data even for a rough comparison

31. The pitch of a spring is 5 mm. The diameter of the spring is 1 cm. The spring spins about its axis with a speed of 2 rotations/s. The spring appears to be moving parallel to its axis with a speed of :

(A) 1 mm/s (B) 5 mm/s

(C) 6 mm/s (D) 10 mm/s

32. A boy holds one end of a rope of length l and the other end is fixed to a thin pole of radius r ($l >> r$). Keeping the rope taut, the boy goes around the pole causing the rope to get wound around the pole. Each round takes 10 s. What is the speed (in units of s^{-1}) with which the boy approaches the pole ?

(A) $\frac{\pi r}{5}$ (B) $\frac{\pi l}{5}$

(C) $20\pi(r+l)$ (D) $\frac{20\pi(r-l)}{5}$

33. A rectangular flask of length 11 cm, width 8 cm and height 20 cm has water filled up to height 5 cm. If 21 spherical marbles of radius 1 cm each are dropped in the flask, what would be the rise in water level ?

(A) 8.8 cm (B) 10 cm

(C) 1 cm (D) 0 cm

34. Deepak starts walking straight towards east. After walking 75 metres, he turns to the left and walks 25 metres straight. Again he turns to the left, walks a distance of 40 metres straight, again he turns to the left and walks a distance of 25 metres. How far is he from the starting point ?

(A) 25 m (B) 50 m

(C) 115 m (D) 35 m

35. A leaf appears green in daylight. If this leaf were observed in red light, what colour would it appear to have ?

(A) green (B) black-brown

(C) red (D) blue

36. The sum of two numbers is equal to sum of square of 11 and cube of 9. The larger number is $(5)^2$ less than square of 25. What is the value of the sum of twice of 24 per cent of the smaller number and half of the larger number ?

(A) 415 (B) 400

(C) 410 (D) 420

37. For which one of the following statements is the converse NOT true ?

(A) If a patient dies even with excellent medical care, he likely had terminal illness.

(B) If a person gets employed, he has good qualifications.

(C) If an integer is even, it is divisible by two.

(D) If an integer is odd, it is not divisible by two.

38. How many numbers from 1 to 100 are there each of which is not only exactly divisible by 4 but also has 4 as a digit ?

(A) 21 (B) 10

(C) 20 (D) 7

39. If a plant with green leaves is kept in a dark room with only green light ON, which one of the following would we observe ?

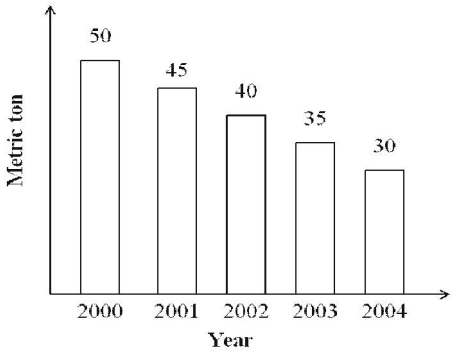
(A) The plant appears brighter than the surroundings

(B) The plant appears darker than the surroundings

(C) We cannot distinguish the plant from the surroundings

(D) It will have above normal photosynthetic activity

40. Wheat production of a country over a number of years is shown. Which year recorded highest per cent reduction in production over the previous year ?



(A) 2001

(B) 2002

(C) 2003

(D) 2004

41. L is the tallest and eldest of a group of five people K, L, M, N and P. M is elder to N and shorter than K. M and P are of same age and P is taller than K. N and K are of same height and K is younger to P. Which of the following inferences is certain ?

(A) P is taller than M

(B) N is the youngest

(C) N is elder to P

(D) N is elder to K

42. In a fast moving car with open windows, the driver feels a continuous incoming breeze. The pressure inside the car, however, does not keep increasing because :

(A) Air coming in from the front window goes out from the rear.

(B) Air comes in as well as goes out through every window but the driver only feels the incoming one.

(C) No air actually comes in and the feeling of breeze is an illusion.

(D) Cool air reduces the temperature therefore the pressure does not increase.

43. A tall metal cylinder is filled end-to-end with n snugly fitting spherical wax balls of diameter d. If the balls melt completely, the volume fraction occupied by the melted wax is :

(A) independent of both d and n

(B) dependent on both d and n

(C) independent of d, but dependent on n

(D) dependent on d, but independent of n

44. In each of the following groups of words is a hidden number, based on which you should arrange them in descending order. Pick the *correct* answer :

E. Papers I Xeroxed
F. Wi-Fi veteran
G. Yourself ourselves
H. Breaks even

(A) E, F, G, H
(B) E, G, F, H
(C) H, F, G, E
(D) H, E, F, G

45. Four circles of unit radius each are drawn such that each one touches two others and their centres lie on the vertices of a square. The area of the region enclosed between the circles is :

(A) π-1
(B) π-2
(C) 4-π
(D) 3-π

46. A film projector and microscope give equal magnification. But a film projector is not used to see living cells because :

(A) a living cell cannot be placed in a film projector.
(B) the viewer's eye is close to a microscope whereas it is far away from the projector's screen.
(C) a microscope produces a virtual image whereas a projector produces a real image.
(D) a microscope has greater resolving power than a projector.

47. Comparing numerical values, which of the following is different from the rest ?

(A) The ratio of the circumference of a circle to its diameter.
(B) The sum of the three angles of a plane triangle expressed in radians.
(C) 22/7.
(D) The net volume of a hemisphere of unit radius, and a cone of unit radius and unit height.

48. Seeds when soaked in water gain about 20% by weight and 10% by volume. By what factor does the density increase ?

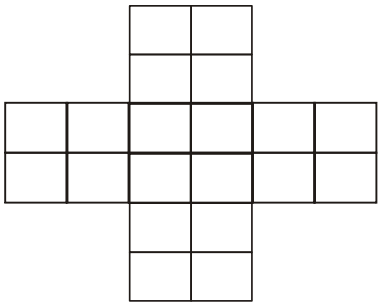
(A) 1.20

(B) 1.10

(C) 1.11

(D) 1.09

49.



The number of squares in the above figure is :

(A) 30 (B) 29

(C) 25 (D) 20

50. Five persons A, B, C, D, and E are sitting in a row with C in the middle of the group. If D is at an extreme end and there are at least two persons between B and E, then which of the following statements is *incorrect* ?

(A) E can be on extreme left

(B) E can be on extreme right

(C) A cannot be on extreme left

(D) A is always a neighbour of B or D

MATERIALS SCIENCE & NANOTECHNOLOGY

51. What type(s) of bonding would be expected for brass (a copper–zinc alloy) ?

(A) Ionic bonding

(B) Metallic bonding

(C) Covalent bonding with some van der Waals bonding

(D) van der Waals bonding

52. Atomic packing factor for the FCC crystal structure :

(A) 0.74 (B) 0.68

(C) 0.34 (D) 0.52

53. For a metal that has an electrical conductivity of $6.1\times10^{7}(\Omega.m)^{-1}$, what is the resistance of a wire that is 4.3 mm in diameter and 8.1 m long ?

(A) $3.93\times10^{-5}\ \Omega$ (B) $2.29\times10^{-3}\ \Omega$

(C) $9.14\times10^{-2}\ \Omega$ (D) $1.46\times10^{11}\ \Omega$

54. For an *n*-type semiconductor, where is the Fermi level located ?

(A) In the valence band

(B) In the band gap just above the top of valence band

(C) In the middle of the band gap

(D) In the band gap just below the bottom of the conduction band

55. Which of the following oxides would you expect to form substitutional solid solutions that have complete solubility with MgO ?

(A) FeO (B) BaO

(C) PbO (D) Li_2O

56. Which one of the following arrangements for the sequence of the main components of UV/Visible spectrophotometer is *correct* ?

(A) Light source $\rightarrow$ Monochromator $\rightarrow$ Sample cell $\rightarrow$ Detector $\rightarrow$ Readout

(B) Light source $\rightarrow$ Detector $\rightarrow$ Sample cell $\rightarrow$ Monochromator $\rightarrow$ Readout

(C) Light source $\rightarrow$ Sample cell $\rightarrow$ Detector $\rightarrow$ Monochromator $\rightarrow$ Readout

(D) Light source $\rightarrow$ Readout $\rightarrow$ Sample cell $\rightarrow$ Detector $\rightarrow$ Monochromator

57. The technique used to identify a functional group in an organic molecule is :

(A) X-ray fluorescence

(B) Transmission Electron Microscope

(C) X-ray Diffraction

(D) Infrared Spectrometry

58. Ground state energy of an electron in C.B. of a Cubical dot of edge L is :

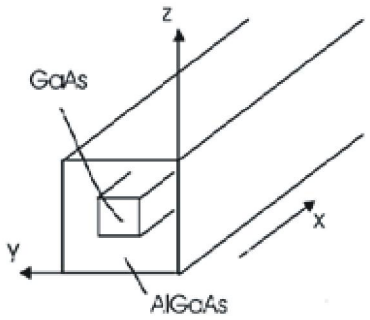
(A) $\frac{5\hbar^2\pi^2}{2m_eL^2}$

(B) $\frac{5\hbar^2\pi^2}{m_eL^2}$

(C) $\frac{3\hbar^2\pi^2}{2m_eL^2}$

(D) $\frac{3\hbar^2\pi^2}{m_eL^2}$

59. What is the name of the quantum confined structure shown below :



(A) Quantum Well (B) Quantum Wire

(C) Quantum Dot (D) None of these

60. Internal structure of specimen can be observed by :

(A) TEM (B) SEM

(C) STM (D) AFM

61. Technique(s) used for the determination of elemental analysis or chemical composition of the sample is/are :

(A) X-ray fluorescence analysis (XRF)

(B) X-ray energy dispersive analysis(EDAX/EDX)

(C) X-ray wavelength dispersion spectroscopy (WDX)

(D) All of the above

62. The technique, which relies upon the inelastic light scattering phenomenon and not upon absorption is :

(A) IR spectroscopy (B) Optical spectroscopy

(C) Raman spectroscopy (D) None of these

63. Which of the following techniques suitable for growth of CNTs ?

(A) Molecular beam epitaxy (B) Electrochemical deposition

(C) Thermilysis (D) Arc plasma discharge

64. Which of the following methods of lithography gives the highest resolution of the feature side of the devices ?

(A) Electron beam lithography (B) X-ray lithography

(C) Photolithography (D) Nano-sphere lithography

65. With a decrease in particle size, the percentage of atoms present on the surface and surface reactivity :

(A) Increases, Increases (B) Decreases, Decreases

(C) Increases, Decreases (D) Decreases, Increases

66. Carbon atoms in CNTs are :

(A) sp^3 hybridized (B) sp^2 hybridized

(C) sp hybridized (D) none of these

67. Which term includes all the others in the list ?

(A) Monosaccharide (B) Carbohydrate

(C) Polysaccharide (D) Starch

68. Which of the following is *not* a protein ?

(A) Haemoglobin (B) Cholesterol

(C) An enzyme (D) Insulin

69. Genetic mutation occurs at :

(A) DNA (B) RNA

(C) Proteins (D) Nucleus

70. Which of the following provides the best evidence that cell signalling pathways evolved early in the history of life ?

(A) They are seen in primitive cells such as yeast

(B) Signal transduction molecules found in distantly related organisms are similar

(C) Signal can be sent long distances by cells

(D) Most signals are received by signal receptors

71. The synthesis of glucose from fats is known as :

(A) Glycolysis (B) Kerb cycle

(C) Saponification (D) Gluconeogenesis

72. A specimen of steel has a rectangular cross-section 20 mm wide and 40 mm thick, a shear modulus of 207 GPa, and a Poisson's ratio of 0.30. If this specimen is pulled in tension with a force of 60,000 N, what is the change in width if deformation is totally elastic ?

(A) Increase in width of 3.62×10^{-6} m

(B) Decrease in width of 7.24×10^{-6} m

(C) Increase in width of 7.24×10^{-6} m

(D) Decrease in width of 2.18×10^{-6} m

73. Which of the following are the two primary constituents of clays ?

(A) Alumina (Al_2O_3) and limestone ($CaCO_3$)

(B) Limestone ($CaCO_3$) and cupric oxide (CuO)

(C) Silica (SiO_2) and limestone ($CaCO_3$)

(D) Alumina (Al_2O_3) and silica (SiO_2)

74. How do the densities compare for crystalline and amorphous polymers of the same material that have identical molecular weights ?

(A) Density of crystalline polymer < density of amorphous polymer

(B) Density of crystalline polymer = density of amorphous polymer

(C) Density of crystalline polymer > density of amorphous polymer

(D) Cannot say anything

75. An infrared LED is optically coupled to a photodiode. When the LED is turned off, the reading on an ammeter in series with the reverse-biased photodiode will :

(A) Not change (B) Decrease

(C) Increase (D) Fluctuate

76. The MOSFET is :

(A) an uni-polar device

(B) a voltage-controlled device

(C) both (A) and (B)

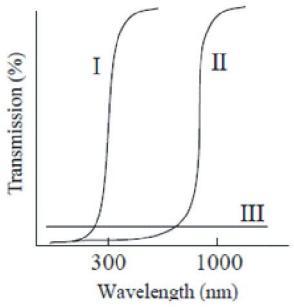
(D) a current-controlled device

77. The potential of a diatomic molecule as a function of the distance r between the atoms is given by $V(r) = -\frac{a}{r^6} + \frac{b}{r^{12}}$. The value of the potential at equilibrium separation between the atoms is :

(A) $-\frac{4a^2}{b}$ (B) $-\frac{2a^2}{b}$

(C) $-\frac{a^2}{2b}$ (D) $-\frac{a^2}{4b}$

78. The experimentally measured transmission spectra of metal, insulator and semiconductor thin films are shown in the figure. It can be inferred that I, II and III correspond, respectively, to :



(A) Semiconductor, metal and insulator

(B) Metal, semiconductor and insulator

(C) Insulator, semiconductor and metal

(D) Insulator, metal and semiconductor

79. An electrochemical cell is composed of pure nickel and pure iron electrodes immersed in solutions of their divalent ions. If the concentrations of Ni^{2+} and Fe^{2+} ions are 0.002 M and 0.40 M, respectively, what voltage is generated at 25°C ? (The respective standard reduction potentials for Ni and Fe are –0.25 V and –0.44 V) :

(A) –0.76 V (B) +0.12 V

(C) –0.26 V (D) +0.76 V

80. An ionic compound has a unit cell consisting of X ions at the corners of cube and Y ions at the centres of the faces of the cube. The empirical formula of the compound would be :

(A) XY_3 (B) X_3Y

(C) XY_2 (D) X_2Y

81. Which statement is *incorrect* in context of Specific heat of a material ?

(A) Constant for a material

(B) Extrinsic property

(C) Heat capacity per unit mass

(D) Has a unit as J/kg-K.

82. Which of the following gas molecules would you expect to have the largest molar specific heat ?

(A) C_6H_6 (B) CH_4

(C) O_2 (D) Ar

83. A piece of copper and the other of germanium are cooled from room temperature to 100 K. What will happen to their conductivities ?

(A) Conductivity of copper decreases while conductivity of germanium, increases

(B) Conductivity of copper increases while conductivity of germanium decreases

(C) Conductivity of both increases

(D) Conductivity of both decreases

84. The total area under the stress-strain curve of a mild steel specimen tested up to failure under tension is a measure of :

(A) Ductility (B) Ultimate strength

(C) Stiffness (D) Toughness

85. A steel bar of 40 mm × 40 mm square cross-section is subjected to an axial compressive load of 100 kN. If the length of the bar is 2 m and E = 200 GPa, the elongation of the bar will be :

(A) 0.625 mm (B) 2.70 mm

(C) 4.05 mm (D) 5.40 mm

86. Fermi velocity (V_f) of electrons in Cs metal is 0.73×10^6 m/s. What would the Fermi temperature (T_f) ?

(A) 1.25×10^4 K (B) 1.75×10^4 K

(C) 500 K (D) 3.75×10^4

87. A particle of mass *m* is confined in one-dimensional infinite well of width L. The probability of finding the particle in first half of the well in 1st excited state is :

(A) 25% (B) 35%

(C) 30% (D) 50%

88. The ratio of de-Broglie wavelengths of He-atom and H-atom at room temperature, when they move with their thermal velocities is

(A) $\frac{\lambda_{He}^{de-Broglie}}{\lambda_{H}^{de-Broglie}} = \frac{1}{2}$ (B) $\frac{\lambda_{He}^{de-Broglie}}{\lambda_{H}^{de-Broglie}} = 2$

(C) $\frac{\lambda_{He}^{de-Broglie}}{\lambda_{H}^{de-Broglie}} = \frac{1}{4}$ (D) $\frac{\lambda_{He}^{de-Broglie}}{\lambda_{H}^{de-Broglie}} = 4$

89. The work function of tungsten is 4.53 eV. If ultraviolet light of wavelength 1.5×10^{-7} m is incident on its surface, what would be the K.E. of the emitted electron ?

(A) 3.75 eV (B) 1.25 eV

(C) 2.75 eV (D) 8.28 eV

90. If a charged particle of mass *m* is accelerated through a potential difference of V volts, the de-Broglie wavelength is proportional to :

(A) V (B) $V^{-1/2}$

(C) V^2 (D) $V^{1/2}$

91. X-rays can be deflected by :

(A) Magnetic field (B) Electric field

(C) Both A and B (D) Cannot be deflected

92. Root mean square speed of oxygen molecule at 0°C is :

(A) 461 m/s (B) 332 m/s

(C) 3×10^6 m/s (D) 166 m/s

93. Consider the Sun as a blackbody at a temperature of 6000 K, what would be estimate of total radiation that consist of yellow light between 570 nm to 590 nm ?

(A) 2.5 % (B) 4.5 %

(C) 3.5 % (D) 5.0 %

94. The ratio of diffusion coefficient for copper in aluminum (D_{300K}/D_{600K}) would be, if Pre-exponential and activation energy values for this system are 6.5×10^{-5} m^2/s and 136,000 J/mol, respectively :

(A) $\exp\left(-\frac{136000}{300K_B}\right)$ (B) $\exp\left(-\frac{136000}{600K_B}\right)$

(C) $\exp\left(\frac{136000}{600K_B}\right)$ (D) $\exp\left(\frac{136000}{300K_B}\right)$

95. Which of the following scales belongs to MEMS devices ?

(A) Macroscopic scale (B) Nanometer scale

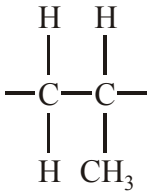
(C) Microscopic scale (D) Astronomical scale

96. Crystal structure analysis can be performed using :

(A) X-ray diffraction (B) Electron diffraction

(C) Both A and B (D) None of the above

97. What is the name of the polymer represented by the following repeat unit ?



(A) Poly (methyl methacrylate)

(B) Polyethylene

(C) Polypropylene

(D) Polystyrene

98. According to Maxwell's law of distribution of velocities of molecules, the most probable velocity is :

(A) Greater than the average velocity

(B) Equal to the average velocity

(C) Equal to root mean square velocity

(D) Less than the root mean square velocity

99. The quantum statistics reduces to classical under the following condition :

(A) $\rho\lambda^3 \approx 1$

(B) $\rho\lambda^3 \gg 1$

(C) $\rho\lambda^3 \ll 1$

(D) $\rho = 0$

100. According to Debye's theory of specific heat, the specific heat at low and high temperature are proportional to :

(A) T^3 and Independent of T respectively

(B) Independent of T and T^3 respectively

(C) T^2 and T respectively

(D) T and T^2 respectively