

# KISHORE VAIGYANIK PRO TSAHAN YOJANA (KVPY)

## STREAM – SB/SX

### **INSTRUCTIONS:**

1. Immediately fill the particulars on this page of the Test Booklet with Blue / Black Ball Point Pen. Use of pencil is strictly prohibited.
2. The Test Booklet consists of 120 questions.
3. There are Two parts in the question paper. The distribution of marks subjectwise in each part is as under for each correct response.

### **MARKING SCHEME :**

#### **PART-I :**

##### **MATHEMATICS**

Question No. 1 to 20 consist of ONE (1) mark for each correct response.

##### **PHYSICS**

Question No. 21 to 40 consist of ONE (1) mark for each correct response.

##### **CHEMISTRY**

Question No. 41 to 60 consist of ONE (1) mark for each correct response.

##### **BIOLOGY**

Question No. 61 to 80 consist of ONE (1) mark for each correct response.

#### **PART-II :**

##### **MATHEMATICS**

Question No. 81 to 90 consist of TWO (2) marks for each correct response.

##### **PHYSICS**

Question No. 91 to 100 consist of TWO (2) marks for each correct response.

##### **CHEMISTRY**

Question No. 101 to 110 consist of TWO (2) marks for each correct response.

##### **BIOLOGY**

Question No. 111 to 120 consist of TWO (2) marks for each correct response.

4. Candidates will be awarded marks as stated above in Instructions No. 3 for correct response of each question. For Part-I 0.25 marks will be deducted for indicating incorrect response of each question and for Part-II 0.50 marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the Answer sheet.
5. No candidate is allowed to carry any textual material, printed or written, bits of papers, paper, mobile phone, any electronic device, etc., except the Admit Card inside the examination hall/room.
6. Rough work is to be done on the space provided for this purpose in the Test Booklet only. This space is given at the bottom of each page.
7. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator on duty in the Room/Hall. However, the candidates are allowed to take away this Test Booklet with them.
8. Do not fold or make any stray marks on the Answer Sheet.

**PART-I**

**ONE MARK QUESTIONS**

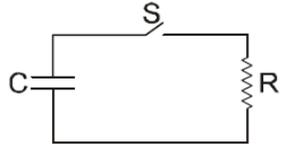
**MATHEMATICS**

- Three children, each accompanied by a guardian, seek admission in a school. The principal wants to interview all the 6 persons one after the other, subject to the condition that no child is interviewed before its guardian. In how many ways can this be done ?  
 (A) 60 (B) 90 (C) 120 (D) 180
- In the real number system, the equation  $\sqrt{x+3} - 4\sqrt{x-1} + \sqrt{x+8} - 6\sqrt{x-1} = 1$  has  
 (A) No solution (B) Exactly two distinct solutions  
 (C) Exactly four distinct solutions (D) Infinitely many solutions
- The maximum value  $M$  of  $3^x + 5^x - 9^x + 15^x - 25^x$ , as  $x$  varies over reals, satisfies :  
 (A)  $3 < M < 5$  (B)  $0 < M < 2$  (C)  $9 < M < 25$  (D)  $5 < M < 9$
- Suppose two perpendicular tangents can be drawn from the origin to the circle  $x^2 + y^2 - 6x - 2py + 17 = 0$ , for some real  $p$ . Then  $|p|$  is equal to  
 (A) 0 (B) 3 (C) 5 (D) 17
- Let  $a, b, c, d$  be numbers in the set  $\{1, 2, 3, 4, 5, 6\}$  such that the curves  $y = 2x^3 + ax + b$  and  $y = 2x^3 + cx + d$  have no point in common. The maximum possible value of  $(a - c)^2 + b - d$  is  
 (A) 0 (B) 5 (C) 30 (D) 36
- Consider the conic  $ex^2 + \pi y^2 - 2e^2x - 2\pi^2y + e^3 + \pi^3 = \pi e$ . Suppose  $P$  is any point on the conic and  $S_1, S_2$  are the foci of the conic, then the maximum value of  $(PS_1 + PS_2)$  is :  
 (A)  $\pi e$  (B)  $\sqrt{\pi e}$  (C)  $2\sqrt{\pi}$  (D)  $2\sqrt{e}$
- Let  $f(x) = \frac{\sin(x-a) + \sin(x+a)}{\cos(x-a) - \cos(x+a)}$ , then  
 (A)  $f(x+2\pi) = f(x)$  but  $f(x+\alpha) \neq f(x)$  for any  $0 < \alpha < 2\pi$   
 (B)  $f$  is a strictly increasing function  
 (C)  $f$  is strictly decreasing function  
 (D)  $f$  is constant function
- The value of  $\tan 81^\circ - \tan 63^\circ - \tan 27^\circ + \tan 9^\circ$  is :  
 (A) 0 (B) 2 (C) 3 (D) 4

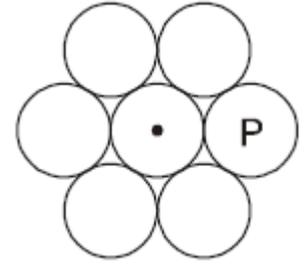
9. The mid-point of the domain of the function  $f(x) = \sqrt{4 - \sqrt{2x + 5}}$  for real  $x$  is  
 (A)  $\frac{1}{4}$  (B)  $\frac{3}{2}$  (C)  $\frac{2}{3}$  (D)  $-\frac{2}{5}$
10. Let  $n$  be a natural number and let  $a$  be a real number. The number of zeros of  $x^{2n+1} - (2n + 1)x + a = 0$  in the interval  $[-1, 1]$  is :  
 (A) 2 if  $a > 0$  (B) 2 if  $a < 0$   
 (C) At most one for every value of  $a$  (D) At least three for every value of  $a$
11. Let  $f : \mathbb{R} \rightarrow \mathbb{R}$  be the function  $f(x) = (x - a_1)(x - a_2) + (x - a_2)(x - a_3) + (x - a_3)(x - a_1)$  with  $a_1, a_2, a_3 \in \mathbb{R}$ . Then  $f(x) \geq 0$  if and only if  
 (A) at least two of  $a_1, a_2, a_3$  are equal (B)  $a_1 = a_2 = a_3$   
 (C)  $a_1, a_2, a_3$  are all distinct (D)  $a_1, a_2, a_3$  are all positive and distinct
12. The value  $\frac{\int_0^{\pi/2} (\sin x)^{\sqrt{2}+1} dx}{\int_0^{\pi/2} (\sin x)^{\sqrt{2}-1} dx}$  is:  
 (A)  $\frac{\sqrt{2}+1}{\sqrt{2}-1}$  (B)  $\frac{\sqrt{2}-1}{\sqrt{2}+1}$  (C)  $\frac{\sqrt{2}+1}{\sqrt{2}}$  (D)  $2 - \sqrt{2}$
13. The value  $\int_{-2012}^{2012} (\sin(x^3) + x^5 + 1) dx$  is:  
 (A) 2012 (B) 2013 (C) 0 (D) 4024
14. Let  $[x]$  and  $\{x\}$  be the integer part and fractional part of a real number  $x$  respectively. The value of the integral  $\int_0^5 [x]\{x\} dx$  is:  
 (A)  $5/2$  (B) 5 (C) 34.5 (D) 35.5
15. Let  $S_n = \sum_{k=1}^n k$  denote the sum of the first  $n$  positive integers. The numbers  $S_1, S_2, S_3, \dots, S_{99}$  are written on 99 cards. The probability of drawing a card with an even number written on it is:  
 (A)  $\frac{1}{2}$  (B)  $\frac{49}{100}$  (C)  $\frac{49}{99}$  (D)  $\frac{48}{99}$
16. A purse contains 4 copper coins and 3 silver coins. A second purse contain 6 copper coins and 4 silver coins. A purse is chosen randomly and a coin is taken out of it. What is the probability that it is a copper coin ?  
 (A)  $\frac{41}{70}$  (B)  $\frac{31}{70}$  (C)  $\frac{27}{70}$  (D)  $\frac{1}{3}$

17. Let H be the orthocenter of an acute-angled triangle ABC and O be its circumcentre. Then  $\overline{HA} + \overline{HB} + \overline{HC}$
- (A) is equal to  $\overline{HO}$  (B) is equal to  $3\overline{HO}$   
 (C) is equal to  $2\overline{HO}$  (D) is not a scalar multiple of  $\overline{HO}$  is general
18. The number of ordered pairs (m, n), where  $m, n \in \{1, 2, 3, \dots, 50\}$ , such that  $6^m + 9^n$  is a multiple of 5 is :
- (A) 1250 (B) 2500 (C) 625 (D) 500
19. Suppose  $a_1, a_2, a_3, \dots, a_{2012}$  are integers arranged on a circle. Each number is equal to the average of its two adjacent numbers. If the sum of all even indexed numbers is 3018, what is the sum of all numbers.
- (A) 0 (B) 1509 (C) 3018 (D) 6036
20. Let  $S = \{1, 2, 3, \dots, n\}$  and  $A = \{(a, b) \mid 1 \leq a, b \leq n\} = S \times S$ . A subset B of A is said to be a good subset if  $(x, x) \in B$  for every  $x \in S$ . Then the number of good subsets of A is :
- (A) 1 (B)  $2^n$  (C)  $2^{n(n-1)}$  (D)  $2^{n^2}$

### PHYSICS

21. An ideal monatomic gas expands to twice its volume. If the process is isothermal, the magnitude of work done by the gas is  $W_i$ . If the process is adiabatic, the magnitude of work done by the gas is  $W_a$ . Which of the following is true ?
- (A)  $W_i = W_a > 0$  (B)  $W_i > W_a = 0$  (C)  $W_i > W_a > 0$  (D)  $W_a > W_i = 0$
22. The capacitor of capacitance C in the circuit shown is fully charged initially. Resistance is R. After the switch S is closed, the time taken to reduce the stored energy in the capacitor to half its initial value is :
- 
- (A)  $RC_2$  (B)  $RC$  (C)  $\ln 2 \cdot 2RC \cdot \ln 2$  (D)  $\frac{RC \ln 2}{2}$
23. A liquid drop placed on a horizontal plane has a near spherical shape (slightly flattened due to gravity). Let R be the radius of its largest horizontal section. A small disturbance cause the drop to vibrate with frequency  $\nu$  about its equilibrium shape. By dimensional analysis the ratio  $\frac{\nu}{\sqrt{\sigma / \rho R^3}}$  can be (Here  $\sigma$  is density, g is acceleration due to gravity, and k is an arbitrary dimensionless constant.)
- (A)  $k\rho g R^2 / \sigma$  (B)  $k\rho R^3 / g\sigma$  (C)  $k\rho R^2 / g\sigma$  (D)  $k\rho / g\sigma$

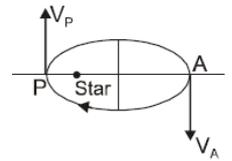
24. Seven identical coins are rigidly arranged on a flat table in the pattern shown so that each coin touches its neighbors. Each coin is a thin disc of mass  $m$  and radius  $r$ . Note that the moment of inertia of an individual coin about an axis passing through centre and perpendicular to the plane of the coin is  $mr^2/2$ .



The moment of inertia of the system of seven coins about an axis that passes through the point P (the centre of the coin positioned directly to the right of the central coin) and perpendicular to the plane of the coins is :

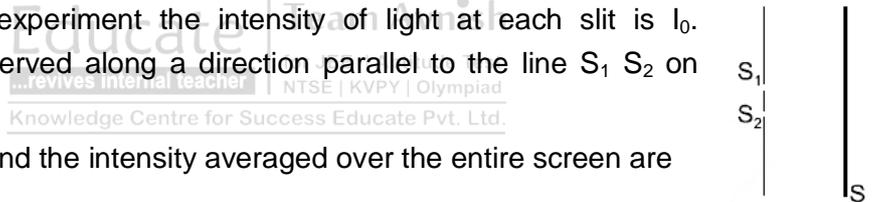
- (A)  $\frac{55}{2}mr^2$       (B)  $\frac{127}{2}mr^2$       (C)  $\frac{111}{2}mr^2$       (D)  $55mr^2$

25. A planet orbits in an elliptical path of eccentricity  $e$  round a massive star considered fixed at one of the foci. The point in space where it is closest to the star is denoted by P and the point where it is farthest is denoted by A. Let  $v_p$  and  $v_A$  be the respective speeds at P and A. Then



- (A)  $\frac{v_p}{v_A} = \frac{1+e}{1-e}$       (B)  $\frac{v_p}{v_A} = 1$       (C)  $\frac{v_p}{v_A} = \frac{1+e^2}{1-e}$       (D) None of these

26. In a young's double slit experiment the intensity of light at each slit is  $I_0$ . Interference pattern is observed along a direction parallel to the line  $S_1 S_2$  on screen S.

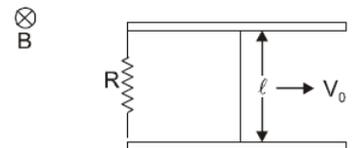


The minimum, maximum, and the intensity averaged over the entire screen are respectively.

- (A)  $0, 4I_0, 2I_0$       (B)  $I_0, 2I_0, 3I_0/2$       (C)  $0, 4I_0I_0$       (D)  $0, 2I_0, I_0$
27. A loop carrying current  $i$  has the shape of a regular polygon of  $n$  sides. If  $R$  is the distance from the centre to any vertex, then the magnitude of the magnetic induction vector  $\vec{B}$  at the centre of the loop is:

- (A)  $n \frac{\mu_0 i}{2\pi R} \tan \frac{\pi}{n}$       (B)  $n \frac{\mu_0 i}{2\pi R} \tan \frac{2\pi}{n}$       (C)  $\frac{\mu_0 i}{2R}$       (D)  $\frac{\mu_0 i}{\pi R} \tan \frac{\pi}{n}$

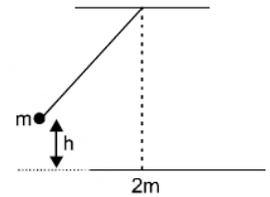
28. A conduction rod of mass  $m$  and length  $\ell$  is free to move without friction on two parallel long conducting rails, as shown below. There is a resistance  $R$  across the rails. In the entire space around, there is a uniform magnetic field  $B$  normal to the plane of the rod and rails. The rod is given an impulsive velocity  $V_0$ .



Finally, the initial energy  $\frac{1}{2}mv_0^2$

- (A) Will be converted fully into heat energy in the resistor  
 (B) Will enable rod to continue to move with velocity  $v_0$  since the rails are frictionless  
 (C) Will be converted fully into magnetic energy due to induced current  
 (D) Will be converted into the work done against the magnetic field
29. A steady current  $I$  flows through a wire of radius  $r$ , length  $L$  and resistivity  $\rho$ . The current produces heat in the wire. The rate of heat loss in a wire is proportional to its surface area. The steady temperature of the wire is independent of :
- (A)  $L$                       (B)  $r$                       (C)  $I$                       (D)  $\rho$
30. The ratio of the speed of sound to the average speed of an air molecule at 300K and 1 atmospheric pressure is close to :
- (A) 1                      (B)  $\sqrt{300}$                       (C)  $\sqrt{1/300}$                       (D) 300
31. In one model of the electron, the electron of mass  $m_e$  is thought to be a uniformly charged shell of radius  $R$  and total charge  $e$ , whose electrostatic energy  $E$  is equivalent to its mass  $m_e$  via Einstein's mass energy relation  $E = m_e c^2$ . In this model,  $R$  is approximately ( $m_e = 9.1 \times 10^{-31}$  kg,  $c = 3 \times 10^8$  m.s $^{-1}$ ,  $1/4 \pi \epsilon_0 = 9 \times 10^9$  Farads.m $^{-1}$ , magnitude of the electron charge =  $1.6 \times 10^{-19}$  C)
- (A)  $1.4 \times 10^{-15}$  m      (B)  $2 \times 10^{-13}$  m      (C)  $5.3 \times 10^{-11}$  m      (D)  $2.8 \times 10^{-35}$  m
32. A body is executing simple harmonic motion of amplitude  $a$  and period  $T$  about the equilibrium position  $x = 0$ . Large numbers of snapshots are taken at random of this body in motion. The probability of the body being found in a very small interval  $x$  to  $x + |dx|$  is highest at :
- (A)  $x = \pm a$                       (B)  $x = 0$                       (C)  $x = \pm a / 2$                       (D)  $x = \pm a / \sqrt{2}$
33. Two identical bodies are made of a material for which the heat capacity increases with temperature. One of these is held at a temperature of 100°C while the other one is kept at 0°C. If the two are brought into contact, then, assuming no heat loss to the environment, the final temperature that they will reach is :
- (A) 50°C                      (B) more than 50°C      (C) less than 50°C      (D) 0°C
34. A particle is acted upon by a force given by  $F = -\alpha x^3 - \beta x^4$  where  $\alpha$  and  $\beta$  are positive constants. At the point  $x = 0$ , the particle is :
- (A) in stable equilibrium                      (B) in unstable equilibrium  
 (C) in neutral equilibrium                      (D) not in equilibrium
35. The potential energy of a point particle is given by the expression  $V(x) = \alpha x + \beta \sin(x / \gamma)$ . A dimensionless combination of the constants  $\alpha$ ,  $\beta$  and  $\gamma$  is :
- (A)  $\alpha/\beta\gamma$                       (B)  $\alpha^2/\beta\gamma$                       (C)  $\gamma/\alpha\beta$                       (D)  $\alpha\gamma/\beta$

36. A ball of mass  $m$  suspended from a rigid support by an inextensible massless string is released from a height  $h$  above its lowest point. At its lowest point it collides elastically with a block of mass  $2m$  at rest on a frictionless surface. Neglect the dimensions of the ball and the block. After the collision the ball rises to a maximum height of :



- (A)  $h/3$                       (B)  $h/2$                       (C)  $h/8$                       (D)  $h/9$

37. A particle released from rest is falling through a thick fluid under gravity. The fluid exerts a resistive force on the particle proportional to the square of its speed. Which one of the following graphs best depicts the variation of its speed  $v$  with time  $t$  ?



38. A cylindrical steel rod of length  $0.10$  m and thermal conductivity  $50 \text{ W m}^{-1} \text{ K}^{-1}$  is welded end to end to copper rod of thermal conductivity  $400 \text{ W m}^{-1} \text{ K}^{-1}$  and of the same area of cross section but  $0.20$  m long. The free end of the steel rod is maintained at  $100^\circ\text{C}$  and that of the copper rod at  $0^\circ\text{C}$ . Assuming that the rods are perfectly insulated from the surrounding, the temperature at the junction of the two rods is :

- (A)  $20^\circ$                       (B)  $30^\circ$                       (C)  $40^\circ$                       (D)  $50^\circ$

39. A parent nucleus  $X$  is decaying into daughter nucleus  $Y$  which in turn decays to  $Z$ . The half lives of  $X$  and  $Y$  are  $40000$  years and  $20$  years respectively. In a certain sample, it is found that the number of  $Y$  nuclei hardly changes with time. If the number of  $X$  nuclei in the sample is  $4 \times 10^{20}$ , the number of  $Y$  nuclei present in it is :

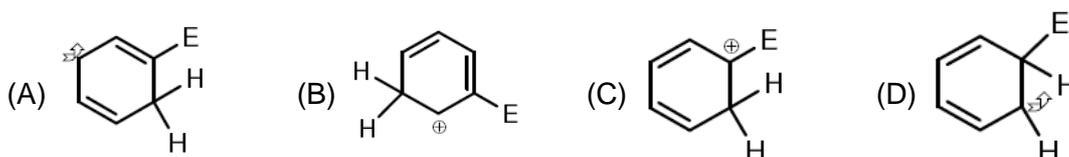
- (A)  $2 \times 10^{17}$                       (B)  $2 \times 10^{20}$                       (C)  $4 \times 10^{23}$                       (D)  $4 \times 10^{20}$

40. An unpolarized beam of light of intensity  $I_0$  passes through two linear polarizers making an angle of  $30^\circ$  with respect to each other. The emergent beam will have an intensity :

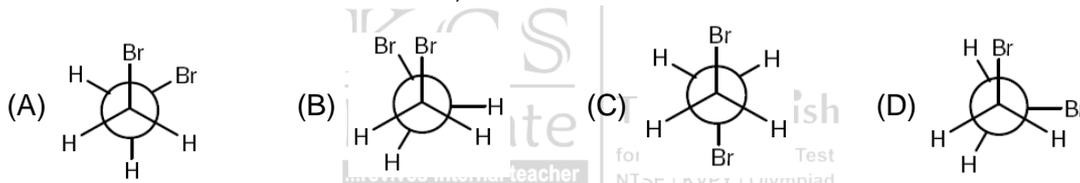
- (A)  $\frac{3I_0}{4}$                       (B)  $\frac{\sqrt{3}I_0}{4}$                       (C)  $\frac{3I_0}{8}$                       (D)  $\frac{I_0}{8}$

## CHEMISTRY

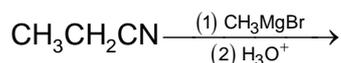
41. Among the following, the species with the highest bond order is :  
 (A)  $O_2$  (B)  $F_2$  (C)  $O_2^+$  (D)  $F_2^-$
42. The molecule with non-zero dipole moment is :  
 (A)  $BCl_3$  (B)  $BeCl_2$  (C)  $CCl_4$  (D)  $NCl_3$
43. For a one-electron atom, the set of allowed quantum numbers is :  
 (A)  $n = 1, \ell = 0, m_\ell = 0, m_s = +1/2$  (B)  $n = 1, \ell = 1, m_\ell = 0, m_s = +1/2$   
 (C)  $n = 1, \ell = 0, m_\ell = -1, m_s = -1/2$  (D)  $n = 1, \ell = 1, m_\ell = 1, m_s = -1/2$
44. In the reaction of benzene with an electrophile  $E^+$ , the structure of the intermediate  $\sigma$ -complex can be represented as :



45. The most stable conformation of 2,3-dibromobutane is :

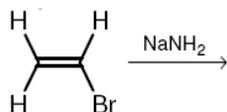


46. Typical electronic energy gaps in molecules are about 1.0 eV. In terms of temperature, the gap is closest to :  
 (A)  $10^2$  K (B)  $10^4$  K (C)  $10^3$  K (D)  $10^5$  K
47. The major final product in the following reaction is :



48. A zero-order reaction,  $A \rightarrow \text{Product}$ , with an initial concentration  $[A]_0$  has a half-life of 0.2 s. If one starts with the concentration  $2[A]_0$ , then the half-life is :  
 (A) 0.1 s (B) 0.4 s (C) 0.2 s (D) 0.8 s
49. The isoelectronic pair of ions is:  
 (A)  $Sc^{2+}$  and  $V^{3+}$  (B)  $Mn^{3+}$  and  $Fe^{2+}$  (C)  $Mn^{2+}$  and  $Fe^{3+}$  (D)  $Mi^{3+}$  and  $Fe^{2+}$

50. The major product in the following reaction is :



- (A)  $\text{H}-\text{C}\equiv\text{C}-\text{H}$       (B)  $\begin{array}{c} \text{H} & \text{H} \\ & \backslash / \\ & \text{C} = \text{C} \\ & / \backslash \\ \text{H} & \text{NH}_2 \end{array}$       (C)  $\begin{array}{c} \text{H}_2\text{C}-\text{CH}_2 \\ | & | \\ \text{H}_2\text{N} & \text{NH}_2 \end{array}$       (D)  $\text{H}_3\text{C}-\text{CH}_2-\text{NH}_2$

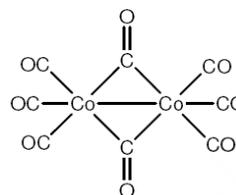
51. The major product of the following reaction is :



- (A)  $\text{HO}-\text{CH}_2-\text{CH}(\text{Br})-\text{CH}_3$       (B)  $\text{Br}-\text{CH}_2-\text{CH}=\text{CH}_2$       (C)  $\text{Br}-\text{CH}_2-\text{CH}=\text{CH}-\text{Br}$       (D)  $\text{H}_3\text{C}-\text{CH}(\text{Br})-\text{CH}_2-\text{Br}$

52. The oxidation state of cobalt in the following molecule is :

- (A) 3      (B) 1  
(C) 2      (D) 0



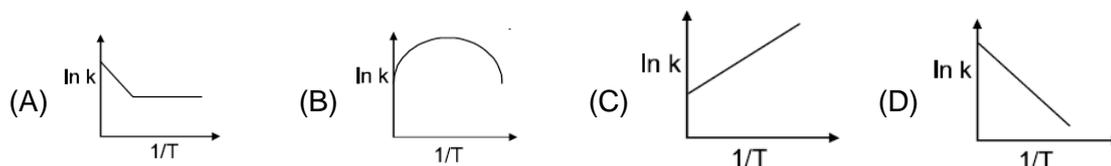
53. The pKa of a weak acid is 5.85. The concentrations of the acid and its conjugate base are equal at a pH of:

- (A) 6.85      (B) 5.85      (C) 4.85      (D) 7.85

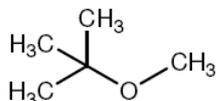
54. For a tetrahedral complex  $[\text{MCl}_4]^{2-}$ , the spin-only magnetic moments is 3.83 BM. The element M is :

- (A) Co      (B) Cu      (C) Mn      (D) Fe

55. Among the following graphs showing variation of rate (k) with temperature (T) for a reaction, the one that exhibits Arrhenius behavior over the entire temperature range is :

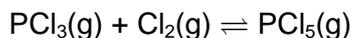
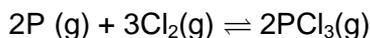


56. The reaction that gives the following molecule as the major product is :

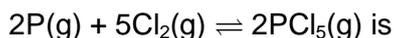


- (A)  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{H}_3\text{C}-\text{C}-\text{Br} \\ | \\ \text{H}_3\text{C} \end{array} + \text{CH}_3\text{ONa}$       (B)  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{H}_3\text{C}-\text{C}-\text{ONa} \\ | \\ \text{H}_3\text{C} \end{array} + \text{CH}_3\text{Br}$   
(C)  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{H}_3\text{C}-\text{C}-\text{OH} \\ | \\ \text{H}_3\text{C} \end{array} + \text{CH}_3\text{ONa}$       (D)  $\begin{array}{c} \text{H}_3\text{C} \\ \backslash \\ \text{C} = \text{CH}_2 \\ / \\ \text{H}_3\text{C} \end{array} + \text{CH}_3\text{ON}$

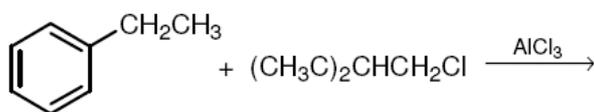
57. The C–O bond length in CO, CO<sub>2</sub>, and CO<sub>3</sub><sup>2-</sup> follows the order:  
 (A) CO < CO<sub>2</sub> < CO<sub>3</sub><sup>2-</sup> (B) CO<sub>2</sub> < CO<sub>3</sub><sup>2-</sup> < CO  
 (C) CO > CO<sub>2</sub> > CO<sub>3</sub><sup>2-</sup> (D) CO<sub>3</sub><sup>2-</sup> < CO<sub>2</sub> < CO
58. The equilibrium constant for the following reactions are K<sub>1</sub> and K<sub>2</sub>, respectively.



Then the equilibrium constant for the reaction



- (A) K<sub>1</sub>K<sub>2</sub> (B) K<sub>1</sub>K<sub>2</sub><sup>2</sup> (C) K<sub>1</sub><sup>2</sup>K<sub>2</sub><sup>2</sup> (D) K<sub>1</sub><sup>2</sup>K<sub>2</sub>
59. The major product of the following reaction is :



- (A) (B)
- (C) (D)

60. Doping silicon with boron produces a :  
 (A) n-type semiconductor (B) metallic conductor  
 (C) p-type semiconductor (D) insulator

### BIOLOGY

61. The disorders that arise when the immune system destroys 'self' cells are called autoimmune disorders. Which of the following would be classified under this ?  
 (A) rheumatoid arthritis (B) asthma  
 (C) rhinitis (D) eczema
62. Which of the following class of immunoglobulin can trigger the complement cascade ?  
 (A) IgA (B) IgM (C) IgD (D) IgE
63. Diabetes insipidus is due to :  
 (A) hypersecretion of vasopressin (B) hyposecretion of insulin  
 (C) hypersecretion of insulin (D) hyposecretion of vasopressin

64. Fossils are most often in which kind of rocks ?  
(A) meteorites (B) sedimentary rocks  
(C) igneous rocks (D) metamorphic rocks
65. Peptic ulcers are caused by :  
(A) a fungus, *Candida albicans* (B) a virus, cytomegalovirus  
(C) a parasite, *Trypanosoma brucei* (D) a bacterium *Helicobacter pylori*
66. Transfer RNA (tRNA)  
(A) is present in the ribosomes and provides structural integrity  
(B) usually has clover leaf-like structure  
(C) carries genetic information from DNA to ribosomes  
(D) codes for proteins
67. Some animals excrete uric acid in urine (uricotelic) as it requires very little water loss. Which animals among the following are most likely to be uricotelic ?  
(A) fishes (B) amphibians (C) birds (D) mammals
68. A ripe mango, kept with unripe mangoes causes their ripening. This is due to the release of a gaseous plant hormone.  
(A) auxin (B) gibberlin (C) cytokinine (D) ethylene
69. Human chromosomes undergo structural changes during the cell cycle. Chromosomal structure can be best visualized if a chromosome is isolated from a cell at :  
(A) G1 phase (B) S phase (C) G2 phase (D) M phase
70. By which of the following mechanisms is glucose reabsorbed from the glomerular filtrate by the kidney tubule ?  
(A) osmosis (B) diffusion (C) active transport (D) passive transport
71. In mammals, the hormones secreted by the pituitary, the master gland, is itself regulated by the pituitary, the master gland, is itself regulated by :  
(A) hypothalamus (B) median cortex (C) pineal gland (D) cerebrum
72. Which of the following is true TCA cycle in eukaryotes ?  
(A) takes place in mitochondrion (B) produces no ATP  
(C) takes place in Golgi complex (D) independent of electron transport chain
73. A hormone molecule binds to a specific protein on the plasma membrane inducing a signal. The protein it binds to is called :  
(A) ligand (B) antibody (C) receptor (D) histone

74. DNA mutations that do not cause any functional change in the protein product are known as :
- (A) nonsense mutations (B) missense mutations  
(C) deletion mutations (D) silent mutations
75. Plant roots are usually devoid of chlorophyll and cannot perform photosynthesis. However, there are exceptions. Which of the following plant root can perform photosynthesis ?
- (A) Arabidopsis (B) Tinospora (C) Rice (D) Hibiscus
76. Vitamin A deficiency leads to night-blindness. Which of the following is the reason for the disease ?
- (A) rod cells are not converted to cone cells  
(B) rhodopsin pigment of rod cells is defective  
(C) melanin pigment is not synthesized in cone cells  
(D) cornea of eye gets dried
77. In Dengue virus infection, patients often develop haemorrhagic fever due to internal bleeding. This happens due to the reduction of :
- (A) platelets (B) RBCs (C) WBCs (D) lymphocytes
78. If the sequence of bases in sense strand of DNA is 5' – GTTCATCG-3', then the sequence of bases in its RNA transcript would be :
- (A) 5'-GTTCATCG-3' (B) 5'-GUUCAUCG-3'  
(C) 5'-CAAGTAGC-3' (D) 5'-CAAGUAGC-3'
79. A reflex action is a quick involuntary response to stimulus. Which of the following is an example of BOTH, unconditioned and conditioned reflex ?
- (A) knee Jerk reflex  
(B) secretion of saliva in response to the aroma of food  
(C) sneezing reflex  
(D) contraction of pupil in response to bright light
80. In a food chain such as grass → deer → lion, the energy cost of respiration as a proportion of total assimilated energy at each level would be :
- (A) 60% - 30% - 20% (B) 20% - 30% - 60%  
(C) 20%- 60%- 30% (D) 30%- 30% - 30%

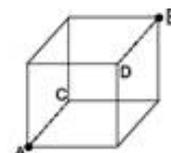
**PART-II**  
**TWO MARKS QUESTIONS**

**MATHEMATICS**

81. Suppose  $a, b, c$  are real numbers, and each of the equations  $x^2 + 2ax + b^2 = 0$  and  $x^2 + 2bx + c^2 = 0$  has two distinct real roots. Then the equation  $x^2 + 2cx + a^2 = 0$  has :  
 (A) two distinct positive real roots (B) two equal roots  
 (C) one positive and one negative root (D) no real roots
82. The coefficient of  $x^{2012}$  in  $\frac{1+x}{(1+x^2)(1-x)}$  is  
 (A) 2010 (B) 2011 (C) 2012 (D) 2013
83. Let  $(x, y)$  be a variable point on the curve  $4x^2 + 9y^2 - 8x - 36y + 15 = 0$ . Then  $\min(x^2 - 2x + y^2 - 4y + 5) + \max(x^2 - 2x + y^2 - 4y + 5)$  is :  
 (A)  $\frac{325}{36}$  (B)  $\frac{36}{325}$  (C)  $\frac{13}{25}$  (D)  $\frac{25}{13}$
84. The sum of all  $x \in [0, \pi]$  which satisfy the equation  $\sin x + \frac{1}{2}\cos x = \sin^2\left(x + \frac{\pi}{4}\right)$  is:  
 (A)  $\frac{\pi}{6}$  (B)  $\frac{5\pi}{6}$  (C)  $\pi$  (D)  $2\pi$
85. A polynomial  $P(x)$  with real coefficients has the property that  $P''(x) \neq 0$  for all  $x$ . Suppose  $P(0) = 1$  and  $P'(0) = -1$ . What can you say about  $P(1)$  ?  
 (A)  $P(1) \geq 0$  (B)  $P(1) \leq 0$  (C)  $P(1) \neq 0$  (D)  $-1/2 < P(1) < 1/2$
86. Define a sequence  $(a_n)$  by  $a_1 = 5, a_n = a_1 a_2 \dots a_{n-1} + 4$  for  $n > 1$ . Then  $\lim_{n \rightarrow \infty} \frac{\sqrt{a_n}}{a_{n-1}}$   
 (A) equals  $\frac{1}{2}$  (B) equal 1 (C) equals  $\frac{2}{5}$  (D) does not exist
87. The value of the integral  $\int_{-\pi}^{\pi} \frac{\cos^2 x}{1+a^x} dx$ , where  $a > 0$ , is:  
 (A)  $\pi$  (B)  $a\pi$  (C)  $\frac{\pi}{2}$  (D)  $2\pi$
88. Consider  
 $L = \sqrt[3]{2012} + \sqrt[3]{2013} + \dots + \sqrt[3]{3011}$   
 $R = \sqrt[3]{2013} + \sqrt[3]{2014} + \dots + \sqrt[3]{3012}$  and  $I = \int_{2012}^{3012} \sqrt[3]{x} dx$ . Then  
 (A)  $L + R < 2I$  (B)  $L + R = 2I$  (C)  $L + R > 2I$  (D)  $\sqrt{LR} = I$
89. A man tosses a coin 10 times, scoring 1 point for each head and 2 points for each tail. Let  $P(K)$  be the probability of scoring at least  $K$  points. The largest value of  $K$  such that  $P(K) > 1/2$  is :  
 (A) 14 (B) 15 (C) 16 (D) 17
90. Let  $f(x) = \frac{x+1}{x-1}$  for all  $x \neq 1$ . Let  $f^1(x) = f(x), f^2(x) = f(f(x))$  and generally  $f^n(x) = f(f^{n-1}(x))$  for  $n > 1$ . Let  $P = f^1(2)f^2(3)f^3(4)f^4(5)$ . Which of the following is a multiple of  $P$   
 (A) 125 (B) 375 (C) 250 (D) 147

## PHYSICS

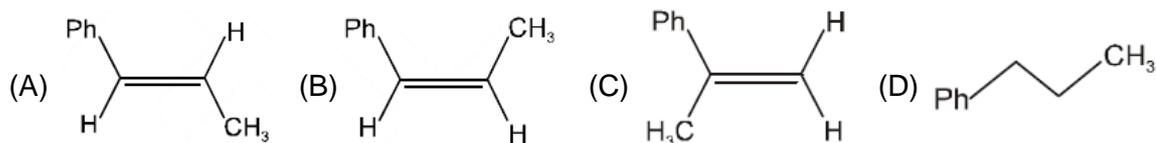
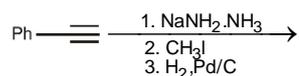
91. The total energy of a black body radiation source is collected for five minutes and used to heat water. The temperature of the water increases from  $10.0^{\circ}\text{C}$  to  $11.0^{\circ}\text{C}$ . The absolute temperature of the black body is doubled and its surface area halved and the experiment repeated for the same time. Which of the following statements would be most nearly correct ?  
 (A) The temperature of the water would increase from  $10.0^{\circ}\text{C}$  to a final temperature of  $12^{\circ}\text{C}$   
 (B) The temperature of the water would increase from  $10.0^{\circ}\text{C}$  to a final temperature of  $18^{\circ}\text{C}$   
 (C) The temperature of the water would increase from  $10.0^{\circ}\text{C}$  to a final temperature of  $14^{\circ}\text{C}$   
 (D) The temperature of the water would increase from  $10.0^{\circ}\text{C}$  to a final temperature of  $11^{\circ}\text{C}$
92. A small asteroid is orbiting around the sun in a circular orbit of radius  $r_0$  with speed  $V_0$ . A rocket is launched from the asteroid with speed  $V = \alpha V_0$ , where  $V$  is the speed relative to the sun. The highest value of  $\alpha$  for which the rocket will remain bound to the solar system (ignoring gravity due to the asteroid and effects of other planets).  
 (A)  $\sqrt{2}$                       (B) 2                      (C)  $\sqrt{3}$                       (D) 1
93. A radioactive nucleus A has a single decay mode with half life  $\tau_A$ . Another radioactive nucleus B has two decay modes 1 and 2. If decay mode 2 were absent, the half life of B would have been  $\tau_A/2$ . If decay mode 1 were absent, the half life of B would have been  $2\tau_A$ . If the actual half life of B is  $\tau_B$ , then the ratio  $\tau_B/\tau_A$  is :  
 (A)  $3/7$                       (B)  $7/2$                       (C)  $7/3$                       (D) 1
94. A stream of photons having energy 3 eV each impinges on a potassium surface. The work function of potassium is 2.3 eV. The emerging photo-electrons are slowed down by a copper plate placed 5 mm away. If the potential difference between the two metal plates is 1 V, the maximum distance the electrons can move away from the potassium surface before being turned back is :  
 (A) 3.5 mm                      (B) 1.5 mm                      (C) 2.5 mm                      (D) 5.0 mm
95. Consider three concentric metallic spheres A, B and C of radii  $a$ ,  $b$ ,  $c$  respectively where  $a < b < c$ . A and B are connected whereas C is grounded. The potential of the middle sphere B is raised to  $V$  then the charge on the sphere C is :  
 (A)  $-4\pi\epsilon_0 V \frac{bc}{c-b}$                       (B)  $+4\pi\epsilon_0 V \frac{bc}{c-b}$                       (C)  $-4\pi\epsilon_0 V \frac{ac}{c-a}$                       (D) Zero
96. On a bright sunny day a diver of height  $h$  stands at the bottom of a lake of depth  $H$ . Looking upwards, he can see objects outside the lake in a circular region of radius  $R$ . Beyond this circle he sees the images of objects lying on the floor of the lake. If refractive index of water is  $4/3$ , then the value of  $R$  is :  
 (A)  $3(H-h)/\sqrt{7}$                       (B)  $3h\sqrt{7}$                       (C)  $(H-h)/\sqrt{7/3}$                       (D)  $(H-h)/\sqrt{5/3}$
97. As shown in the figure below, a cube is formed with ten identical resistances  $R$  (thick lines) and two shorting wires (dotted lines) along the arms AC and BD. Resistance between point A and B is :  
 (A)  $R/2$                       (B)  $5R/6$                       (C)  $3R/4$                       (D)  $R$





## CHEMISTRY

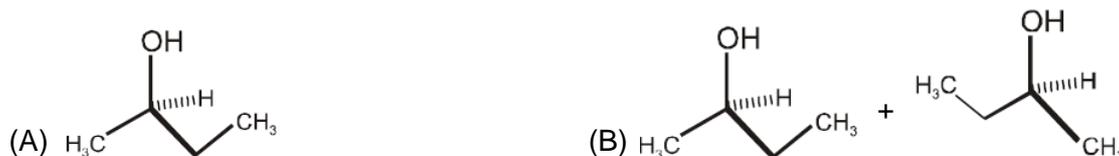
101. The final major product obtained in the following sequence of reaction is :



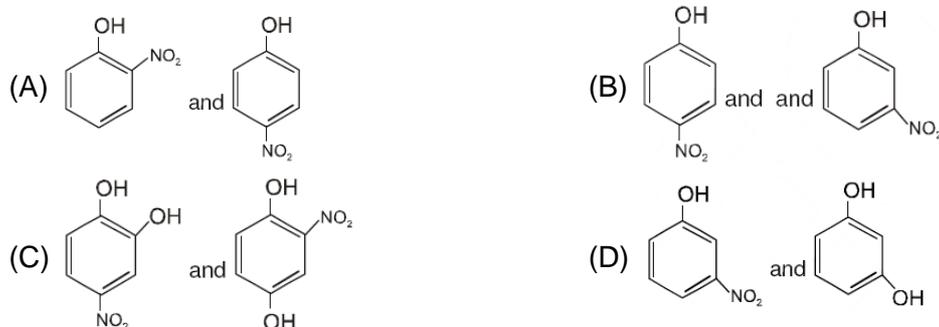
102. In the DNA of E. Coli the mole ratio of adenine to cytosine is 0.7. If the number of moles of adenine in the DNA is 350000, the number of moles of guanine is equal to :

- (A) 350000 (B) 500000 (C) 225000 (D) 700000

103. (R)-2-bromobutane upon treatment with aq. NaOH gives :



104. Phenol on treatment with dil.  $\text{HNO}_3$  gives two products P and Q. P is steam volatile but Q is not. P and Q are, respectively :



105. A metal is irradiated with light of wavelength 660 nm. Given that the work function of the metal is 1.0 eV, the de Broglie wavelength of the ejected electron is close to :

- (A)  $6.6 \times 10^{-7}$  m (B)  $8.9 \times 10^{-11}$  m (C)  $1.3 \times 10^{-9}$  m (D)  $6.6 \times 10^{-13}$  m

106. The inter-planar spacing between the (2 2 1) planes of a cubic lattice of length 450 pm is :

- (A) 50 pm (B) 150 pm (C) 300 pm (D) 450 pm

107. The  $\Delta H$  for vaporization of a liquid is 20 kJ/mol. Assuming ideal behaviour, the change in internal energy for the vaporization of 1 mol of the liquid at 60°C and 1 bar is close to :

- (A) 13.2 kJ/mol (B) 17.2 kJ/mol (C) 19.5 kJ/mol (D) 20.0 kJ/mol

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[15]

108. Among the following, the species that is both tetrahedral and diamagnetic is :  
 (A)  $[\text{NiCl}_4]^{2-}$  (B)  $[\text{Ni}(\text{CN})_4]^{2-}$  (C)  $\text{Ni}(\text{CO})_4$  (D)  $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$
109. Three moles of an ideal gas expands reversibly under isothermal condition from 2 L to 20 L at 300 K. The amount of heat-change (in kJ/mol) in the process is :  
 (A) 0 (B) 7.2 (C) 10.2 (D) 17.2
110. The following data are obtained for a reaction,  $X + Y \rightarrow \text{Products}$ .
- | Expt. | $[\text{X}_0] / \text{mol}$ | $[\text{Y}_0] / \text{mol}$ | rate / $\text{mol L}^{-1}\text{s}^{-1}$ |
|-------|-----------------------------|-----------------------------|---|
| 1.    | 0.25                        | 0.25                        | $1.0 \times 10^{-6}$                    |
| 2.    | 0.50                        | 0.25                        | $4.0 \times 10^{-6}$                    |
| 3.    | 0.25                        | 0.50                        | $8.0 \times 10^{-6}$                    |
- The overall order of the reaction is:  
 (A) 2 (B) 4 (C) 3 (D) 5

### BIOLOGY

111. When hydrogen peroxide is applied on the wound as a disinfectant, there is frothing at the site of injury, which is due to the presence of an enzyme in the skin that uses hydrogen peroxide as a substrate to produce :  
 (A) hydrogen (B) carbon Dioxide (C) water (D) oxygen
112. Persons suffering from hypertension (high blood pressure) are advised a low-salt diet because  
 (A) more salt is absorbed in the body of a patient with hypertension  
 (B) high salt leads to water retention in the blood that further increases the blood pressure  
 (C) high salt increases nerve conduction and increases  
 (D) high salt causes adrenaline release that increases blood pressure
113. Insectivorous plants that mostly grow on swampy soil use insects as a source of :  
 (A) carbon (B) nitrogen (C) phosphorous (D) magnesium
114. In cattle, the coat colour red and white are two dominant traits, which express equally in F1 to produce roan (red and white colour in equal proportion). If F1 progeny are self-bred, the resulting progeny in F2 will have phenotypic ratio (red : roan : white) is :  
 (A) 1 : 1 : 1 (B) 3 : 9 : 3 (C) 1 : 2 : 1 (D) 3 : 9 : 4
115. The restriction endonuclease EcoR-I recognises and cleaves DNA sequence as shown below :

5'-G A A T T C-3'

3' - C T T A A G-5'

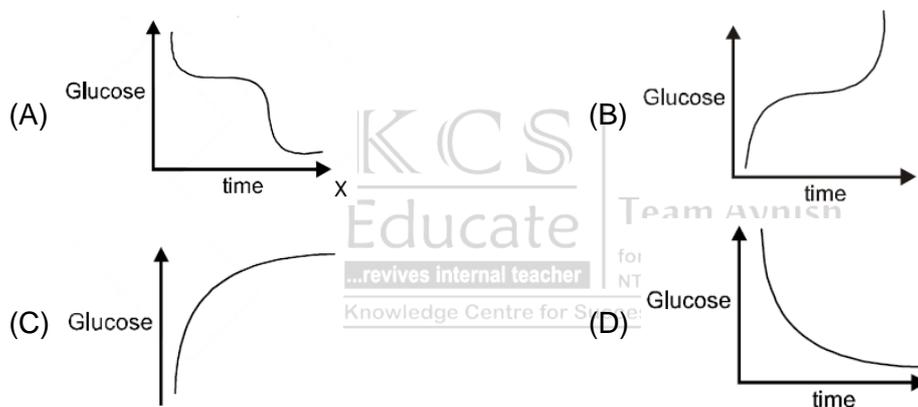
What is the probable number of cleavage sites that can occur in a 10 kb long random DNA sequence ?

- (A) 10 (B) 2 (C) 100 (D) 50

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116. Which one of the following is true about enzyme catalysis ?
- (A) the enzyme changes at the end of the reaction  
 (B) the activation barrier of the process is lower in the presence of an enzyme  
 (C) the rate of the reaction is retarded in the presence of an enzyme  
 (D) the rate of the reaction is independent of substrate concentration
117. *Vibrio cholerae* causes cholera in humans. Ganga water was once used successfully to combat the infection. The possible reason could be :
- (A) high salt content of Ganga water  
 (B) low salt content of Ganga water  
 (C) presence of bacteriophages in Ganga water  
 (D) presence of antibiotics in Ganga water
118. When a person begins to fast, after some time glycogen stored in the liver is mobilized as a source of glucose. Which of the following graphs best represents the change of glucose level (y axis) in his blood, starting from the time (x axis) when he begins to fast ?



119. The following sequence contains the open reading frame of a polypeptide. How many amino acids will the polypeptide consist of ?
- 5'-AGCATATGATCGTTTCTCTGCTTTGAACT-3'
- (A) 4                      (B) 2                      (C) 10                      (D) 7
120. Insects constitute the largest animals group on earth. About 25-30% of the insect species are known to be herbivores. In spite of such huge herbivore pressure, globally, green plants have persisted. One possible reason for this persistence is :
- (A) food presence of insects has tended to change with time  
 (B) herbivore insects have become inefficient feeders of green plants  
 (C) herbivore population has been kept in control by predators  
 (D) decline in reproduction of herbivores with time

## ANSWERS

1.	(B)	21.	(B)	41.	(C)	61.	(A)	81.	(D)	101.	(D)
2.	(D)	22.	(D)	42.	(D)	62.	(B)	82.	(A)	102.	(B)
3.	(B)	23.	(A)	43.	(A)	63.	(D)	83.	(A)	103.	(C)
4.	(C)	24.	(C)	44.	(D)	64.	(B)	84.	(C)	104.	(A)
5.	(B)	25.	(A)	45.	(C)	65.	(D)	85.	(C)	105.	(C)
6.	(C)	26.	(A)	46.	(C)	66.	(B)	86.	(C)	106.	(B)
7.	(D)	27.	(A)	47.	(B)	67.	(C)	87.	(C)	107.	(B)
8.	(D)	28.	(A)	48.	(B)	68.	(D)	88.	(A)	108.	(C)
9.	(B)	29.	(A)	49.	(C)	69.	(D)	89.	(B)	109.	(D)
10.	(C)	30.	(A)	50.	(A)	70.	(B)	90.	(B)	110.	(C)
11.	(B)	31.	(A)	51.	(D)	71.	(A)	91.	(B)	111.	(D)
12.	(D)	32.	(A)	52.	(D)	72.	(A)	92.	(A)	112.	(B)
13.	(D)	33.	(B)	53.	(B)	73.	(C)	93.	(A)	113.	(B)
14.	(B)	34.	(A)	54.	(A)	74.	(D)	94.	(A)	114.	(C)
15.	(C)	35.	(D)	55.	(D)	75.	(B)	95.	(A)	115.	(B)
16.	(A)	36.	(D)	56.	(B)	76.	(B)	96.	(A)	116.	(B)
17.	(C)	37.	(A)	57.	(A)	77.	(A)	97.	(A)	117.	(D)
18.	(B)	38.	(A)	58.	(B)	78.	(B)	98.	(D)	118.	(A)
19.	(D)	39.	(A)	59.	(A)	79.	(B)	99.	(A)	119.	(D)
20.	(C)	40.	(A)	60.	(C)	80.	(D)	100.	(B)	120.	(C)

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