TEST PAPER
KVPY-2017

KISHORE VAIGYANIK PROTSAHAN YOJANA STREAM (SB/SX)

INSTRUCTIONS FOR MARKING ON ANSWER SHEET

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

Choose the correct (✓) answer:

1. Let BC be a fixed line segment in the plane. The locus of a point A such that the triangle ABC is isosceles, is (with finitely many possible exceptional points)

   (1) a line

   (2) a circle

   (3) the union of a circle and a line

   (4) the union of two circles and a line

2. The number of solution pairs (x, y) of the simultaneous equations

   $\log_{1/3}(x + y) + \log_3(x - y) = 2$ and $2y^2 = 512^{x+1}$ is

   (1) 0   (2) 1

   (3) 2   (4) 3

3. The value of the limit $\lim\limits_{x \to -\infty}\left(\sqrt{4x^2 - x + 2x}\right)$ is

   (1) $-\infty$ (2) $-\dfrac{1}{4}$

   (3) 0   (4) $\dfrac{1}{4}$

4. Let R be a relation on the set of all natural numbers given by $a\,R\,b \Leftrightarrow a$ divides b^2. Which of the following properties does R satisfy ?

   I. Reflexivity   II. Symmetry   III. Transitivity

   (1) I only   (2) III only

   (3) I and III only   (4) I and II only

5. The fractional part of a real number x is x –[x], where [x] is the greatest integer less than or equal to x. Let F_1 and F_2 be the fractional parts of $(44 - \sqrt{2017})^{2017}$ and $(44 + \sqrt{2017})^{2017}$ respectively. Then $F_1 + F_2$ lies between the numbers

   (1) 0 and 0.45   (2) 0.45 and 0.9

   (3) 0.9 and 1.35   (4) 1.35 and 1.8

6. The number of real solutions of the equation $2\sin 3x + \sin 7x - 3 = 0$ which lie in the interval $[-2\pi, 2\pi]$ is

   (1) 1   (2) 2

   (3) 3   (4) 4

7. Suppose p, q, r are real numbers such that

   $q = p(4 - p), r = q(4 - q), p = r(4 - r)$.

   The maximum possible value of p + q + r is

   (1) 0   (2) 3

   (3) 9   (4) 27

8. The parabola $y^2 = 4x + 1$ divides the disc $x^2 + y^2 \le 1$ into two regions with areas A_1 and A_2. Then $|A_1 - A_2|$ equals

   (1) $\dfrac{1}{3}$ (2) $\dfrac{2}{3}$

   (3) $\dfrac{\pi}{4}$ (4) $\dfrac{\pi}{3}$

9. A shooter can hit a given target with probability $\dfrac{1}{4}$. She keeps firing a bullet at the target until she hits it successfully three times and then she stops firing. The probability that she fires exactly six bullets lies in the interval

   (1) (0.5272, 0.5274)   (2) (0.2636, 0.2638)

   (3) (0.1317, 0.1319)   (4) (0.0658, 0.0660)

10. Consider the following events :

E_1 : Six fair dice are rolled and at least one die shows six.

E_2 : Twelve fair dice are rolled and at least two dice show six.

Let p_1 be the probability of E_1 and p_2 be the probability of E_2. Which of the following is true ?

(1) $p_1 > p_2$ (2) $p_1 = p_2 = 0.6651$

(3) $p_1 < p_2$ (4) $p_1 = p_2 = 0.3349$

11. For how many different values of a does the following system have at least two distinct solutions ?

$ax + y = 0$

$x + (a + 10) y = 0$

(1) 0   (2) 1

(3) 2   (4) Infinitely many

12. Let R be the set of real numbers and $f : R \to R$ be defined by $f(x) = \dfrac{\{x\}}{1+[x]^2}$, where [x] is the greatest integer less than or equal to x, and $\{x\} = x - [x]$. Which of the following statements are true ?

I. The range of f is a closed interval

II. f is continuous on R.

III. f is one-one on R.

(1) I only   (2) II only

(3) III only   (4) None of I, II and III

13. Let $x_n = (2^n + 3^n)^{1/2n}$ for all natural numbers n. Then

(1) $\lim\limits_{n\to\infty} x_n = \infty$ (2) $\lim\limits_{n \to \infty} x_n = \sqrt{3}$

(3) $\lim\limits_{n\to\infty} x_n = \sqrt{3} + \sqrt{2}$ (4) $\lim\limits_{n\to\infty} x_n = \sqrt{5}$

14. One of the solutions of the equation $8 \sin^3\theta - 7 \sin \theta + \sqrt{3} \cos \theta = 0$ lies in the interval

(1) $(0, 10°]$ (2) $(10°, 20°]$

(3) $(20°, 30°]$ (4) $(30°, 40°]$

15. Let a, b, c, d, e, be real numbers such that $a + b < c + d, b + c < d + e, c + d < e + a, d + e < a + b$. Then

(1) The largest is a and the smallest is b

(2) The largest is a and the smallest is c

(3) The largest is c and the smallest is e

(4) The largest is c and the smallest is b

16. If a fair coin is tossed 5 times, the probability that heads does not occur two or more times in a row is

(1) $\dfrac{12}{2^5}$ (2) $\dfrac{13}{2^5}$

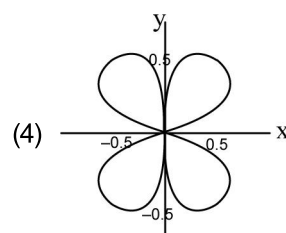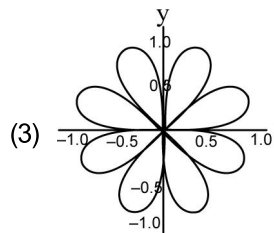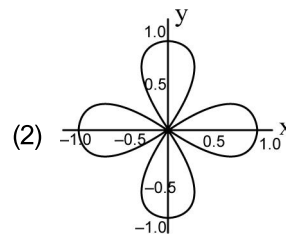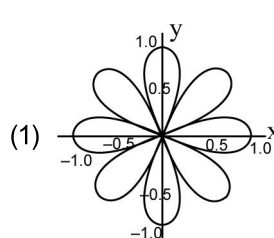(3) $\dfrac{14}{2^5}$ (4) $\dfrac{15}{2^5}$

17. Consider the following parametric equation of a curve :

$x (\theta) = | \cos 4\theta | \cos \theta$

$y(\theta) = | \cos 4\theta| \sin \theta$

for $0 \le \theta \le 2\pi$

Which one of the following graphs represents the curve?

(1) (2)

(3) (4)

18. Let $A = (a_1, a_2)$ and $B = (b_1, b_2)$ be two points in the plane with integer coordinates. Which one of the following is not a possible value of the distance between A and B?

(1) $\sqrt{65}$ (2) $\sqrt{74}$

(3) $\sqrt{83}$ (4) $\sqrt{97}$

19. Let $f(x) = \max\left\{3, x^2, \dfrac{1}{x^2}\right\}$ for $\dfrac{1}{2} \le x \le 2$. Then the value of

the integral $\displaystyle\int_{1/2}^{2} f(x)dx$

(1) $\dfrac{11}{3}$

(2) $\dfrac{13}{3}$

(3) $\dfrac{14}{3}$

(4) $\dfrac{16}{3}$

20. Let $a_i = i + \dfrac{1}{i}$ for $i = 1, 2, \ldots\ldots, 20$. Put

$p = \dfrac{1}{20}(a_1 + a_2 + \ldots\ldots + a_{20})$ and

$q = \dfrac{1}{20}\left(\dfrac{1}{a_1} + \dfrac{1}{a_2} + \ldots\ldots + \dfrac{1}{a_{20}}\right)$. Then

(1) $q \in \left(0, \dfrac{22-p}{21}\right)$

(2) $q \in \left(\dfrac{22-p}{21}, \dfrac{2(22-p)}{21}\right)$

(3) $q \in \left(\dfrac{2(22-p)}{21}, \dfrac{22-p}{7}\right)$

(4) $q \in \left(\dfrac{22-p}{7}, \dfrac{4(22-p)}{21}\right)$

PHYSICS

21. The magnitude of acceleration of the electron in the nth orbit of hydrogen atom is a_H and that of singly ionized helium atom is a_{He}. The ratio $a_H : a_{He}$ is

(1) $1 : 8$

(2) $1 : 4$

(3) $1 : 2$

(4) dependent on n

22. A carrot looks orange in colour because of the β carotene molecule in it. This means that the β carotene molecule absorbs light of wavelengths

(1) longer than 550 nm.

(2) shorter than 550 nm.

(3) longer than 700 nm.

(4) shorter than 700 nm.

23. If some charge is given to a solid metallic sphere, the field inside remains zero and by Gauss's law all the charge resides on the surface. Suppose now that Colomb's force between two charges varies as $1/r^3$. Then, for a charged solid metallic sphere

(1) field inside will be zero and charge density inside will be zero.

(2) field inside will not be zero and charge density inside will not be zero.

(3) field inside will not be zero and charge density inside will be zero.

(4) field inside will be zero and charge density inside will not be zero.

24. Using dimensional analysis the resistivity in terms of fundamental constants h, m_e, c, e, ε_0 can be expressed as

(1) $\dfrac{h}{\varepsilon_0 m_e c e^2}$

(2) $\dfrac{\varepsilon_0 m_e c e^2}{h}$

(3) $\dfrac{h^2}{m_e c e^2}$

(4) $\dfrac{m_e \varepsilon_0}{c e^2}$

25. Consider a bowl filled with water on which some black pepper powder have been sprinkled uniformly. Now a drop of liquid soap is added at the centre of the surface of water. The picture of the surface immediately after this will look like

(1)

(2)

(3)

(4)
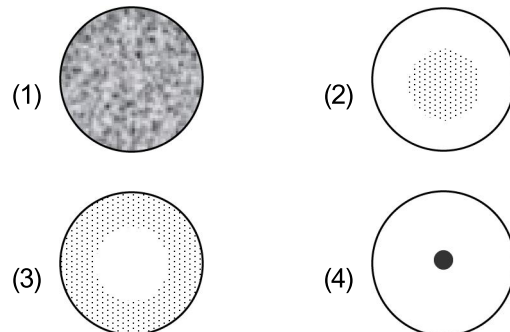
26. It was found that the refractive index of material of a certain prism varied as $1.5 + 0.004/\lambda^2$, where λ is the wavelength of light used to measure the refractive index. The same material was then used to construct a thin prism of apex angle 10°. Angles of minimum deviation (δ_m) of the prism were recorded for the sources with wavelengths λ_1 and λ_2 respectively. Then

(1) $\delta_m (\lambda_1) < \delta_m (\lambda_2)$ if $\lambda_1 < \lambda_2$.

(2) $\delta_m (\lambda_1) > \delta_m (\lambda_2)$ if $\lambda_1 > \lambda_2$.

(3) $\delta_m (\lambda_1) > \delta_m (\lambda_2)$ if $\lambda_1 < \lambda_2$.

(4) δ_m is the same in both the cases.

27. Two circularly shaped linear polarisers are placed coaxially. The transmission axis of the first polarizer is at 30° from the vertical while the second one is at 60°, both in the clockwise sense. If an unpolarised beam of light of intensity $I = 20$ W/m^2 is incident on this pair of polarisers, then the intensities I_1 and I_2 transmitted by the first and the second polarisers, respectively, will be close to

(1) $I_1 = 10.0$ W/m^2 and $I_2 = 7.5$ W/m^2

(2) $I_1 = 20.0$ W/m^2 and $I_2 = 15$ W/m^2

(3) $I_1 = 10.0$ W/m^2 and $I_2 = 8.6$ W/m^2

(4) $I_1 = 15.0$ W/m^2 and $I_2 = 0.0$ W/m^2

28. An electron in an electron microscope with initial velocity $v_0 \hat{i}$ enters a region of a stray transverse electric field $E_0 \hat{j}$. The time taken for the change in its de-Broglie wavelength from the initial value of λ to $\lambda/3$ is proportional to

(1) E_0

(2) $\dfrac{1}{E_0}$

(3) $\dfrac{1}{\sqrt{E_0}}$

(4) $\sqrt{E_0}$

29. A bird sitting on a single high tension wire does not get electrocuted because

(1) the circuit is not complete.

(2) the bird feet has an insulating covering.

(3) capacitance of the bird is too small and the line frequency is too small.

(4) resistance of the bird is too high

30. A positive charge q is placed at the center of a neutral hollow cylindrical conducting shell with its cross section as shown in the figure below.
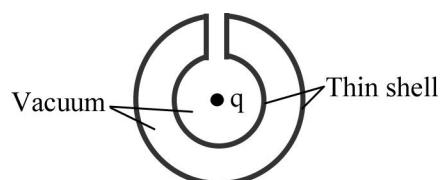
Which one of the following figures correctly indicates the induced charge distribution on the conductor (ignore edge effects).
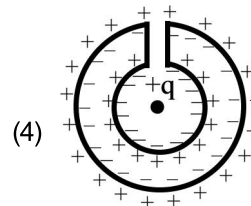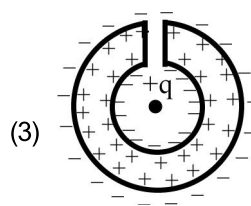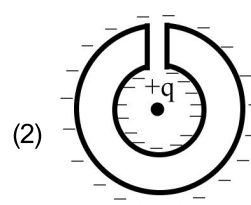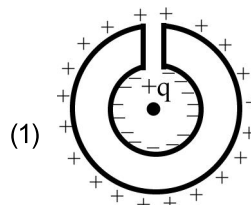
31. A transverse wave of frequency 500 Hz and speed 100 m/s is traveling in the positive x direction on a long string. At time $t = 0$ s the displacements at $x = 0.0$ m and at $x = 0.25$ m are 0.0 m and 0.02 m, respectively. The displacement at $x = 0.2$ m at $t = 5 \times 10^{-4}$ s is

(1) -0.04 m   (2) -0.02 m

(3) 0.04 m   (4) 0.02 m

32. A thin piece of thermal conductor of constant thermal conductivity insulated on the lateral sides connects two reservoirs which are maintained at temperatures T_1 and T_2 as shown. Assuming that the system is in steady state, which of the following plots best represents the dependence of the rate of change of entropy of the ratio of temperatures T_1/T_2

(1)

(2)

(3)

(4)
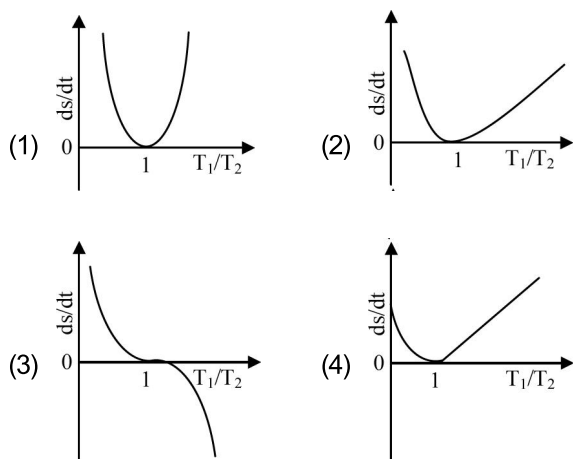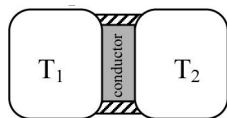
33. Which of the following plots represents schematically the dependence of the time period of a pendulum if measured and plotted as a function of its oscillations? (Note : amplitude need not be small)

(1)

(2)

(3)

(4)
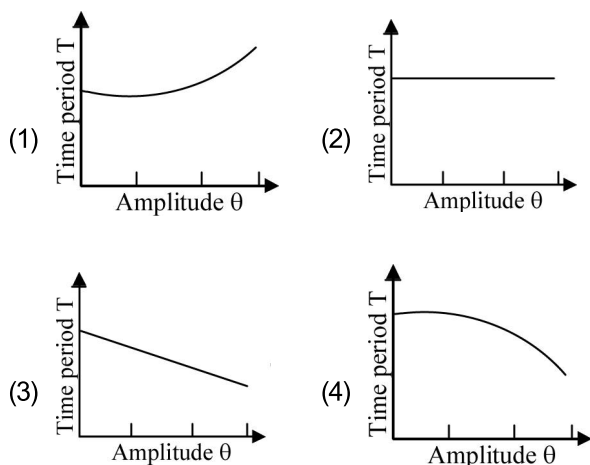
34. On a pulley of mass M hangs a rope with two masses m_1 and m_2 ($m_1 > m_2$) tied at the ends as shown in the figure. The pulley rotates without any friction, whereas the friction between the rope and the pulley is large enough to prevent any slipping. Which of the following plots best represents the difference between the tensions in the rope on the two sides of the pulley as a function of the mass of the pulley ?

(1)

(2)

(3)

(4)
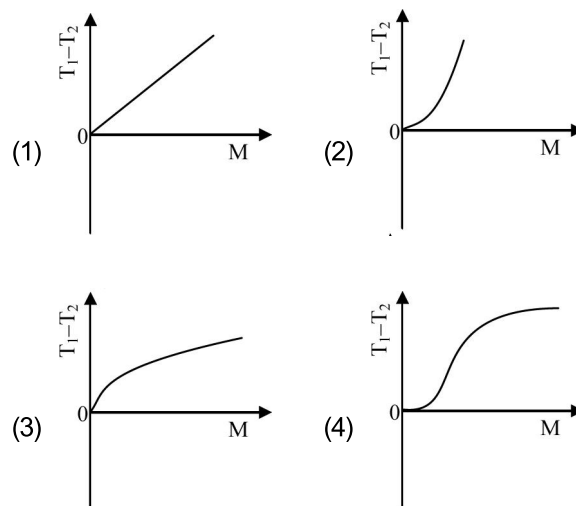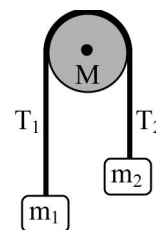
35. Two satellites S_1 and S_2 are revolving around a planet in the opposite sense in coplanar circular concentric orbits. At time t = 0, the satellites are farthest apart. The periods of revolution of S_1 and S_2 are 3 h and 24 h respectively. The radius of the orbit of S_1 is 3×10^4 km. Then the orbital speed of S_2 as observed from

(1) the planet is $4\pi \times 10^4$ km h^{-1} when S_2 is closest from S_1.

(2) the planet is $2\pi \times 10^4$ km h^{-1} when S_2 is closest from S_1.

(3) S_1 is $\pi \times 10^4$ km h^{-1} when S_2 is closest from S_1

(4) S_1 is $3\pi \times 10^4$ km h^{-1} when S_2 is closest from S_1

36. A rectangular region of dimensions w × l (w << l) has a constant magnetic field into the plane of the paper as shown. On one side the region is bounded by a screen. On the other side positive ions of mass m and charge q are accelerated from rest and towards the screen by a parallel plate capacitor at constant potential difference V < 0, and come out through a small hole in the upper plate. Which one of the following statements is correct regarding the charge on the ions that hit the screen ?

Screen

w   B ⊗

V
0   q
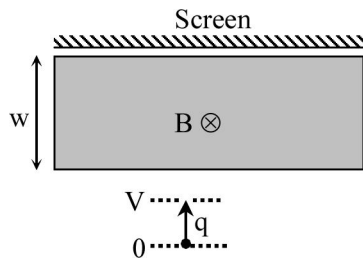
(1) Ions with q > $\dfrac{2|v|m}{B^2w^2}$ will hit the screen.

(2) Ions with q < $\dfrac{2|v|m}{B^2w^2}$ will hit the screen.

(3) All ions will hit the screen.

(4) Only ions with q = $\dfrac{2|v|m}{B^2w^2}$ will hit the screen.

37. Force $\vec{F}$ applied on a body is written as $\vec{F} = (\hat{n}.\hat{f})\,\hat{n} + \vec{G}$, where $\hat{n}$ is a unit vector. The vector $\vec{G}$ is equal to

(1) $\hat{n} \times \vec{F}$

(2) $\hat{n} \times (\hat{n} \times \vec{F})$

(3) $(\hat{n} \times \vec{F}) \times \vec{F}/|\vec{F}|$

(4) $(\hat{n} \times \vec{F}) \times \hat{n}$

38. A particle of mass m moves around the origin in a potential $\dfrac{1}{2} m\omega^2 r^2$, where r is the distance from the origin. Applying the Bohr model in this case, the radius of the particle in its nth orbit in terms of $a = \sqrt{h/(2\pi m\omega)}$ is

(1) $a\sqrt{n}$

(2) an

(3) an^2

(4) $an\sqrt{n}$

39. Two bottles A and B have radii R_A and R_B and heights h_A and h_B respectively with $R_B = 2R_A$ and $h_B = 2h_A$. These are filled with hot water at 60°C. Consider that heat loss for the bottles takes place only from side surfaces. If the time the water to cool down to 50°C is t_A and t_B for the bottles A and B, respectively, then t_A and t_B are best related as

(1) $t_A = t_B$

(2) $t_B = 2t_A$

(3) $t_B = 4t_A$

(4) $t_A = t_A/2$

40. The number of gas molecules striking per second per square meter of the top surface of a table placed in a room at 20°C and 1 atmospheric pressure is of the order of ($k_B = 1.4 \times 10^{-23}$ J/K, and the average mass of an air molecules is 5×10^{-27} kg)

(1) 10^{27}

(2) 10^{23}

(3) 10^{25}

(4) 10^{29}

CHEMISTRY

41. The major product formed in the following reaction is

$$\xrightarrow[\text{Conc.H}_2\text{SO}_4]{\text{Conc.HNO}_3}$$

(1)

(2)

(3)

(4)
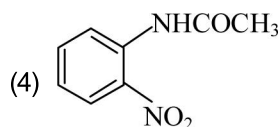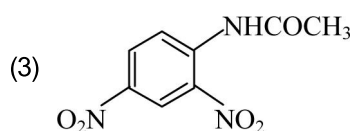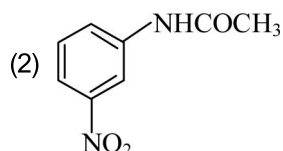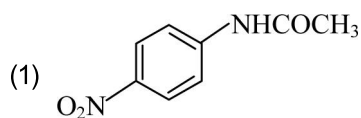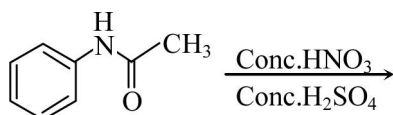
42. Among the α-amino acids - threonine, tyrosine, methionine, arginine and tryptophan, those which contain an aromatic group in their side chain are

(1) threonine and arginine

(2) tyrosine and tryptophan

(3) methionine and tyrosine

(4) arginine and tryptophan

43. The number of stereoisomers possible for the following compound is

CH_3-CH=CH-CH(OH)-CH_3
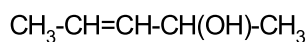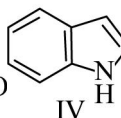
(1) 1   (2) 2
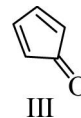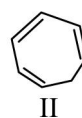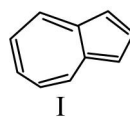
(3) 3   (4) 4

44. In electrophilic aromatic substitution reactions of chlorobenzene, the ortho/para-directing ability of chlorine is due to its

(1) positive inductive effects (+I)

(2) negative inductive effect (–I)

(3) positive resonance effect (+R)

(4) negative resonance effect (–R)

45. Among the following,

the antiaromatic compounds are

(1) I and IV   (2) III and V

(3) II and V   (4) I and III

46. Upon reaction with CH_3MgBr followed by protonation, the compound that produces ethanol is

(1) CH_3CHO (2) HCOOH

(3) HCHO   (4) $(CHO)_2$

47. Which of the following is **NOT** an oxidationreduction reaction ?

(1) $H_2 + Br_2 \rightarrow 2HBr$

(2) $NaCl + AgNO_3 \rightarrow NaNO_3 + AgCl$

(3) $2\,Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2NaI$

(4) $Cl_2 + H_2O \rightarrow HCl + HOCl$

48. The thermal stability of alkaline earth metal carbonates–$MgCO_3$, $CaCO_3$, $SrCO_3$ and $BaCO_3$, follows the order

(1) $BaCO_3 > SrCO_3 > CaCO_3 > MgCO_3$

(2) $CaCO_3 > SrCO_3 > BaCO_3 > MgCO_3$

(3) $MgCO_3 > CaCO_3 > SrCO_3 > BaCO_3$

(4) $SrCO_3 > CaCO_3 > MgCO_3 > BaCO_3$

49. When a mixture of diborane and ammonia is heated, the final product is

(1) BH_3 (2) NH_4BH_4

(3) NH_2NH_2 (4) $B_3N_3H_6$

50. Among the following metals, the strongest reducing agent is

(1) Ni   (2) Cu

(3) Zn   (4) Fe

51. The molecule which is **NOT** hydrolysed by water at 25°C is

    (1) $AlCl_3$ (2) $SiCl_4$

    (3) BF_3 (4) SF_6

52. Among the following compounds, the one which does **NOT** produce nitrogen gas upon heating is

    (1) $(NH_4)_2 Cr_2O_7$ (2) NaN_3

   (3) NH_4NO_2 (4) $(NH_4)_2 (C_2O_4)$

53. Chlorine has two naturally occurring isotopes, ^{35}Cl and ^{37}Cl. If the atomic mass of Cl is 35.45, the ratio of natural abundance of ^{35}Cl and ^{37}Cl is closest to

    (1) 3.5 : 1   (2) 3 : 1

    (3) 2.5 : 1   (4) 4 : 1

54. The reaction C_2H_6 (g) $\rightleftharpoons$ C_2H_4 (g) + H_2 (g) is at equilibrium in a closed vessel at 1000 K. The enthalpy change (ΔH) for the reaction is 137.0 kJ mol^{-1}. Which one of the following actions would shift the equilibrium to the right ?

    (1) Decreasing the volume of the closed reaction vessel

    (2) Decreasing the temperature at which the reaction is performed

    (3) Adding an inert gas to the closed reaction vessel

    (4) Increasing the volume of the closed reaction vessel

55. The enthalpy (H) of an elementary exothermic reaction A $\rightleftharpoons$ B is schematically plotted against the reaction coordinate. The plots in the presence and absence of a catalyst are shown in dashed and solid lines, respectively. Identify the correct plot for the reaction.
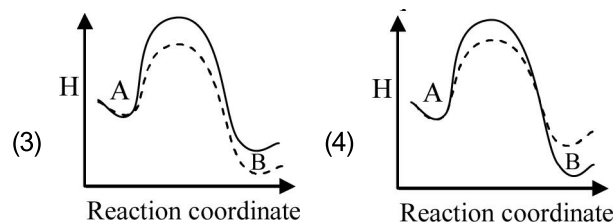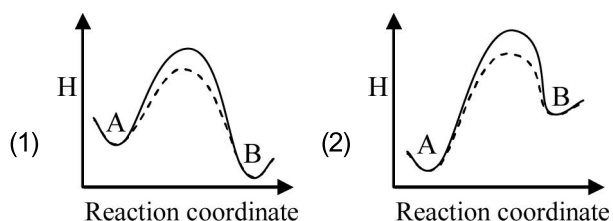
56. $Mg(OH)_2$ is precipitated when NaOH is added to a solution of Mg^{2+}. If the final concentration of Mg^{2+} is 10^{-10} M, the concentration of OH$^-$(M) in the solution is
[Solubility product for Mg $(OH)_2$ = 5.6×10^{-12}]

    (1) 0.056   (2) 0.12

    (3) 0.24   (4) 0.025

57. A constant current (0.5 amp) is passed for 1 hour through (i) aqueous $AgNO_3$, (ii) aqueous $CuSO_4$ and (iii) molten AlF_3, separately. The ratio of the mass of the metals deposited on the cathode is
[M_{Ag}, M_{Cu}, M_{Al} are molar masses of the respective metals]

    (1) M_{Ag} : 2 M_{Cu} : 3 M_{Al} (2) M_{Ag} : M_{Cu} : M_{Al}

    (3) 6 M_{Ag} : 3 M_{Cu} : 2 M_{Al} (4) 3 M_{Ag} : 2 M_{Cu} : M_{Al}

58. A reaction has an activation energy of 209 kJ mol^{-1}. The rate increases 10–fold when the temperature is increased from 27°C to X °C. The temperature X is closest to
[Gas constant, R = 8.314 J mol^{-1} K^{-1}]

    (1) 35   (2) 40

    (3) 30   (4) 45

59. A mineral consists of a cubic close-packed structure formed by O^{2-} ions where half the octahedral voids are occupied by Al^{3+} and oneeighth of the tetrahedral voids are occupied by Mn^{2+}. The chemical formula of the mineral is

    (1) $Mn_3Al_2O_6$ (2) $MnAl_2O_4$

    (3) $MnAl_4O_7$ (4) $Mn_2Al_2O_5$

60. For a 4p orbital, the number of radial and angular nodes, respectively, are

    (1) 3,2   (2) 1,2

    (3) 2, 4   (4) 2,1

BIOLOGY

61. Interferons combat viral infection by

    (1) inhibiting viral packaging directly.

    (2) increasing the binding of antibodies to viruses.

    (3) binding to the virus and agglutinating them.

    (4) restricting viral spread to the neighboring cells.

62. Leydig cells synthesize

    (1) insulin   (2) growth hormone

    (3) testosterone   (4) estrogen

63. Glucagon increases the blood glucose concentration by

    (1) promoting glycogenolysis.

    (2) increasing the concentration of fructose 2,–6-bisphosphate.

    (3) increasing the concentration of pyruvate kinase.

    (4) inhibiting gluconeogenesis.

64. Which ONE of the following is NOT essential for Polymerase Chain Reaction (PCR) ?

    (1) Restriction enzyme

    (2) Denaturation of DNA

    (3) Primers

    (4) DNA polymerase

65. CO_2 acts as a greenhouse gas because

    (1) it is transparent to heat but traps sunlight.

    (2) it is transparent to sunlight but traps heat.

    (3) it is transparent to both sunlight and heat.

    (4) it traps both sunlight and heat.

66. A graph of species richness *vs* area on log-log axes is

    (1) linear   (2) sigmoidal

    (3) oscillatory   (4) parabolic

67. Concentration of Na^+ ions outside a nerve cell is ~100 times more than inside. The concentration of K^+ ions is more inside the cells. The levels of Na^+ ions and K^+ ions are maintained by

    (1) free diffusion of Na^+ ions and pumping of K^+ ions across the membrane.

    (2) Na^+ and K^+ pumps in the membrane.

    (3) free diffusion of K^+ ions and pumping of Na^+ ions across the membrane.

    (4) water channels formed by lipids in the membrane.

68. In a chemical reaction, enzymes catalyze the reaction by

    (1) lowering the activation energy.

    (2) increasing the activation energy.

    (3) decreasing the free energy change between reactants and products.

    (4) increasing the free energy change between reactants and products.

69. The rigidity of cellulose is due to

    (1) coiled structure of glucose polymer

    (2) $\beta(1 \rightarrow 4)$ glycosidic linkage

    (3) hydrogen bonding with adjacent glucose polymer

    (4) cross-linking between glucose and peptides

70. Antigen-angtibody reactions

    (1) always result in precipitation of the complex

    (2) depend only on covalent interactions.

    (3) are irreversible.

    (4) depend on ionic and hydrophobic interactions.

71. Which ONE of the following combinations of molecular masses of polypeptides are obtained from purified human IgM when analysed on sodium dodecyl suplhate polyacrylamide gel electrophoresis (SDS-PAGE) under reducing conditions?

    (1) 55 kDa, 15 kDa

    (2) 70 kDa, 25 kDa, 15 kDa

    (3) 55 kDa, 25 kDa

    (4) 155 kDa

72. For a particular gene that determines the coat color in a diploid organism, there are three different alleles that are codominant. How many different skin colors are possible in such an organism?

   (1) 9   (2) 6

   (3) 4   (4) 3

73. Two genetic loci controlling two different traits are linked. During the inheritance of these traits, the Mendelian laws that would be affected is/are

   (1) Law of dominance, law of segregation and law of independent assortment

   (2) Law of segregation and Law of independent assortment

   (3) Only Law of independent assortment

   (4) Only Law of segregation

74. Which ONE of the following statements is INCORRECT?

   (1) Alleles are different forms of the same gene.

   (2) Alleles are present at the same locus.

   (3) Alleles code for different isoforms of a protein.

   (4) Alleles are non-heritable.

75. Which ONE of the following statements is INCORRECT about restriction endonucleases?

   (1) They serve as primitive form of immune system in bacteria.

   (2) They digest the DNA non-randomly.

   (3) They digest the DNA at specific location.

   (4) They digest the DNA from free ends.

76. The number of net ATP molecules produced from 1 glucose molecule during glycolysis is

   (1) 1   (2) 2

   (3) 3   (4) 4

77. Which ONE of the following coenzymes is required for the conversion of L-alanine to a racemic mixture of D-and L-alanine ?

   (1) Pyridoxal-6-phosphate

   (2) Thiamine pyrophosphate

   (3) Coenzyme A

   (4) Flavin adenine dinucleotide

78. The cyclic electron flow during photosynthesis generates
   (1) NADPH alone.

   (2) ATP and NADPH.

   (3) ATP alone.

   (4) ATP, NADPH and O_2.

79. Match the type of cells given in Column I with organisms given in Column II. Choose the appropriate combination from the options below.

Column I	Column II
(P) Flame cells	(i) Sponges
(Q) Collar cells	(ii) Hydra
(R) Stinging cells	(iii) Planaria

   (1) P-iii, Q-i, R-ii   (2) P-iii, Q-ii, R-i

   (3) P-i, Q-ii, R-iii   (4) P-ii, Q-iii, R-i

80. Compared to the atmospheric air, the alveolar air has

   (1) more pO_2 and less pCO_2

   (2) less pO_2 and pCO_2

   (3) more pO_2 and more pCO_2

   (4) less pO_2 and less pCO_2

Space For Rough Work

PART-II
Two Mark Questions
### MATHEMATICS

81. Let x,y,z be positive integers such that HCF (x,y,z) = 1 and $x^2 + y^2 = 2z^2$. Which of the following statements are true?

   I.   4 divides x or 4 divides y.

   II. 3 divides x + y or 3 divides x – y.

   III. 5 divides $z(x^2 - y^2)$

  (1) I and II only   (2) II and III only

  (3) II only   (4) III only

82. How many different (mutually noncongruent) trapeziums can be constructed using four distinct side lengths from the set {1,3,4,5,6}?

  (1) 5   (2) 11

  (3) 15   (4) 30

83. A solid hemisphere is mounted on a solid cylinder, both having equal radii. If the whole solid is to have a fixed surface area and the maximum possible volume, then the ratio of the height of the cylinder to the common radius is

  (1) 1:1   (2) 1:2

  (3) 2:1   (4) $\sqrt{2}$:1

84. Let ABC be an acute scalene triangle, and O and H be its circumcentre and orthocenter respectively. Further let N be the midpoint of OH. The value of the vector sum

  $\overrightarrow{NA} + \overrightarrow{NB} + \overrightarrow{NC}$ is

  (1) $\vec{0}$ (zero vector)   (2) $\overrightarrow{HO}$

  (3) $\frac{1}{2}\overrightarrow{HO}$ (4) $\frac{1}{2}\overrightarrow{OH}$

85. The quotient when $1 + x^2 + x^4 + x^6 + \ldots\ldots + x^{34}$ is divided by $1 + x + x^2 + x^3 + \ldots\ldots + x^{17}$ is

  (1) $x^{17} - x^{15} + x^{13} - x^{11} \ldots\ldots + x$

  (2) $x^{17} + x^{15} + x^{13} + x^{11} + \ldots\ldots + x$

  (3) $x^{17} + x^{16} + x^{15} + x^{14} + \ldots\ldots +1$

  (4) $x^{17} - x^{16} + x^{15} - x^{14} + \ldots\ldots -1$

86. Let R be the region of the disc $x^2 + y^2 \le 1$ in the first quadrant. Then the area of the largest possible circle contained in R is

  (1) $\pi(3 - 2\sqrt{2})$ (2) $\pi(4 - 3\sqrt{2})$

  (3) $\frac{\pi}{6}$ (4) $\pi(2\sqrt{2} - 2)$

87. Let R be the set of real numbers and f : R → R be given by $f(x) = \sqrt{|x|} - \log(1 + |x|)$. We now make the following assertions:

   I.   There exists a real number A such that $f(x) \le A$ for all x.

   II. There exists a real number B such that $f(x) \ge B$ for all x.

  (1) I is true and II is false   (2) I is false and II is true

  (3) I and II both are true   (4) I and II both are false

88. Define $g(x) = \int\limits_{-3}^{3} f(x - y)f(y)dy$, for all real x,

  where $f(t) = \begin{cases} 1, & 0 \le t \le 1, \\ 0, & \text{elsewhere.} \end{cases}$

  Then

  (1) g(x) is not continuous everywhere

  (2) g(x) is continuous everywhere but differentiable nowhere

  (3) g(x) is continuous everywhere and differentiable everywhere except at x = 0,1

  (4) g(x) is continuous everywhere and differentiable everywhere except at x = 0,1,2

89. The integer part of the number

  $\sum\limits_{k=0}^{44} \dfrac{1}{\cos k^{\circ} \cos(k + 1)^{\circ}}$ is

  (1) 50   (2) 52   (3) 57   (4) 59

90. The number of continuous functions f:[0,1]„_R that satisfy

  (1) 0   (2) 1

  (3) 2   (4) infinity

PHYSICS

91 One end of a rod of length L=1 m is fixed to a point on the circumference of a wheel of radius $R = 1/\sqrt{3}$ m. The other end is sliding freely along a straight channel passing through the center O of the wheel as shown in the figure below. The wheel is rotating with a constant angular velocity ω about O.
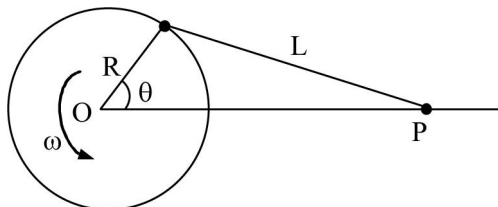

The speed of the sliding end P when $\theta = 60°$ is

(1) $\dfrac{2\omega}{3}$ (2) $\dfrac{\omega}{3}$

(3) $\dfrac{2\omega}{\sqrt{3}}$ (4) $\dfrac{\omega}{\sqrt{3}}$

92. One mole of an ideal monatomic gas undergoes the following four reversible processes :

Step1 : It is first compressed adiabatically from volume V_1 to $1 m^3$.

Step 2 : then expanded isothermally to volume $10 m^3$.

Step 3 : then expanded adiabatically to volume V_3.

Step 4 : then compressed isothermally to volume V_1.

If the efficiency of the above cycle is 3/4 then V_1 is,

(1) $2 m^3$ (2) $4 m^3$

(3) $6 m^3$ (4) $8 m^3$

93. A neutron star with magnetic moment of magnitude m is spinning with angular velocity ω about its magnetic axis. The electromagnetic power P radiated by it is given by $\mu_0^x m^y \omega^z c^u$ where μ_0 and c are the permeability and speed of light in free space, respectively. Then

(1) x = 1, y = 2, z = 4 and u = –3

(2) x = 1, y = 2, z = 4 and u = 3

(3) x = –1, y = 2, z = 4 and u = –3

(4) x = –1, y = 2, z = 4 and u = 3

94. A solid cube of wood of side 2a and mass M is resting on a horizontal surface as shown in the figure. The cube is free to rotate about a fixed axis AB. A bullet of mass m (<<M) and speed v is shot horizontally at the face opposite to ABCD at a height 4a/3 from the surface to impart the cube an angular speed ω. It strike the face and embeds in the cube. Then ω_c is close to (note : the moment of inertia of the cube about an axis perpendicular to the face and passing through the center of mass is $2Ma^2/3$)

(1) Mv/ma

(2) Mv/2ma

(3) mv/Ma

(4) mv/2Ma
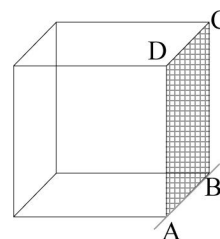
95. A gas obeying the equation of state PV = RT undergoes a hypothetical reversible process described by the equation, $PV^{5/3} \exp\left(-\dfrac{PV}{E_0}\right) = c_1$ where c_1 and E_0 are dimensioned constants. Then, for this process, the thermal compressibility at high temperature

(1) approaches a constant value.

(2) is proportional to T.

(3) is proportional to $T^{1/2}$

(4) is proportional to T^2.

96. To calculate the size of a hydrogen anion using the Bohr model, we assume that its two electrons move in an orbit such that they are always on diametrically opposite sides of the nucleus. With each electron having the angular momentum $\hbar$ = h/2π, and taking electron interaction into account the radius of the orbit in terms of the Bohr radius of hydrogen atom $a_B = \dfrac{4\pi\varepsilon_0 h^2}{me^2}$ is

(1) a_B (2) $\dfrac{4}{3} a_B$

(3) $\dfrac{2}{3} a_B$ (4) $\dfrac{3}{2} a_B$

97. A square-shaped conducting wire loop of dimension *a* moving parallel to the x-axis approaches a square region of size *b* (*a* < *b*) where a uniform magnetic field B exists pointing into the plane of the paper (see figure). As the loop passes through this region, the plot correctly depicting its speed (v) as a function of x is


(1)   (2)

(3)   (4)
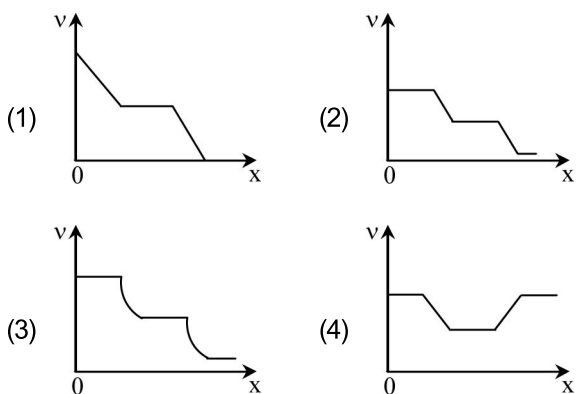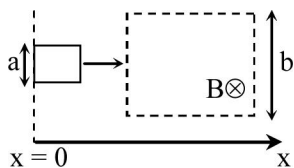
98. The figure of a centimeter scale below shows a particular position of the vernier calipers. In this position the value of x shown in the figure is (figure is not to scale)
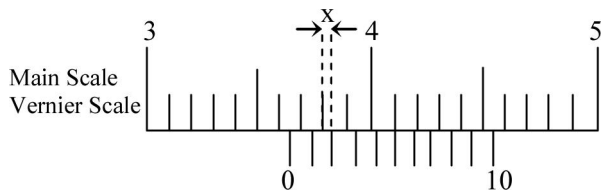
(1) 0.02 cm   (2) 3.65 cm

(3) 4.15 cm   (4) 0.03 cm

99. A parallel beam of light is incident on a tank filled with water up to a height of 61.5 mm as shown in the figure below. Ultrasonic waves of frequency 0.5 MHz are sent along the length of the water column using a transducer placed at the top, and they form longitudinal standing waves in the water. Which of the schematic plots below best describes the intensity distribution of the light as seen on the screen ? Take the speed of sound in water to be 1,500 m/s.

(1)   (2)

(3)   (4)
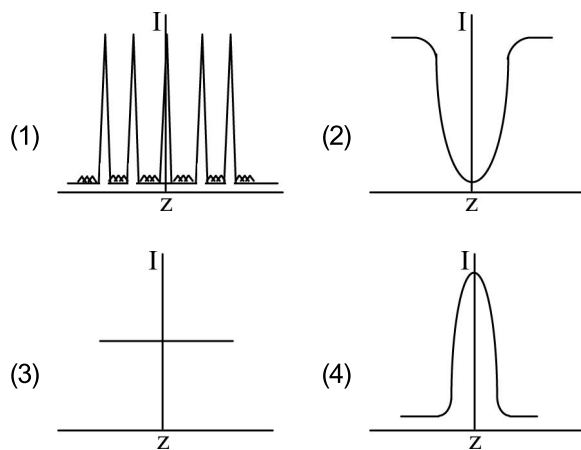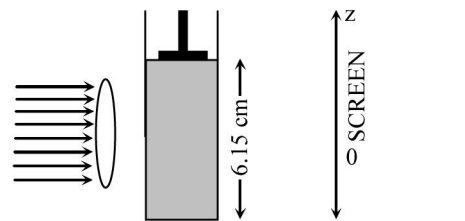
100. A star of mass M (equal to the solar mass) with a planet (much smaller than the star) revolves around the star in a circular orbit. The velocity of the star with respect to the center of mass of the star-planet system is shown below :
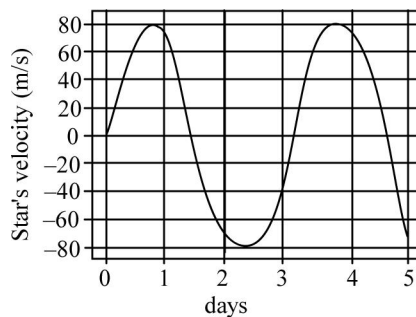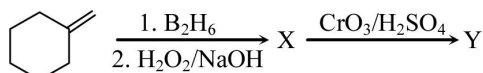

The radius of the planet's orbit is closest to
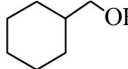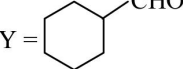
(1 A. U. = Earth-Sun distance)
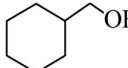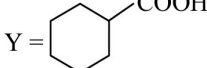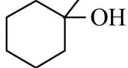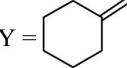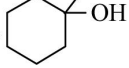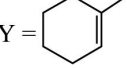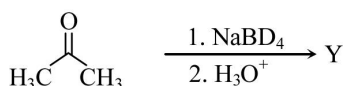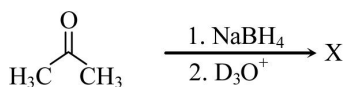
(1) 0.004 A. U.

(2) 0.008 A.U.

(3) 0.004 A.U.

(4) 0.12 A.U.

CHEMISTRY

101. In the following reaction sequence

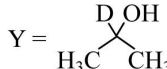$$\xrightarrow[\text{2. } H_2O_2/NaOH]{\text{1. } B_2H_6} X \xrightarrow{CrO_3/H_2SO_4} Y$$

X and Y are

(1)

(2)

(3)

(4)
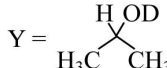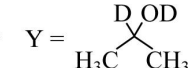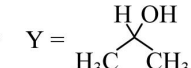
102. In the following reactions

 $\xrightarrow[\text{2. } D_3O^+]{\text{1. NaBH}_4} X$

 $\xrightarrow[\text{2. } H_3O^+]{\text{1. NaBD}_4} Y$

X and Y are

(1)

(2)

(3) X = Y =

(4) X = Y =

103. Which of the following alkenes can generate optically active compounds upon hydrogenation ?
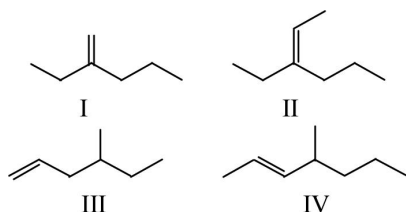
(1) I, III and IV   (2) II and III

(3) I and III   (4) II and IV

104. When heated in air, brown copper powder turns black. This black powder would turn brown again when heated with

(1) CO   (2) O_2 (3) H_2 (4) NH_3

105. The geometry and magnetic property of $[NiCl_4]^{2-}$, respectively, are

(1) tetrahedral, paramagnetic

(2) tetrahedral, diamagnetic

(3) square planar, paramagnetic

(4) square planar, diamagnetic

106. Among (i) $[Cr(en)_3]^{3+}$, (ii) trans-$[Cr(en)_2 Cl_2]^+$, (iii) Cis-$[Cr(en)_2 Cl_2]^+$ (iv) $[Co(NH_3)_4Cl_2]^+$ the optically active complexes are

(1) i and ii   (2) i and iii

(3) ii and iii   (4) ii and iv

107. ^{227}Ac has a half-life of 22 years with respect to radioactive decay. The decay follows two parallel paths : ^{227}Ac $\rightarrow$ ^{227}Th and ^{227}Ac $\rightarrow$ ^{223}Fr. If the percentage of the two daughter nuclides are 2.0 and 98.0, respectively, the decay constant (in year^{-1}) for ^{227}Ac $\rightarrow$ ^{227}Th path is closest to

(1) 6.3×10^{-2} (2) 6.3×10^{-3}

(3) 6.3×10^{-1} (4) 6.3×10^{-4}

108. A system consisting of 1 mol of an ideal gas undergoes a reversible process, A $\rightarrow$ B $\rightarrow$ C $\rightarrow$ A (schematically indicated in the figure below). If the temperature at the starting point A is 300 K and the work done in the process B $\rightarrow$ C is 1 L atm, the heat exchanged in the entire process in L atm is

(1) 1.0

(2) 0.0

(3) 1.5

(4) 0.5
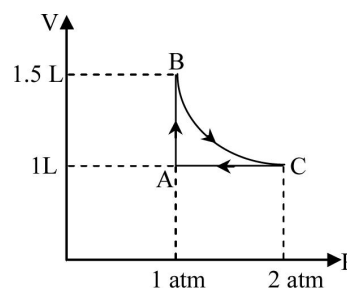
109. A mixture of toluene and benzene boils at 100°C. Assuming ideal behaviour, the mole fraction of toluene in the mixture is closest to [Vapour pressures of pure toluene and pure benzene at 100°C are 0.742 and 1.800 bar respectively. 1 atm = 1.013 bar]

(1) 0.824   (2) 0.744

(3) 0.544   (4) 0.624

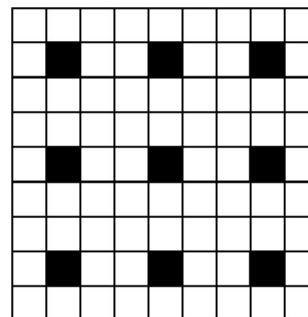**110.** A two-dimensional solid pattern formed by two different atoms X and Y is shown below. The black and white squares represent atoms X and Y, respectively. The simplest formula for the compound based on the unit cell from the pattern is

(1) XY_8 (2) X_4Y_9

(3) XY_2 (4) XY_4

BIOLOGY

111. The genetic distance between genes A and B is 10 cm. An organism with Ab combination of the alleles is crossed with the organism with aB combination of alleles. What will be the percentage of the gametes with AB allele combination by an F1 individual ?

(1) 1   (2) 5

(3) 10   (4) 50

112. Proteins P, Q, and R are associated with intact organellar membrane in a cell. If the intact organellel is treated with a high ionic strength buffer, only protein R remained associated with the membrane fraction. Based on this, one could conclude that

(1) P and Q are peripheral membrane proteins.

(2) R is a peripheral membrane protein.

(3) P and Q are integral membrane bound proteins.

(4) P is peripheral and Q is integral membrane protein.

113. In photosynthesis, oxygen is produced by

(1) photosystem I from carbon dioxide.

(2) photosystem II from carbon dioxide.

(3) photosystem I from water.

(4) photosystem II from water.

114. How many different proteins consisting of 100 amino acids can be formed from 20 different amino acids ?

(1) 20^{100} (2) 100^{20}

(3) 2^{20} (4) 20×100

115. Molecular weight of *E. Coli* DNA is 3.1×10^9 g/mol. Average molecular weight of nucleotide pair is 660 g/mol and each nucleotide pair contributes to 0.34 nm to the length of DNA. The length of *E. coli* DNA molecule will be approximately

(1) 0.8 nm   (2) 1.6 nm

(3) 1.6 μm   (4) 1.6 mm

116. Which ONE of the following options is TRUE with respect to Emigration ?

(1) It is the difference between the births and deaths in a population.

(2) It is the difference between individuals who have come to a habitat and who have left the habitat.

(3) It involves individuals of different species coming to a habitat from elsewhere during the period under consideration

(4) It involves individuals of a population leaving a habitat during the time period under consideration.

117. Choose the CORRECT combination of statements given below related to cysteine residue in proteins.
   i.   Cysteine can be linked to tyrosine by S-O bond.
   ii. Cysteine can be linked to another cysteine by S-S bond.
   iii. Cysteine can complex with Zn^{2+}.
   iv. Cysteine can be linked to methionine by S-S bond
   (1) i and ii   (2) ii and iii
   (3) iii and iv   (4) i and iv

118. The minimum number of plants to be screened to obtain a plant of the genotype AabbCcDd from a cross beteen plants of genotypes AaBbCcDd and AABbCCDd is
   (1) 8   (2) 16
   (3) 32   (4) 64

119. When a pure bred, red flower-producing plant of genotype RR is crossed with a pure bred, white flower-producing plant of genotype rr, all the F_1 plants produced pink flowers If all the plants in each generation from F_1 to F_6 are selfed, what will be the percentage of plants with red and white flowers in the final population consisting of a large number of individuals ? (Consider that flower colour has no effect on reproduction and survival.)
   (1) 3 – 4   (2) 12 –13
   (3) 49 – 51   (4) 97 – 100

120. The schematic below describes the status of *lac* operon in the absence of lactose. Which ONE of the following happens when lactose is present in the cell?
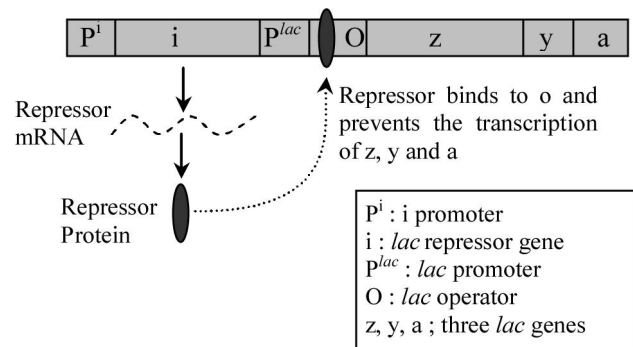
(1) Lactose binds to P^i and stops the transcription of *i*.

(2) Lactose is converted to allolactose, which binds to P^{lac} and results in the displacements of the repressor from O.

(3) Lactose is converted to allolactose, which binds to the repressor protein and prevents its interaction with O.

(4) Lactose has no effect on the status of the *lac* operon.

Space For Rough Work

ANSWERS
KVPY-SB/SX_05.11.2017

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