

TEST PAPER

KVPY-2017

Date : 19-11-2017

Time Allowed: 3 Hrs.

Maximum Marks: 160

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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.

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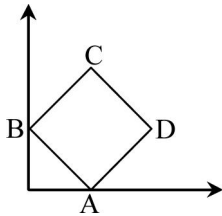
PART-I

One Mark Questions

MATHEMATICS

Choose the correct (✓) answer:

1. Consider a rigid square ABCD as in the figure with A and B on the x and y axis respectively. When A and B slide along their respective axes, the locus of C forms a part of



- (1) a circle
 (2) a parabola
 (3) a hyperbola
 (4) an ellipse which is not a circle
2. Among the inequalities below, which ones are true for all natural numbers n greater than 1000 ?

- I. $n! \leq n^n$ II. $(n!)^2 \leq n^n$
 III. $10^n \leq n!$ IV. $n^n \leq (2n)!$
- (1) I and IV only (2) I, III and IV only
 (3) II and IV only (4) I, II, III and IV

3. Let

$$S = \left\{ \frac{a^2 + b^2 + c^2}{ab + bc + ca} : a, b, c \in \mathbb{R}, ab + bc + ca \neq 0 \right\}$$

where \mathbb{R} is the set of real numbers. Then S equals

- (1) $(-\infty, -1] \cup [1, \infty)$ (2) $(-\infty, 0) \cup (0, \infty)$
 (3) $(-\infty, -1] \cup [2, \infty)$ (4) $(-\infty, -2] \cup [1, \infty)$
4. Let S be the infinite sum given by

$$S = \sum_{n=0}^{\infty} \frac{a_n}{10^{2n}}$$

where $\{a_n\}_{n \geq 0}$ is a sequence defined by $a_0 = a_1 = 1$ and $a_j = 20a_{j-1} - 108a_{j-2}$ for $j \geq 2$.

If S is expressed in the form $\frac{a}{b}$, where a, b are coprime positive integers, then a equals

- (1) 2017 (2) 2020
 (3) 2023 (4) 2025

5. Define a function $f(x) = \frac{16x^2 - 96x + 153}{x - 3}$ for all real

$x \neq 3$. The least positive value of $f(x)$ is

- (1) 16 (2) 18
 (3) 22 (4) 24

6. Let $n > 2$ be an integer and define a polynomial

$$p(x) = x^n + a_{n-1}x^{n-1} + \dots + a_1x + a_0$$

where a_0, a_1, \dots, a_{n-1} are integers. Suppose we know that $np(x) = (1+x)p'(x)$. If $b = p(1)$, then

- (1) b is divisible by 10
 (2) b is divisible by 3
 (3) b is a power of 2
 (4) b is a power of 5

7. The number of 5-tuples (a, b, c, d, e) of positive integers such that

- I. a, b, c, d, e are the measures of angles of a convex pentagon in degrees ;
 II. $a \leq b \leq c \leq d \leq e$;
 III. a, b, c, d, e are in arithmetic progression is

- (1) 35 (2) 36
 (3) 37 (4) 126

Space For Rough Work

8. Thirty two persons X_1, X_2, \dots, X_{32} are randomly seated around a circular table at equal intervals. Two persons X_i and X_j are said to be within earshot of each other if there are at most three persons between them on the minor arc joining X_i and X_j . The probability that X_1 and X_2 are within earshot of each other is,

$$\left(\text{Here } \binom{n}{r} = \frac{n!}{(n-r)!r!} \right)$$

$$(1) \frac{\binom{32}{2} 30!}{8(32!)} \quad (2) \frac{\binom{32}{2} 30!}{4(32!)}$$

$$(3) \frac{8}{31} \quad (4) \frac{4}{31}$$

9. Let n be the smallest positive integer such that

$$1 + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{n} \geq 4.$$

Which one of the following statements is true?

- (1) $20 < n \leq 60$ (2) $60 < n \leq 80$
 (3) $80 < n \leq 100$ (4) $100 < n \leq 120$

10. A pair of 12-sided fair dice with faces numbered 1, 2, 3, ..., 12 is rolled. The probability that the sum of the numbers appearing has remainder 2 when divided by 9 is

$$(1) \frac{7}{72} \quad (2) \frac{5}{48}$$

$$(3) \frac{11}{144} \quad (4) \frac{1}{9}$$

11. Let x_1, x_2, \dots, x_6 be the roots of the polynomial equation $x^6 + 2x^5 + 4x^4 + 8x^3 + 16x^2 + 32x + 64 = 0$. Then

- (1) $|x_i| = 2$ for exactly one value of i
 (2) $|x_i| = 2$ for exactly two values of i
 (3) $|x_i| = 2$ for all values of i
 (4) $|x_i| = 2$ for no value of i

12. In the complex plane, let $z_1 = \sqrt{3} + i$ and $z_2 = \sqrt{3} - i$ be two adjacent vertices of an n -sided regular polygon centered at origin. Then n equals

- (1) 4 (2) 6
 (3) 8 (4) 12

13. Let $A^{-1} = \begin{bmatrix} 1 & 2017 & 2 \\ 1 & 2017 & 4 \\ 1 & 2018 & 8 \end{bmatrix}$. Then $|2A| - |2A^{-1}|$ is

equal to

- (1) 3 (2) -3
 (3) 12 (4) -12

14. An ellipse with its minor and major axis parallel to the coordinate axes passes through $(0,0)$, $(1,0)$ and $(0,2)$. One of its foci lies on the y -axis. The eccentricity of the ellipse is

- (1) $\sqrt{3} - 1$ (2) $\sqrt{5} - 2$
 (3) $\sqrt{2} - 1$ (4) $\frac{\sqrt{3}-1}{2}$

15. Let $I_n = \int_0^1 e^{-y} y^n dy$, where n is a non-negative integer.

Then $\sum_{n=1}^{\infty} \frac{I_n}{n!}$ is

- (1) 1 (2) $1 - \frac{1}{e}$
 (3) $\frac{1}{e}$ (4) $1 + \frac{1}{e}$

16. The number of solutions of the equation $\sin\theta + \cos\theta = \sin 2\theta$ in the interval $[-\pi, \pi]$ is

- (1) 1 (2) 2
 (3) 3 (4) 4

17. Let z_1, z_2, \dots, z_7 be the vertices of a regular heptagon that is inscribed in the unit circle with centre at the origin

in the complex plane. Let $w = \sum_{1 \leq i < j \leq 7} z_i z_j$, then $|w|$ is equal

to

- (1) 0 (2) 1
 (3) 2 (4) 3

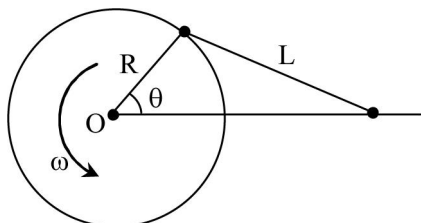
- 18.** The sound of a cannon firing is heard one second later at a position B than at position A. If the speed of sound is uniform, then
- (1) The positions A and B are foci of a hyperbola, with cannon's position on one branch of the hyperbola
 - (2) the position A and B are foci of an ellipse with cannon's position on the ellipse
 - (3) One of the positions A,B is focus of a parabola with cannon's position on the parabola
 - (4) It is not possible to describe the positions of A, B and the cannon with the given information
- 19.** A spherical ball is kept at the corner of a rectangular room such that the ball touches two (Perpendicular) walls and lies on the floor. If a point on the sphere is at distances of 9, 16, 25 from the two walls and the floor, then a possible radius of the sphere is
- (1) 13
 - (2) 15
 - (3) 26
 - (4) 36
- 20.** Let m, n be two distinct integers chosen randomly from the set $\{0, 1, 2, \dots, 99\}$. Then the probability that $4^m + 4^n + 3$ is divisible by 5 lies in the interval
- (1) $(0, 0.25]$
 - (2) $(0.25, 0.5]$
 - (3) $(0.5, 0.75]$
 - (4) $(0.75, 1)$

PHYSICS

- 21.** The distance s travelled by a particle in time t is
- $$s = ut - \frac{1}{2}gt^2$$
- The initial velocity of the particle was measured to be $u = 1.11 \pm 0.01$ m/s and the time interval of the experiment was $t = 1.01 \pm 0.1$ s. The acceleration was taken to be $g = 9.8 \pm 0.1$ m/s². With these measurements, the student estimates the total distance travelled. How should the student report the result?
- (1) 1.121 ± 0.1 m
 - (2) 1.1 ± 0.1 m
 - (3) 1.12 ± 0.07 m
 - (4) 1.1 ± 0.07 m
- 22.** A massive black hole of mass m and radius R is spinning with angular velocity ω . The power P radiated by it as gravitational waves is given by $P = Gc^{-5}m^xR^y\omega^z$, where c and G are speed of light in free space, and the universal gravitational constant, respectively. Then
- (1) $x = -1, y = 2, z = 4$
 - (2) $x = 1, y = 1, z = 4$
 - (3) $x = -1, y = 4, z = 4$
 - (4) $x = 2, y = 4, z = 6$
- 23.** Consider the following statements for air molecules in an air tight container.
- (I) the average speed of molecules is larger than root mean square speed
 - (II) mean free path of molecules is larger than the mean distance between molecules
 - (III) mean free path of molecules increases with temperature
 - (IV) the rms speed of nitrogen molecule is smaller than oxygen molecule
- The true statements are :
- (1) only II
 - (2) II & III
 - (3) II & IV
 - (4) I, II & IV
- 24.** Three circularly shaped linear polarisers are placed coaxially. The transmission axis of the first polariser is at 30° , the second one is at 60° and the third at 90° to the vertical all in the clockwise sense. Each polariser additionally absorbs 10% of the light. If a vertically polarised beam of light of intensity $I = 100$ W/m² is incident on this assembly of polarisers, then the final intensity of the transmitted light will be close to
- (1) 10 W/m²
 - (2) 20 W/m²
 - (3) 30 W/m²
 - (4) 50 W/m²

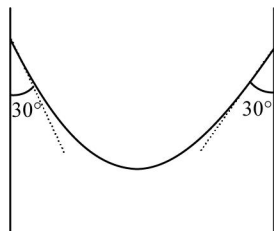
Space For Rough Work

25. One end of a rod of length L is fixed to a point on the circumference of a wheel of radius R . The other end is sliding freely along a straight channel passing through the centre O of the wheel as shown in the figure below. The wheel is rotating with a constant angular velocity ω about O . Taking $T = \frac{2\pi}{\omega}$ the motion of the rod is



- (1) simple harmonic with a period of T
 (2) simple harmonic with a period of $T/2$
 (3) not simple harmonic but periodic with a period of T
 (4) not simple harmonic but periodic with a period of $T/2$
26. A rope of mass 5 kg is hanging between two supports as shown. The tension at the lowest point of the rope is close to (take $g = 10 \text{ m/s}^2$)

- (1) 22 N
 (2) 44 N
 (3) 28 N
 (4) 14 N



27. A uniform rope of total length l is at rest on a table with fraction f of its length hanging (see figure). If the coefficient of friction between the table and the chain is μ then



- (1) $f = \mu$ (2) $f = 1/(1 + \mu)$
 (3) $f = 1/(1 + 1/\mu)$ (4) $f = 1/(\mu + 1/\mu)$

28. A light beam travelling along the x axis with planar wavefront is incident on a medium of thickness t . In the region, where light is falling the refractive index can be taken to be varying such that $\frac{dn}{dy} > 0$. The light beam on the other side of the medium will emerge

- (1) parallel to the x -axis
 (2) bending downward
 (3) bending upward
 (4) split into two or more beams

29. Let the electrostatic field E at distance r from a point charge q not be an inverse square but, instead an inverse cubic, e.g. $\vec{E} = k \frac{q}{r^3} \hat{r}$

Here k is a constant. Consider the following two statements

- (i) Flux through a spherical surface enclosing the charge is $\phi = q_{\text{enclosed}} / \epsilon_0$
 (ii) A charge placed inside uniformly charged shell will experience a force.

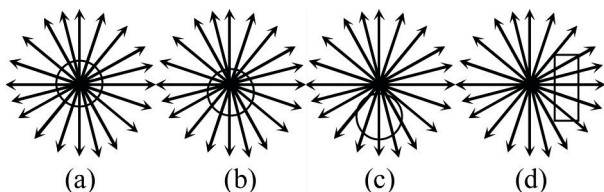
Choose the correct option.

- (1) Only (i) is valid
 (2) Only (ii) is valid
 (3) Both (i) and (ii) are invalid
 (4) Both (i) and (ii) are valid

30. A star of mass M and radius R is made up of gases. The average gravitational pressure compressing the star due to gravitational pull of the gases making up the star depends on R as

- (1) $\frac{1}{R^4}$ (2) $\frac{1}{R}$
 (3) $\frac{1}{R^2}$ (4) $\frac{1}{R^6}$

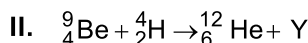
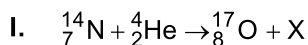
31. The black shapes in the figure below are closed surfaces. The electric field lines are in red. For which case the net flux through the surfaces is non-zero ?



- (1) In all cases net flux is non-zero
 (2) Only (c) and (d)
 (3) Only (a) and (b)
 (4) Only (b), (c) and (d)
32. A particle of charge q and mass m enters a region of a transverse electric field of $E_0 \hat{j}$ with initial velocity $v_0 \hat{i}$. The time taken for the change in the de Broglie wavelength of the charge from the initial value of λ_0 to $\lambda_0/3$ is proportional to

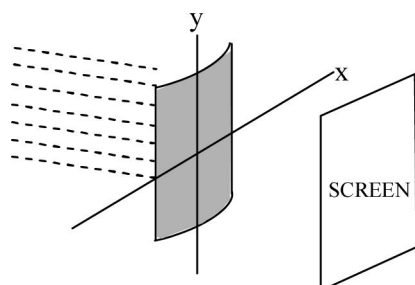
- (1) $\frac{q}{m}$ (2) $\frac{m}{q}$ (3) $\sqrt{\frac{q}{m}}$ (4) $\sqrt{\frac{m}{q}}$

33. Consider the following nuclear reactions :



Then

- (1) X and Y are both protons.
 (2) X and Y are both neutrons.
 (3) X is a proton and Y is a neutron.
 (4) X is a neutron and Y is a proton
34. Consider a plane parallel beam of light incident on a plano-cylindrical lens as shown below. Which of the following will you observe on a screen placed at the focal plane of the lens ?

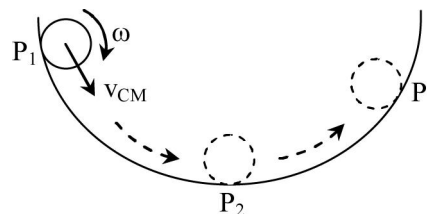


- (1) The screen will be uniformly illuminated.
 (2) There will be a single bright spot on the screen.
 (3) There will be a single bright line on the screen parallel to the x-axis
 (4) There will be a single bright line on the screen parallel to the y-axis

35. The n-side of the depletion layer of a p-n junction :

- (1) always has same width as of the p-side.
 (2) has no bound charges.
 (3) is negatively charged.
 (4) is positively charged.

36. A small ring is rolling without slipping on the circumference of a large bowl as shown in the figure. The ring is moving down at P_1 , comes down to the lower most point P_2 and is climbing up at P_3 . Let \vec{v}_{CM} denote the velocity of the centre of mass of the ring. Choose the correct statement regarding the frictional force on the ring.

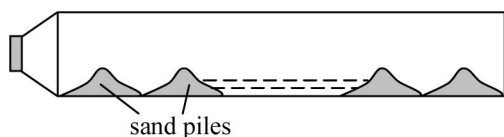


- (1) It is opposite to \vec{v}_{CM} at the points P_1 , P_2 and P_3 .
 (2) It is opposite to CM \vec{v}_{CM} at P_1 and in the same direction as CM \vec{v}_{CM} at P_3 .
 (3) It is in the same direction as \vec{v}_{CM} at P_1 and opposite to \vec{v}_{CM} at P_3 .
 (4) It is zero at the points P_1 , P_2 and P_3 .
37. A bomb explodes at time $t = 0$ in a uniform, isotropic medium of density ρ and releases energy E , generating a spherical blast wave. The radius R of this blast wave varies with time t as :

- (1) t (2) $t^{2/5}$
 (3) $t^{1/4}$ (4) $t^{3/2}$

Space For Rough Work

38. A closed pipe of length 300 cm contains some sand. A speaker is connected at one of its ends. The frequency of the speaker at which the sand will arrange itself in 20 equidistant piles is close to (velocity of sound is 300 m/s)



- (1) 10 kHz (2) 5 kHz
(3) 1 kHz (4) 100 kHz

39. A planet of radius R_p is revolving around a star of radius R^* , which is at temperature T^* . The distance between the star and the planet is d . If the planet's temperature is fT^* , then f is proportional to

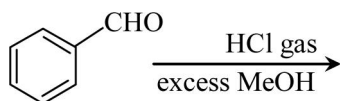
- (1) $\sqrt{R^*/d}$ (2) R^*/d
(3) R^*R_p/d^2 (4) $(R^*/d)^4$

40. Some of the wavelength observed in the emission spectrum of neutral hydrogen gas are 912, 1026, 1216, 3646, 6563 Å. If broad band light is passing through neutral hydrogen gas at room temperature, the wavelength that will not be absorbed strongly is

- (1) 1026 Å (2) 1216 Å
(3) 912 Å (4) 3646 Å

CHEMISTRY

41. The major product formed in the following reaction is



- (1) (2)
(3) (4)

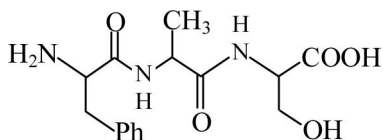
42. Which among the following is a non-benzenoid aromatic compound ?

- (1) *o*-Xylene (2) Phenanthrene
(3) Indole (4) Thiophene

43. Natural rubber is a polymer of

- (1) Neoprene (2) Chloroprene
(3) Isoprene (4) Styrene

44. The following tripeptide



can be represented as

- (1) Tyr-Val-Thr (2) Phe-Ala-Ser
(3) Phe-Leu-Cys (4) Lys-Ala-Ser

45. The sugar units present in natural DNA and RNA, respectively, are

- (1) D-2-deoxyribose and L-ribose
(2) L-2-deoxyribose and D-ribose
(3) D-2-deoxyribose and D-ribose
(4) L-2-deoxyribose and L-ribose

46. The major product formed in the following reaction is $\text{CH}_3\text{Br} + \text{CH}_3\text{CH}_2\text{ONa} \rightarrow$

- (1) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ (2) CH_3OCH_3
(3) $\text{CH}_3\text{CH}_2\text{OCH}_3$ (4) $\text{CH}_3\text{CH}_2\text{OCH}_2\text{Br}$

47. The most abundant metal ion present in the human body is

- (1) Zn^{2+} (2) Ca^{2+}
(3) Na^+ (4) Fe^{2+}

48. Phosphorous reacts with chlorine gas to give a colourless liquid, which fumes in moist air to produce HCl and

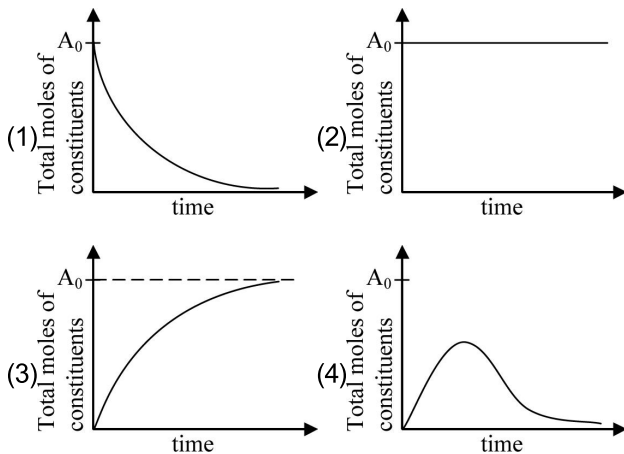
- (1) POCl_3 (2) H_3PO_3
(3) PH_3 (4) H_3PO_4

49. The oxidising ability of the given anions follows the order

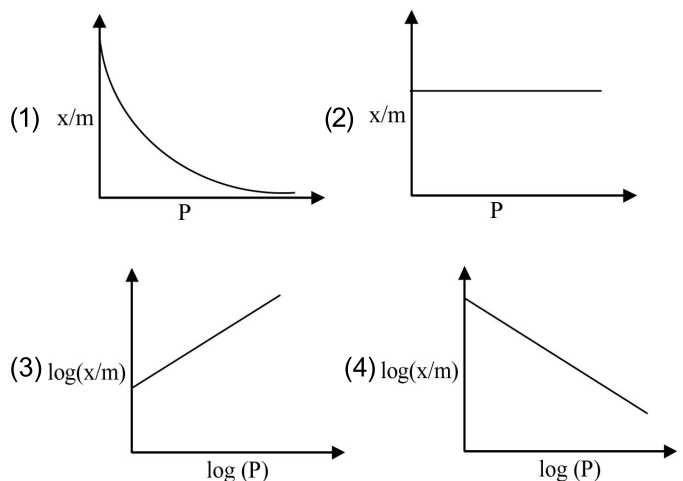
- (1) $\text{TiO}_4^{4-} < \text{VO}_4^{3-} < \text{CrO}_4^{2-} < \text{MnO}_4^-$
(2) $\text{VO}_4^{3-} < \text{CrO}_4^{2-} < \text{MnO}_4^- < \text{TiO}_4^{4-}$
(3) $\text{CrO}_4^{2-} < \text{MnO}_4^- < \text{VO}_4^{3-} < \text{TiO}_4^{4-}$
(4) $\text{VO}_4^{3-} < \text{TiO}_4^{4-} < \text{CrO}_4^{2-} < \text{MnO}_4^-$

Space For Rough Work

50. The complete hydrolysis of XeF_6 results in the formation of
- (1) XeO_2F_2 (2) XeOF_4
 (3) XeO_3 (4) XeO_2
51. The reactivity of the following compounds towards water is in the order
- (1) $\text{Cl}_2\text{O}_7 < \text{P}_2\text{O}_5 < \text{B}_2\text{O}_3$ (2) $\text{B}_2\text{O}_3 < \text{P}_2\text{O}_5 < \text{Cl}_2\text{O}_7$
 (3) $\text{P}_2\text{O}_5 < \text{B}_2\text{O}_3 < \text{Cl}_2\text{O}_7$ (4) $\text{B}_2\text{O}_3 < \text{Cl}_2\text{O}_7 < \text{P}_2\text{O}_5$
52. Among the following complexes, the one that can exist as facial (*fac*) and meridional (*mer*) isomers is
- (1) $[\text{Co}(\text{NO}_2)_3(\text{NH}_3)_3]$ (2) $\text{K}_3[\text{Fe}(\text{CN})_6]$
 (3) $[\text{Co}(\text{H}_2\text{O})_2(\text{NH}_3)_4]\text{Cl}_3$ (4) $[\text{CoCl}(\text{NH}_3)_5]\text{Cl}_2$
53. An excess of $\text{Ag}_2\text{CrO}_4(\text{s})$ is added to a $5 \times 10^{-3} \text{ M}$ K_2CrO_4 solution. The concentration of Ag^+ in the solution is closest to
 [Solubility product for $\text{Ag}_2\text{CrO}_4 = 1.1 \times 10^{-12}$]
- (1) $2.2 \times 10^{-10} \text{ M}$ (2) $1.5 \times 10^{-5} \text{ M}$
 (3) $1.0 \times 10^{-6} \text{ M}$ (4) $5.0 \times 10^{-3} \text{ M}$
54. The packing efficiency in a body-centred cubic (bcc) structure is closest to
- (1) 74 % (2) 63%
 (3) 68 % (4) 52%
55. The consecutive reaction $\text{X} \rightarrow \text{Y} \rightarrow \text{Z}$ takes place in a closed container. Initially, the container has A_0 moles of X (and no Y and Z). The plot of total moles of the constituents in the container as a function of time will be



56. The particle emitted during the sequential radioactive decay of $^{238}\text{U}_{92}$ to $^{206}\text{Pb}_{82}$ are
- (1) 5 α and 6 β (2) 6 α and 8 β
 (3) 8 α and 4 β (4) 8 α and 6 β
57. The allowed set of quantum numbers for an electron in a hydrogen atom is
- (1) $n = 4, l = 2, m_l = 0, m_s = 0$
 (2) $n = 3, l = 1, m_l = -3, m_s = -1/2$
 (3) $n = 3, l = 3, m_l = -1, m_s = 1/2$
 (4) $n = 2, l = 1, m_l = -1, m_s = 1/2$
58. The plot that best represents the relationship between the extent of adsorption (x/m) and pressure (P) is



59. The pH of 0.1 M acetic acid solution is closest to
 [Dissociation constant of acid $K_a = 1.8 \times 10^{-5}$]
- (1) 2.87 (2) 1.00
 (3) 2.07 (4) 4.76
60. The limiting molar conductivities of the given electrolytes at 298 K follow the order
 [$\lambda^0(\text{K}^+) = 73.5, \lambda^0(\text{Cl}^-) = 76.3,$
 $\lambda^0(\text{Ca}^{2+}) = 119.0, \lambda^0(\text{SO}_4^{2-}) = 160.0 \text{ S cm}^2 \text{ mol}^{-1}$]
- (1) $\text{KCl} < \text{CaCl}_2 < \text{K}_2\text{SO}_4$
 (2) $\text{KCl} < \text{K}_2\text{SO}_4 < \text{CaCl}_2$
 (3) $\text{K}_2\text{SO}_4 < \text{CaCl}_2 < \text{KCl}$
 (4) $\text{CaCl}_2 < \text{K}_2\text{SO}_4 < \text{KCl}$

Space For Rough Work

BIOLOGY

- 61.** Resting membrane potential of a neuron is approximately
- (1) -70 mV (2) $+70$ mV
 (3) -0.7 V (4) $+0.7$ V
- 62.** Amphimixis is
- (1) A fusion of pronuclei of male gametes.
 (2) a fusion of pronuclei from male and female gametes
 (3) a fusion of pronuclei of female gametes
 (4) the development of a somatic cell into an embryo
- 63.** Activation of sympathetic nervous system
- (1) decreases blood pressure.
 (2) causes pupil contraction.
 (3) increases heart rate.
 (4) causes bronchoconstriction.
- 64.** At physiological temperature, sterols in biological membranes
- (1) increase their fluidity.
 (2) decrease their fluidity.
 (3) increase their permeability to water.
 (4) decrease their permeability to water.
- 65.** Which ONE of the following is a heteropolysaccharide ?
- (1) Glycogen (2) Starch
 (3) Cellulose (4) Hyaluronic acid
- 66.** Bacterial plasmids are genetic entities that,
- (1) are non-transferable to the same bacterial species.
 (2) are capable of independent replication.
 (3) have RNA as genetic material.
 (4) always require integration in the genome for their replication.
- 67.** Skin-prick test on the forearm is conducted to identify the responsible allergen. This is because
- (1) of the presence of mast cells under the skin.
 (2) lymphocytes migrate rapidly from the blood to the skin.
 (3) hair follicles can enhance the reaction.
 (4) Neutrophils migrate rapidly from the blood to the skin.
- 68.** Which ONE of the following processes in *E coli* does NOT directly involve RNA ?
- (1) DNA replication (2) Transcription
 (3) Translation (4) DNA repair
- 69.** Which ONE of the following statements is INCORRECT for translation in cytoplasm ?
- (1) One codon codes for only one amino acid.
 (2) One amino acid may be coded by many codons.
 (3) More than one amino acids are coded by one specific condon.
 (4) There are some codons that do not code for any amino acid.
- 70.** Two homozygous parents harboring two different alleles of a gene, exhibiting incomplete dominance for flower colour were used for a genetic experiment. Which ONE of the following statements is INCORRECT ?
- (1) The F_2 generation will consist of plants of three different flower colours
 (2) The genotypic and phenotypic ratios obtained in the F_2 generation will be different
 (3) The F_1 generation will be of a different flower colour compared to both the parents
 (4) The genotypic ratio obtained in the F_2 generation will be the same irrespective of whether it is complete dominance or incomplete dominance
- 71.** Which ONE of the following is an essential condition for a population to be at Hardy-Weinberg equilibrium ?
- (1) Random mating (2) Immigration
 (3) Emigration (4) Geographical isolation
- 72.** Inbreeding in a population leads to
- (1) decrease in recessive disorders
 (2) heterosis
 (3) increase in homozygosity
 (4) increase in heterozygosity

Space For Rough Work

73. Which ONE of the following molecules serves as a substrate for direct synthesis of ATP ?
- (1) 1, 3-bisphosphoglycerate
 - (2) Glucose 6-phosphate
 - (3) Pyruvate
 - (4) Fructose 1,6-bisphosphate
74. If a pure chlorophyll solution is illuminated with ultraviolet light, the solution appears
- (1) green
 - (2) violet
 - (3) red
 - (4) black
75. Botanical names of plants are given in Column-I, and the family/order name in Column-II. Choose the appropriate combination from the options below
- | Column-I | Column-II |
|--------------------------------|--------------------|
| (P) <i>Tamarindus indica</i> | (i) Areaceae |
| (Q) <i>Cocos nucifera</i> | (ii) Liliaceae |
| (R) <i>Colchicum autumnale</i> | (iii) Solanaceae |
| (S) <i>Withania somnifera</i> | (iv) Papilionaceae |
- (1) P-iv, Q-i, R-ii, S-iii
 - (2) P-iv, Q-ii, R-iii, S-i
 - (3) P-i, Q-ii, R-iv, S-iii
 - (4) P-iv, Q-i, R-iii, S-ii
76. Nitrogen fixation is inhibited by oxygen. However, in aerobic nitrogen fixing bacteria, nitrogen is fixed in the presence of oxygen. Nitrogenase in such organisms is protected by which ONE of the following mechanisms
- (1) channelizing oxygen to form ozone
 - (2) removal of oxygen by metabolic activity
 - (3) utilizing oxygen for membrane remodelling
 - (4) utilizing oxygen for synthesis of pentapeptide chain in peptidoglycan
77. Frederick Griffith performed an experiment where mice were killed when injected with a mixture of killed S-type *Streptococcus* (HKS) and live R-type *Streptococcus* (LRS) but not with HKS or LRS separately. Mice were killed because
- (1) lipids from HKS made LRS virulent
 - (2) RNA from HKS transformed LRS and made it virulent
 - (3) proteins from HKS made LRS virulent
 - (4) DNA from HKS transformed LRS and made it virulent
78. In diabetic patients, the pH of blood plasma can decrease leading to acidosis. This is because tissues catabolise
- (1) amino acids leading to loss of buffering capacity of the blood
 - (2) stored glycogen leading to the accumulation of pyruvic acid
 - (3) stored fatty acids leading to the accumulation of beta hydroxybutyric acid and acetoacetic acid
 - (4) nucleic acid pool leading to decrease in blood pH
79. If the number of alveoli in an individual is doubled without changing the total alveolar volume, the gas exchange capacity of the lungs will
- (1) increase for both O₂ and CO₂
 - (2) decrease for both O₂ and CO₂
 - (3) remain unaltered for both O₂ and CO₂
 - (4) increase for O₂ and decrease for CO₂
80. In an experiment, bacteria were infected with ³²P labelled virus in a ratio of 5 : 1. The culture was rigorously shaken followed by centrifugation. Radioactivity was
- (1) lost due to metabolic activity
 - (2) detected in supernatant as inorganic phosphate
 - (3) detected in the supernatant in association with viral capsid
 - (4) detected in bacterial cell pellet

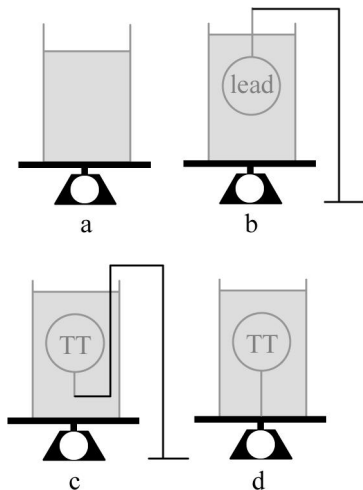
PART-II

Two Mark Questions

MATHEMATICS

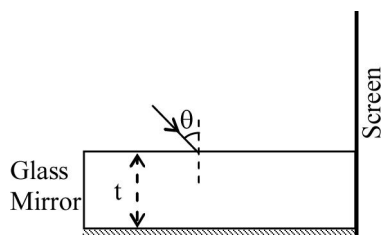
- 81.** Let AB be the latus rectum of the parabola $y^2 = 4ax$ in the xy-plane. Let T be the region bounded by the finite arc AB of the parabola and the line segment AB. A rectangle PQRS of maximum possible area is inscribed in T with P, Q on line AB, and R, S on arc AB. Then $\text{area}(PQRS)/\text{area}(T)$ equals
- (1) $\frac{1}{2}$ (2) $\frac{1}{3}$ (3) $\frac{1}{\sqrt{2}}$ (4) $\frac{1}{\sqrt{3}}$
- 82.** Let A be the set of all permutations a_1, a_2, \dots, a_6 of 1, 2, ..., 6 such that a_1, a_2, \dots, a_k is not a permutation of 1, 2, ..., k for any $k, 1 \leq k \leq 5$. Then the number of elements in A is
- (1) 192 (2) 408
(3) 312 (4) 528
- 83.** The area bounded by the curve $y = \frac{1}{4} |4 - x^2|$ and $y = 7 - |x|$ is
- (1) 18 (2) 32
(3) 36 (4) 64
- 84.** An ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1, a > b$ and the parabola $x^2 = 4(y + b)$ are such that the two foci of the ellipse and the end points of the latus rectum of parabola are the vertices of a square. The eccentricity of the ellipse is
- (1) $\frac{1}{\sqrt{13}}$ (2) $\frac{2}{\sqrt{13}}$
(3) $\frac{1}{\sqrt{11}}$ (4) $\frac{2}{\sqrt{11}}$
- 85.** A sector is removed from a metallic disc and the remaining region is bent into the shape of a circular conical funnel with volume $2\sqrt{3}\pi$. The least possible diameter of the disc is
- (1) 4 (2) 6 (3) 8 (4) 12
- 86.** Let $g(x) = \int_0^{|x|^{2/4}} t^{2/3} \sin \frac{1}{t} dt$, for all real x. Then $\lim_{x \rightarrow 0} \frac{g(x)}{x}$ is equal to
- (1) ∞ (2) $-\infty$
(3) 0 (4) $\frac{3}{4}$
- 87.** Let $a_n = \int_{-\pi}^{\pi} |x-1| \cos nx \, dx$ for all natural numbers n. Then the sequence $(a_n)_{n \geq 0}$ satisfies
- (1) $\lim_{n \rightarrow \infty} a_n = \infty$
(2) $\lim_{n \rightarrow \infty} a_n = -\infty$
(3) $\lim_{n \rightarrow \infty} a_n$ exists and is positive
(4) $\lim_{n \rightarrow \infty} a_n = 0$
- 88.** Let $f(x)$ be a polynomial with integer coefficients satisfying $f(1) = 5$ and $f(2) = 7$. The smallest possible positive value of $f(12)$ is
- (1) 5 (2) 7
(3) 27 (4) 15
- 89.** Suppose four balls labelled 1, 2, 3, 4 are randomly placed in boxes B_1, B_2, B_3, B_4 . The probability that exactly one box is empty is
- (1) $\frac{8}{256}$ (2) $\frac{9}{16}$ (3) $\frac{27}{256}$ (4) $\frac{9}{64}$
- 90.** Let $f(x) = \log(1 + x^2)$ and A be a constant such that $\frac{|f(x) - f(y)|}{|x - y|} \leq A$ for all x, y real and $x \neq y$. Then the least possible value of A is
- (1) equal to 1
(2) bigger than 1 but less than 2
(3) bigger than 0 but less than 1
(4) bigger than 2

97. Four identical beakers contain same amount of water as shown below. Beaker 'a' contains only water. A lead ball is held submerged in the beaker 'b' by string from above. A same sized plastic ball, say a table tennis (TT) ball, is held submerged in beaker 'c' by a string attached to a stand from outside. Beaker 'd' contains same sized TT ball which is held submerged from a string attached to the bottom of the beaker. These beakers (without stand) are placed on weighing pans and register reading W_a , W_b , W_c and W_d for a, b, c and d, respectively. (Effects of the mass and volume of the stand and string are to be neglected)



- (1) $W_a = W_b = W_c = W_d$ (2) $W_b = W_c > W_d > W_a$
 (3) $W_b = W_c > W_a > W_d$ (4) $W_b > W_c > W_d > W_a$

98. Back surface of a glass (refractive index n and thickness t) is polished to work as a mirror as shown below. A laser beam falls on it and is partially reflected and refracted at the air-glass interface and fully reflected at the mirror surface respectively. A pattern of discrete spots of light is observed on the screen.



The spacing between the spots on the screen will be

(1) $\frac{2t \cos \theta}{\sqrt{n^2 - \sin^2 \theta}}$

(2) $\frac{2t \sin \theta}{\sqrt{n^2 - \sin^2 \theta}}$

(3) $\frac{2t \tan \theta}{\sqrt{n^2 - \sin^2 \theta}}$

(4) $\sqrt{1 - \frac{\sin^2 \theta}{n^2}}$

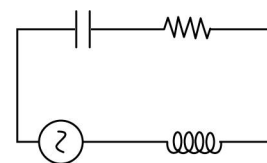
99. Consider the following statements regarding the photoelectric effect experiment :

- (I) Photoelectrons are emitted as soon as the metal is exposed to light
 (II) There is a minimum frequency below which no photo-current is observed
 (III) The stopping potential is proportional to the frequency of light
 (IV) The photo-current varies linearly with the intensity of the light

Which of the above statements indicate that light consists of quanta (photons) with energy proportional to frequency ?

- (1) I and III only (2) II and III only
 (3) II, III and IV only (4) I, II and III only

100. Consider the R-L-C circuit given below. The circuit is driven by a 50 Hz AC source with peak voltage 220 V. If $R = 400 \Omega$, $C = 200 \mu\text{F}$ and $L = 6 \text{ H}$, the maximum current in the circuit is closest to

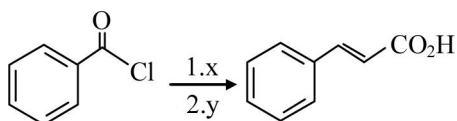


- (1) 0.120 A (2) 0.55 A
 (3) 1.2 A (4) 5.5 A

Space For Rough Work

CHEMISTRY

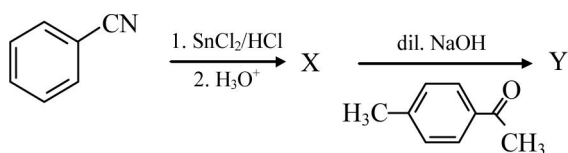
101. In the reaction



x and y are

- (1) $x = \text{H}_2, \text{Pd/BaSO}_4$; $y = \text{NaOAc, Ac}_2\text{O}$
- (2) $x = \text{LiAlH}_4$; $y = \text{NaOAc, Ac}_2\text{O}$
- (3) $x = \text{H}_2, \text{Pd/C}$; $y = \text{NaOH, Ac}_2\text{O}$
- (4) $x = \text{LiAlH}_4$; $y = \text{NaOH, Ac}_2\text{O}$

102. In the following reaction



X and Y are

- (1) $X =$ $Y =$
- (2) $X =$ $Y =$
- (3) $X =$ $Y =$

- (4) $X =$
- $Y =$

103. Acetophenone (PhCOCH_3) reacts with perbenzoic acid to produce a compound X. Reaction of X with excess CH_3MgBr followed by treatment with aqueous acid predominantly produces

- (1)
- (2)
- (3)
- (4)

104. The fusion of chromite ore (FeCr_2O_4) with Na_2CO_3 in air gives a yellow solution upon addition of water. Subsequent treatment with H_2SO_4 produces an orange solution. The yellow and orange colours, respectively, are due to the formation of

- (1) Na_2CrO_4 and $\text{Na}_2\text{Cr}_2\text{O}_7$
- (2) $\text{Cr}(\text{OH})_3$ and $\text{Na}_2\text{Cr}_2\text{O}_7$
- (3) $\text{Cr}_2(\text{CO}_3)_3$ and $\text{Fe}_2(\text{SO}_4)_3$
- (4) $\text{Cr}(\text{OH})_3$ and Na_2CrO_4

105. Hybridization and geometry of $[\text{Ni}(\text{CN})_4]^{2-}$ are

- (1) sp^2d and tetrahedral
- (2) sd^3 and square planar
- (3) sp^3 and tetrahedral
- (4) dsp^2 and square planar

106. The total number of geometrical isomers possible for an octahedral complex of the type $[\text{MA}_2\text{B}_2\text{C}_2]$ is

(M = transition metal ; A, B and C are monodentate ligands)

- (1) 3
- (2) 4
- (3) 5
- (4) 6

Space For Rough Work

- 107.** The maximum work (in kJ mol^{-1}) that can be derived from complete combustion of 1 mol of CO at 298 K and 1 atm is
[Standard enthalpy of combustion of CO = $-283.0 \text{ kJ mol}^{-1}$; standard molar entropies at 298 K; $S_{\text{O}_2} = 205.1 \text{ J mol}^{-1}$, $S_{\text{CO}} = 197.7 \text{ J mol}^{-1}$, $S_{\text{CO}_2} = 213.7 \text{ J mol}^{-1}$]
- (1) 257 (2) 227
(3) 57 (4) 127
- 108.** 18 g of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) dissolved in 1 kg of water is heated to boiling. The boiling point (in K) measured at 1 atm pressure is closest to [Ebulioscopic constant, K_b for water is $0.52 \text{ K kg mol}^{-1}$. Consider absolute zero to be -273.15°C]
- (1) 373.15 (2) 373.10
(3) 373.20 (4) 373.25
- 109.** Polonium (atomic mass = 209) crystallizes in a simple cubic structure with a density of 9.32 g cm^{-3} . Its lattice parameter (in pm) is closest to
(1) 421 (2) 334 (3) 481 (4) 193
- 110.** The following reaction takes place at 298 K in an electrochemical cell involving two metals A and B,
 $\text{A}^{2+}(\text{aq.}) + \text{B}(\text{s}) \rightarrow \text{B}^{2+}(\text{aq.}) + \text{A}(\text{s})$
With $[\text{A}^{2+}] = 4 \times 10^{-3} \text{ M}$ and $[\text{B}^{2+}] = 2 \times 10^{-3} \text{ M}$ in the respective half-cells, the cell EMF is 1.091 V. The equilibrium constant of the reaction is closest to
(1) 4×10^{36} (2) 2×10^{37}
(3) 2×10^{34} (4) 4×10^{37}

BIOLOGY

- 111.** Suppose the three non-linked autosomal genes A, B and C control coat color in an animal and the dominant alleles A, B and C are responsible for dark color and the recessive alleles a, b and c are responsible for light color. If a cross between a male of AABBCc genotype and a female of aabbcc genotype produce 640 offsprings in the F_2 generation, how many of them are likely to be of the parental genotype ?
(1) 10 (2) 20
(3) 160 (4) 640
- 112.** In a population of families having three children each, the percentage of population of families having both boys and girls is
(1) 10 (2) 25
(3) 50 (4) 75
- 113.** As indicated in the gel image, lanes X and Y represent samples obtained from a circular plasmid DNA after complete digestion using restriction enzyme X or Y with different sites, respectively. How many sites for X and Y are present in the plasmid (sizes of the bands in kilo base pairs (kb) is shown) ?
- | | X | Y |
|------|----------|----------|
| 6 kb | ████████ | |
| 5 kb | | ████████ |
| 4 kb | ████████ | |
- (1) 1 for X, 1 for Y (2) 2 for X, 1 for Y
(3) 1 for X, 2 for Y (4) 2 for X, 2 for Y
- 114.** Matthew Meselson and Franklin Stahl grew *E. coli* (doubling time is 20 min) in medium containing $^{15}\text{NH}_4\text{Cl}$ for many generations. Then the *E. coli* was transferred to medium containing $^{14}\text{NH}_4\text{Cl}$. After 40 minutes, the cells were harvested and DNA was extracted and subjected to cesium chloride density gradient centrifugation. The proportion of light and hybrid DNA densities will be
(1) 50% light and 50% hybrid DNA
(2) 100% light DNA
(3) 100% hybrid DNA
(4) 25% light and 75% hybrid DNA

Space For Rough Work

115. In a population interaction between the species X and the species Y, which ONE of the following statements is CORRECT ?

- (1) When X benefits and Y is disadvantaged, it is Competition
- (2) When both X and Y benefit, it is Mutualism
- (3) When both X and Y are disadvantaged, it is Predation
- (4) When both X and Y are disadvantaged, it is Parasitism

116. The protein P, the oligosaccharide O, and the oligonucleotide N are composed of 100 amino acid residues, 100 hexose residues, and 100 nucleotides, respectively. Which ONE of the following orders of molecular weights is CORRECT ?

- (1) $P > O > N$
- (2) $P > N > O$
- (3) $N > O > P$
- (4) $O > P > N$

117. An octapeptide ($\text{NH}_2\text{-Asn-Glu-Tyr-Lys-Trp-Met-Glu-Gly}$) is subjected to complete protease and chemical digestion. Based on the results obtained, choose the INCORRECT option from below.

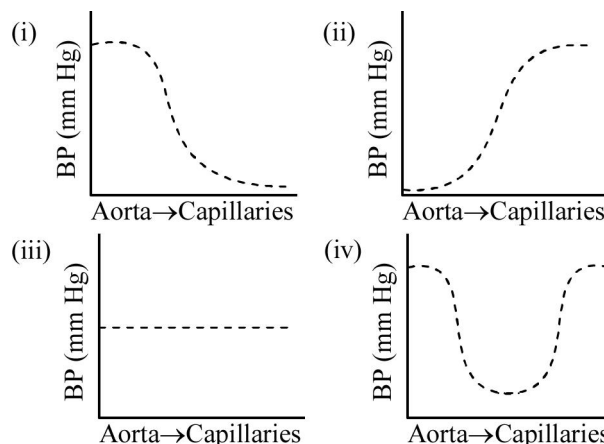
- (1) Trypsin generates mixtures of dimer and trimer
- (2) Trypsin generates tetramers only
- (3) Cyanogen bromide generates a hexamer and a dimer
- (4) Chymotrypsin generates mixture of dimer and trimers

118. Match the enzymes in column-I with their respective biochemical reactions in column-II. Choose the CORRECT combination from below

Column-I	Column-II
(P) Transaminases acid	(i) removal of phosphoryl group from a specific amino
(Q) Protein Kinases acid	(ii) removal of α -amino group from a specific amino
(R) Protein Phosphatases acid	(iii) addition of phosphoryl group to a specific amino
(S) Dehydrogenases	(iv) interconversion of optical isomers
	(v) oxidation and reduction of substrates

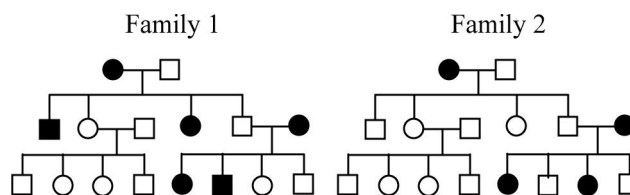
- (1) P-iv, Q-ii, R-iii, S-v
- (2) P-ii, Q-i, R-ii, S-iv
- (3) P-ii, Q-iii, R-i, S-v
- (4) P-v, Q-ii, R-iii, S-i

119. Which ONE of the following graphs best describes the blood pressure (BP) change when blood moves from aorta to capillaries ?



- (1) (i)
- (2) (ii)
- (3) (iii)
- (4) (iv)

120. The following two pedigrees describe the autosomal genetic disorders P and Q in Family 1 and Family 2, respectively. Choose the CORRECT statement from the following options.



- (1) Both P and Q are dominant traits
- (2) P is a dominant trait and Q is a recessive trait
- (3) Both P and Q are recessive traits
- (4) P is a recessive trait and Q is a dominant trait

Space For Rough Work

ANSWERS
KVPY-SB/SX_19.11.2017

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