

TEST PAPER

KVPY-2018

Date : 04-11-2018

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. Suppose $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$ is a real matrix with nonzero entries, $ad - bc = 0$, and $A^2 = A$. Then $a + d$ equals
 - (1) 1
 - (2) 2
 - (3) 3
 - (D) 4
2. On any given arc of positive length on the unit circle $|z|=1$ in the complex plane,
 - (1) there need not be any root of unity
 - (2) there lies exactly one root of unity
 - (3) there are more than one but finitely many roots of unity
 - (D) there are infinitely many roots of unity
3. For $0 < \theta < \frac{\pi}{2}$, four tangents are drawn at the four points $(\pm 3\cos \theta, \pm 2\sin \theta)$ to the ellipse $\frac{x^2}{9} + \frac{y^2}{4} = 1$. If $A(\theta)$ denotes the area of the quadrilateral formed by these four tangents, the minimum value of $A(\theta)$ is
 - (1) 21
 - (2) 24
 - (3) 27
 - (D) 30
4. Let $S = \{x \in \mathbb{R} : \cos(x) + \cos(\sqrt{2}x) < 2\}$. Then
 - (1) $S = \phi$
 - (2) S is a non-empty finite set
 - (3) S is an infinite proper subset of $\mathbb{R} \setminus \{0\}$
 - (D) $S = \mathbb{R} \setminus \{0\}$
5. On a rectangular hyperbola $x^2 - y^2 = a^2$, $a > 0$, three points A, B, C are taken as follows : $A = (-a, 0)$; B and C are placed symmetrically with respect to the x-axis on the branch of the hyperbola not containing A. Suppose that the triangle ABC is equilateral. If the side-length of the triangle ABC is ka , then k lies in the interval
 - (1) $(0, 2]$
 - (2) $(2, 4]$
 - (3) $(4, 6]$
 - (D) $(6, 8]$
6. The number of real solutions x of the equation

$$\cos^2(x \sin(2x)) + \frac{1}{1+x^2} = \cos^2 x + \sec^2 x$$
 is
 - (1) 0
 - (2) 1
 - (3) 2
 - (D) infinite
7. Let $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, $a > b$, be an ellipse with foci F_1 and F_2 . Let AO be its semi-minor axis. Where O is the centre of the ellipse. The lines AF_1 and AF_2 , when extended, cut the ellipse again at points B and C respectively. Suppose that the triangle ABC is equilateral. Then the eccentricity of the ellipse is
 - (1) $\frac{1}{\sqrt{2}}$
 - (2) $\frac{1}{\sqrt{3}}$
 - (3) $\frac{1}{3}$
 - (D) $\frac{1}{2}$

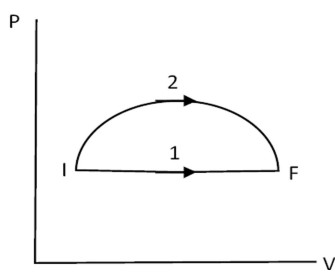
Space For Rough Work

8. Let $a = \cos 1^\circ$ and $b = \sin 1^\circ$. We say that a real number is algebraic if it is a root of a polynomial with integer coefficients. Then
- a is algebraic but b is not algebraic
 - b is algebraic but a is not algebraic
 - both a and b are algebraic
 - neither a nor b is algebraic
9. A rectangle with its sides parallel to the x -axis and y -axis is inscribed in the region bounded by the curves $y = x^2 - 4$ and $2y = 4 - x^2$. The maximum possible area of such a rectangle is closest to the integer
- 10
 - 9
 - 8
 - 7
10. Let $f(x) = x |\sin x|$, $x \in \mathbb{R}$. Then
- f is differentiable for all x , except at $x = \eta\pi$, $\eta = 1, 2, 3, \dots$
 - f is differentiable for all x , except at $x = \eta\pi$, $\eta = \pm 1, \pm 2, \pm 3, \dots$
 - f is differentiable for all x , except at $x = \eta\pi$, $\eta = 0, 1, 2, 3, \dots$
 - f is differentiable for all x , except at $x = \eta\pi$, $\eta = 0, \pm 1, \pm 2, \pm 3, \dots$
11. Let $f : [-1, 1] \rightarrow \mathbb{R}$ be a function defined by
- $$f(x) = \begin{cases} x^2 \left| \cos\left(\frac{\pi}{x}\right) \right| & \text{for } x \neq 0, \\ 0 & \text{for } x = 0, \end{cases}$$
- The set of points where f is not differentiable is
- $\{x \in [-1, 1] : x \neq 0\}$
 - $\{x \in [-1, 1] : x = 0 \text{ or } x = \frac{2}{2n+1}, n \in \mathbb{Z}\}$
 - $\{x \in [-1, 1] : x = \frac{2}{2n+1}, n \in \mathbb{Z}\}$
 - $[-1, 1]$
12. The value of the integral $\int_0^\pi (1 - |\sin 8x|) dx$ is
- 0
 - $\pi - 1$
 - $\pi - 2$
 - $\pi - 3$
13. Let $\ln x$ denote the logarithm of x with respect to the base e . Let $S \subset \mathbb{R}$ be the set of all points where the function $\ln(x^2 - 1)$ is well-defined. Then the number of functions $f : S \rightarrow \mathbb{R}$ that are differentiable, satisfy $f'(x) = \ln(x^2 - 1)$ for all $x \in S$ and $f(2) = 0$, is
- 0
 - 1
 - 2
 - infinite
14. Let S be the set of real numbers p such that there is no nonzero continuous function $f : \mathbb{R} \rightarrow \mathbb{R}$ satisfying $\int_0^x f(t) dt = p f(x)$ for all $x \in \mathbb{R}$. Then S is
- the empty set
 - the set of all rational numbers
 - the set of all irrational numbers
 - the whole set \mathbb{R}
15. The probability of men getting a certain disease is $\frac{1}{2}$ and that of women getting the same disease is $\frac{1}{5}$. The blood test that identifies the disease gives the correct result with probability $\frac{4}{5}$. Suppose a person is chosen at random from a group of 30 males and 20 females, and the blood test of that person is found to be positive. What is the probability that the chosen person is a man?
- $\frac{75}{107}$
 - $\frac{3}{5}$
 - $\frac{15}{19}$
 - $\frac{3}{10}$

- 16.** The number of functions $f : [0, 1] \rightarrow [0, 1]$ satisfying $|f(x) - f(y)| = |x - y|$ for all x, y in $[0, 1]$ is
- (1) exactly 1 (2) exactly 2
(3) more than 2, but finite (D) infinite
- 17.** Suppose A is a 3×3 matrix consisting of integer entries that are chosen at random from the set $\{-1000, 999, \dots, 999, 1000\}$. Let P be the probability that either $A^2 = -I$ or A is diagonal, where I is the 3×3 identity matrix. Then
- (1) $P < \frac{1}{10^{18}}$ (2) $P = \frac{1}{10^{18}}$
(3) $\frac{5^2}{10^{18}} \leq P \leq \frac{5^3}{10^{18}}$ (D) $P \geq \frac{5^4}{10^{18}}$
- 18.** Let X_k be real numbers such that $X_k \geq k^4 + k^2 + 1$ for $1 \leq k \leq 2018$. Denote $N = \sum_{k=1}^{2018} k$. Consider the following inequalities:
- I. $\left(\sum_{k=1}^{2018} k x_k \right)^2 \leq N \left(\sum_{k=1}^{2018} k x_k^2 \right)$
- II. $\left(\sum_{k=1}^{2018} k x_k \right)^2 \leq N \left(\sum_{k=1}^{2018} k^2 x_k^2 \right)$
- Then
- (1) both I and II are true (2) I is true and II is false
(3) I is false and II is true (D) both I and II are false
- 19.** Let $x^2 = 4ky$, $k > 0$, be a parabola with vertex A . Let BC be its latus rectum. An ellipse with center on BC touches the parabola at A , and cuts BC at points D and E such that $BD = DE = EC$ (B, D, E, C in that order). The eccentricity of the ellipse is
- (1) $\frac{1}{\sqrt{2}}$
(2) $\frac{1}{\sqrt{3}}$
(3) $\frac{\sqrt{5}}{3}$
(D) $\frac{\sqrt{3}}{2}$
- 20.** Let $f : [0, 1] \rightarrow [-1, 1]$ and $g : [-1, 1] \rightarrow [0, 2]$ be two functions such that g is injective and $g \circ f : [0, 1] \rightarrow [0, 2]$ is surjective. Then
- (1) f must be injective but need not be surjective
(2) f must be surjective but need not be injective
(3) f must be bijective
(D) f must be a constant function

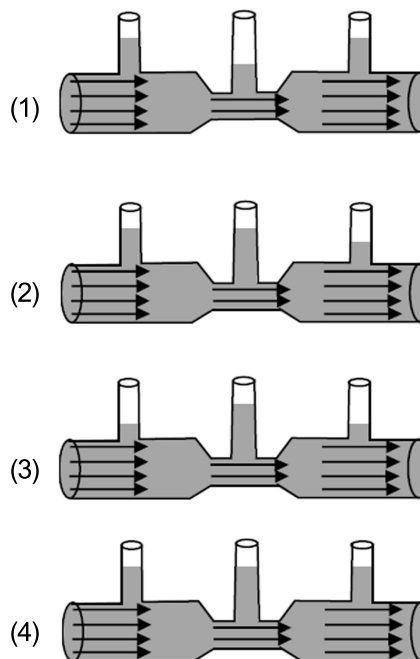
PHYSICS

- 21.** A table has a heavy circular top of radius 1m and mass 20 kg, placed on four light (considered massless) legs placed symmetrically on its circumference. The maximum mass that can be kept anywhere on the table without toppling it is close to
- (1) 20 kg (2) 34 kg
(3) 47 kg (4) 59 kg
- 22.** Air (density ρ) is being blown on a soap film (surface tension T) by a pipe of radius R with its opening right next to the film. The film is deformed and a bubble detaches from the film when the shape of the deformed surface is a hemisphere. Given that the dynamic pressure on the film due to the air blown at speed v is $\frac{1}{2}\rho v^2$, the speed at which the bubble is formed is
- (1) $\sqrt{\frac{T}{\rho R}}$ (2) $\sqrt{\frac{2T}{\rho R}}$
(3) $\sqrt{\frac{4T}{\rho R}}$ (4) $\sqrt{\frac{8T}{\rho R}}$
- 23.** For an ideal gas the internal energy is given by $U = 5PV/2 + C$, where C is a constant. The equation of the adiabats in the PV plane will be
- (1) $P^5V^7 = \text{constant}$ (2) $P^7V^5 = \text{constant}$
(3) $P^3V^5 = \text{constant}$ (4) $P^5V^2 = \text{constant}$
- 24.** An ideal gas undergoes change in its state from the initial state I to the final state F via two possible paths as shown. Then



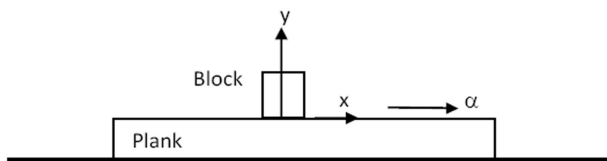
- (1) there is no change in internal energy along path 1
(2) heat is not absorbed by the gas in both paths
(3) the temperature of the gas first increases and then decreases for path 2
(4) work done by the gas is larger in path 1.

- 25.** A thermally insulated rigid container of one litre volume contains a diatomic ideal gas at room temperature. A small paddle installed inside the container is rotated from the outside such that the pressure rises by 10^5 Pa. The change in internal energy is close to
- (1) 0 J (2) 67 J
(3) 150 J (4) 250 J
- 26.** In a Young's double slit experiment the amplitudes of the two waves incident on the two slits are A and $2A$. If I_0 is the maximum intensity, then the intensity at a spot on the screen where the phase difference between the two interfering waves is ϕ .
- (1) $I_0 \cos^2(\phi/2)$ (2) $\frac{I_0}{3} \sin^2(\phi/2)$
(3) $\frac{I_0}{9}(5 + 4 \cos(\phi))$ (4) $\frac{I_0}{9}(5 + 8 \cos(\phi))$
- 27.** Figure below show water flowing through a horizontal pipe from left to right. Note that the pipe in the middle is narrower. Choose the most appropriate depiction of water levels in the vertical pipes.



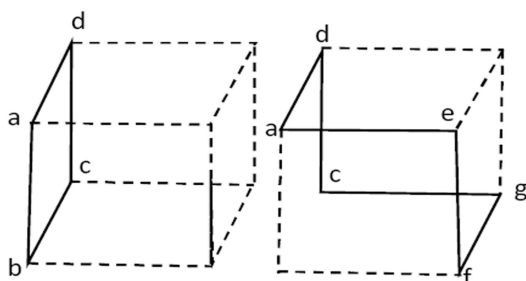
Space For Rough Work

28. A plank is moving in a horizontal direction with a constant acceleration $a \hat{i}$. A uniform rough cubical block of side ℓ rests on the plank, and is at rest relative to the plank.



Let the center of mass of the block be at $(0, \ell/2)$ at a given instant. If $a = g/10$, then the normal reaction exerted by the plank on the block at that instant acts at

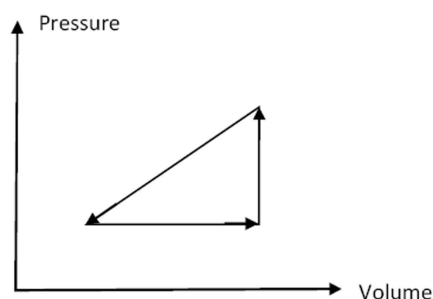
- (1) $(0,0)$ (2) $(-\ell/20,0)$
 (3) $(-\ell/10,0)$ (4) $(\ell/10,0)$
29. Using the Heisenberg uncertainty principle, arrange the following particles in the order of increasing lowest energy possible
- (I) an electron in H_2 molecule
 (II) a H atom in a H_2 molecule
 (III) a proton in the carbon nucleus
 (IV) a H_2 molecule within a nanotube
- (1) (I) < (III) < (II) < (IV) (2) (IV) < (II) < (I) < (III)
 (3) (II) < (IV) < (III) < (I) (4) (IV) < (I) < (II) < (III)
30. The current is flowing along the path abcd of a cube (shown to the left) produces a magnetic field at the centre of cube of magnitude B . Dashed line depicts the non-conducting part of the cube.



Consider a cubical shape shown to the right which is identical in size and shape to the left. If the same current now flows in along the path daefgd, then the magnitude of magnetic field at the centre will be

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

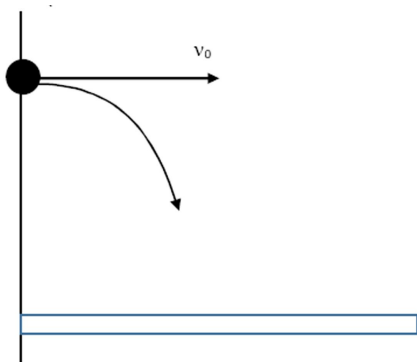
31. A thin metallic disc is rotating with constant angular velocity about a vertical axis that is perpendicular to its plane and passes through its centre. The rotation causes the free electrons in the disc to redistribute. Assume that there is no external electric or magnetic field. Then
- (1) a point on the rim of the disc is at a higher potential than the centre.
 (2) a point on the rim of the disc is at a lower potential than the centre.
 (3) a point on the rim of the disc is at the same potential as the centre
 (4) the potential in the material has an extremum between center and the rim
32. One mole of a monatomic gas and one mole of a diatomic gas are initially in the same state. Both gases are expanded isothermally and then adiabatically such that they acquire the same final state. Choose the correct statement.
- (1) work done by diatomic gas is more than that by monatomic gas
 (2) work done by monatomic gas is more than that by diatomic gas
 (3) work done by both the gases are equal
 (4) change in internal energies of both the gases are equal
33. An ideal gas is made to undergo the cyclic process shown in the figure below. Let ΔW depict the work done, ΔU be the change in internal energy of the gas and Q be the heat added to the gas. sign of each of these three quantities for the whole cycle will be (0 refers to no change)



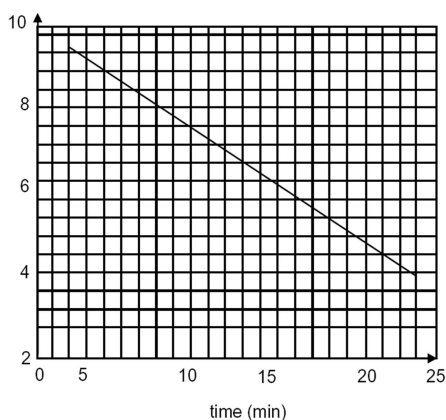
- (1) $-, 0, -$ (2) $+, 0, +$
 (3) $0,0,0$ (4) $+,+,+$

Space For Rough Work

34. Two balls of mass M and $2M$ are thrown horizontally with the same initial velocity v_0 from top of a tall tower and experience a drag force of $-kv$ ($k > 0$), where v is the instantaneous velocity. Then

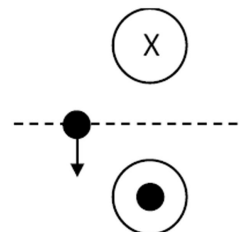


- (1) the heavier ball will hit the ground further away than the lighter ball
 (2) the heavier ball will hit the ground closer than the lighter ball
 (3) both balls will hit the ground at the same point
 (4) both balls will hit the ground at the same time
35. Consider a glass cube slab of dielectric bound by the planes $x = 0$, $x = a$; $y = 0$, $y = b$; $z = 0$, $z = c$; with $b > a > c$. The slab is placed in air and has a refractive index of n . The minimum value of n such that all rays entering the dielectric at $y = 0$ reach $y = b$ is
- (1) 1 (2) $\sqrt{2}$
 (3) $\sqrt{3}$ (4) 2
36. The graph shows the log of activity ($\log R$) of a radioactive material as a function of time t in minutes



The half-life (in minutes) for the decay is closest to

- (1) 2.1 (2) 3.0
 (3) 3.9 (4) 4.4
37. The magnetic field is uniform for $y > 0$ and points into the plane. The magnetic field is uniform and points out of the plane for $y < 0$. A proton denoted by filled circle leaves $y = 0$ in the $-y$ direction with some speed as shown below.



Which of the following best denotes the trajectory of the proton.

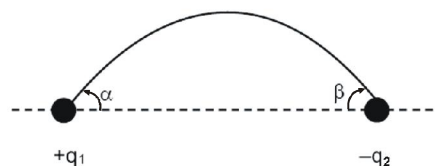
- (1)
- (2)
- (3)
- (4)

38. The Hitomi satellite recently observed the Lyman alpha emission line ($n = 2$ to $n = 1$) of Hydrogen-like iron ion (atomic number of iron is 26) from the Perseus galaxy cluster. The wavelength of the line is closest to
- (1) 2 \AA (2) 1 \AA
 (3) 50 \AA (4) 10 \AA

Space For Rough Work

39. Assume that the drag force on a football depends only on the density of the air, velocity of the ball and the cross-sectional area of the ball. Balls of different sizes but the same density are dropped in an air column. The terminal velocity reached by balls of masses 250 g and 125 g are in the ratio :
- (1) $2^{1/6}$ (2) $2^{1/3}$
 (3) $2^{1/2}$ (4) $2^{2/3}$

40. An electrostatic field line leaves at an angle α from point charge q_1 and connects with point charge $-q_2$ at an angle β (q_1 and q_2 are positive) (see figure below). If $q_2 = \frac{3}{2} q_1$ and $\alpha = 30^\circ$, then



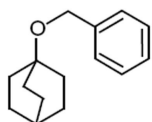
- (1) $0^\circ < \beta < 30^\circ$ (2) $\beta = 30^\circ$
 (3) $30^\circ < \beta \leq 60^\circ$ (4) $60^\circ < \beta \leq 90^\circ$

CHEMISTRY

41. The amount (in mol) of bromoform (CHBr_3) produced when 1.0 mol of acetone reacts completely with 1.0 mol of bromine in the presence of aqueous NaOH is

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

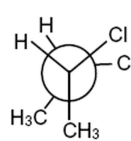
42. The following compound



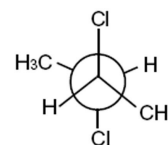
can readily be prepared by Williamson ether synthesis by reaction between

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

43. X and Y



X



Y

are

- (1) enantiomers (2) diastereomers
 (3) constitutional isomers (4) conformers

44. The higher stabilities of tert-butyl cation over isopropyl cation, and trans-2-butene over propene, respectively, are due to orbital interactions involving.

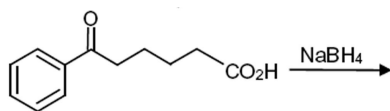
- (1) $\sigma \rightarrow \pi$ and $\sigma \rightarrow \pi^*$
 (2) $\sigma \rightarrow$ vacant p and $\pi \rightarrow \pi^*$
 (3) $\sigma \rightarrow \sigma^*$ and $\sigma \rightarrow \pi$
 (4) $\sigma \rightarrow$ vacant p and $\sigma \rightarrow \pi^*$

45. Benzaldehyde can be converted to benzyl alcohol in concentrated aqueous NaOH solution using

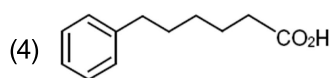
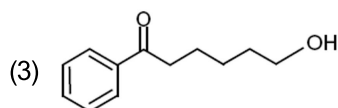
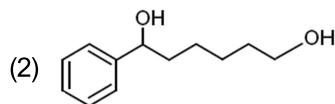
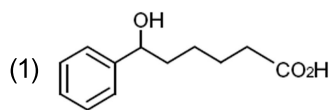
- (1) acetone (2) acetaldehyde
 (3) formic acid (4) formaldehyde

Space For Rough Work

46. The major product of the following reaction



is



47. Among the following species, the H–X–H angle (X=B, N or P) follows the order

- (1) $\text{PH}_3 < \text{NH}_3 < \text{NH}_4^+ < \text{BF}_3$
- (2) $\text{NH}_3 < \text{PH}_3 < \text{NH}_4^+ < \text{BF}_3$
- (3) $\text{BF}_3 < \text{PH}_3 < \text{NH}_4^+ < \text{NH}_3$
- (4) $\text{BF}_3 < \text{NH}_4^+ < \text{NH}_3 < \text{PH}_3$

48. The ionic radii of Na^+ , F^- , O^{2-} , N^{3-} follow the order

- (1) $\text{O}^{2-} > \text{F}^- > \text{Na}^+ > \text{N}^{3-}$
- (2) $\text{N}^{3-} > \text{Na}^+ > \text{F}^- > \text{O}^{2-}$
- (3) $\text{N}^{3-} > \text{O}^{2-} > \text{F}^- > \text{Na}^+$
- (4) $\text{Na}^+ > \text{F}^- > \text{O}^{2-} > \text{N}^{3-}$

49. The oxoacid of phosphorus having the strongest reducing property is

- (1) H_3PO_3
- (2) H_3PO_2
- (3) H_3PO_4
- (4) $\text{H}_4\text{P}_2\text{O}_7$

50. Among C, S and P, the element(s) that produce (s) SO_2 on reaction with hot conc. H_2SO_4 is/are

- (1) only S
- (2) only C and S
- (3) only S and P
- (4) C, S and P

51. The complex that can exhibit linkage isomerism is

- (1) $[\text{Co}(\text{NH}_3)_5(\text{H}_2\text{O})]\text{Cl}_3$
- (2) $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]\text{Cl}_2$
- (3) $[\text{Co}(\text{NH}_3)_5(\text{NO}_3)](\text{NO}_3)_2$
- (4) $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{SO}_4$

52. The tendency of X in BX_3 (X = F, Cl, OMe, NMe) to form a π bond with boron follows the order

- (1) $\text{BCl}_3 < \text{BF}_3 < \text{B}(\text{OMe})_3 < \text{B}(\text{NMe}_2)_3$
- (2) $\text{BF}_3 < \text{BCl}_3 < \text{B}(\text{OMe})_3 < \text{B}(\text{NMe}_2)_3$
- (3) $\text{BCl}_3 < \text{B}(\text{NMe}_2)_3 < \text{B}(\text{OMe})_3 < \text{BF}_3$
- (4) $\text{BCl}_3 < \text{BF}_3 < \text{B}(\text{NMe}_2)_3 < \text{B}(\text{OMe})_3$

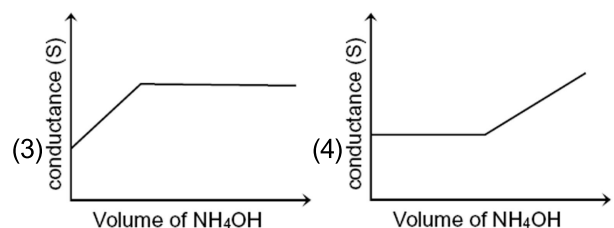
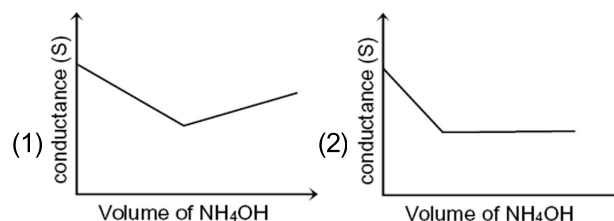
53. Consider the following statements about Langmuir isotherm :

- (i) The free gas and adsorbed gas are in dynamic equilibrium
- (ii) All adsorption sites are equivalent
- (iii) The initially adsorbed layer can act as a substrate for further adsorption
- (iv) The ability of a molecule to get adsorbed at a given site is independent of the occupation of neighboring sites

The correct statements are

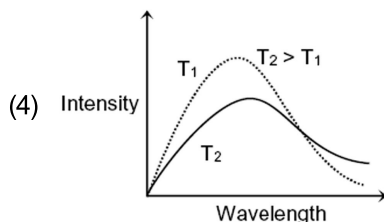
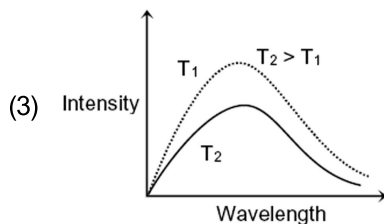
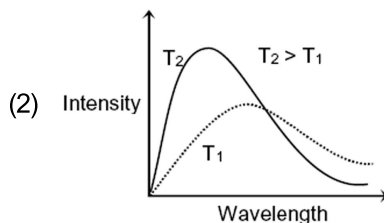
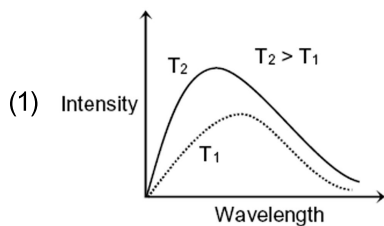
- (1) (i), (ii), (iii) and (iv)
- (2) only (i), (ii) and (iv)
- (3) only (i), (iii) and (iv)
- (4) only (i), (ii) and (iii)

54. Among the following, the plot that correctly represents the conductometric titration of 0.05 M H_2SO_4 with 0.1 M NH_4OH is

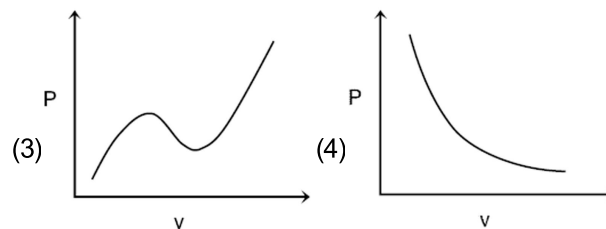
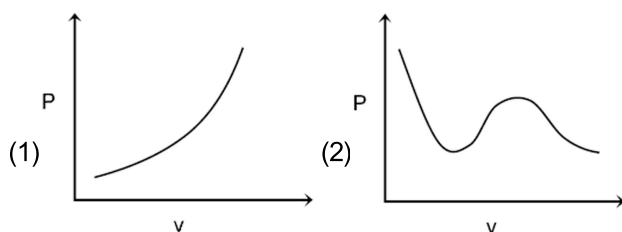


Space For Rough Work

55. The correct representation of wavelength intensity relationship of an ideal blackbody radiation at two different temperatures T_1 and T_2 is



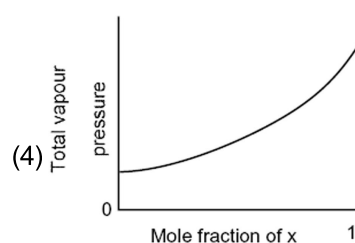
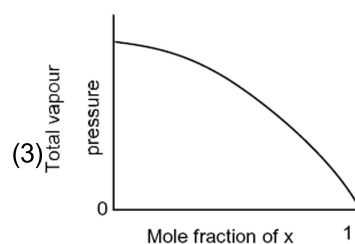
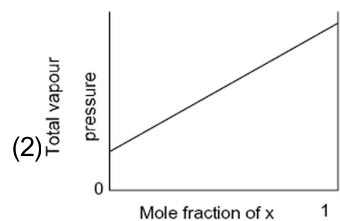
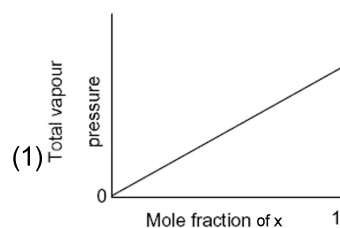
56. The pressure (P)-volume (V) isotherm of a van der Waals gas, at the temperature at which it undergoes gas to liquid transition, is correctly represented by



57. A buffer solution can be prepared by mixing equal volumes of

- (1) 0.2 M NH_4OH and 0.1 M HCl
- (2) 0.2 M NH_4OH and 0.2 M HCl
- (3) 0.2 M NaOH and 0.1 M CH_3COOH
- (4) 0.1 M NH_4OH and 0.2 M HCl

58. The plot of total vapour pressure as a function of mole fraction of the components of an ideal solution formed by mixing liquids X and Y is

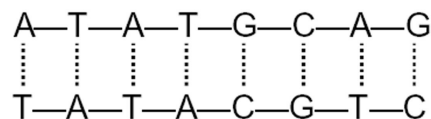


Space For Rough Work

59. On complete hydrogenation, natural rubber produces

- (1) polyethylene
- (2) ethylene-propylene copolymer
- (3) polyvinyl chloride
- (4) polypropylene

60. The average energy of each hydrogen bond in A-T pair is $x \text{ kcal mol}^{-1}$ and that in G-C pair is $y \text{ kcal mol}^{-1}$. Assuming that no other interaction exists between the nucleotides, the approximate energy required in kcal mol^{-1} to split the following double stranded DNA into two single strands is



[Each dashed line may represent more than one hydrogen bond between the base pairs]

- (1) $10x + 9y$
- (2) $5x + 3y$
- (3) $15x + 6y$
- (4) $5x + 4.5y$

BIOLOGY

61. What is the maximum number of oxygen atoms that a molecule of hemoglobin can bind?

- (1) 2
- (2) 4
- (3) 8
- (4) 16

62. Bt toxin produced by *Bacillus thuringiensis* does not kill the producer because the toxin is

- (1) In an inactive protoxin form
- (2) Rapidly secreted outside
- (3) Inactivated by an antitoxin
- (4) In unfolded form

63. An angiosperm was identified with its endosperm of 6n. Assuming that it is a self-pollinating species, which ONE of the following is the correct ploidy of the parent?

- (1) $3n$
- (2) $4n$
- (3) $6n$
- (4) $8n$

64. Which ONE of the following statements is TRUE about viruses?

- (1) All viruses possess a protein coat around its genetic material at all stages of their life cycle
- (2) All viruses contain RNA as genetic material
- (3) All viruses contain DNA as genetic material
- (4) All viruses replicate only within the host cell

65. Mitochondrial cristae are infoldings of the

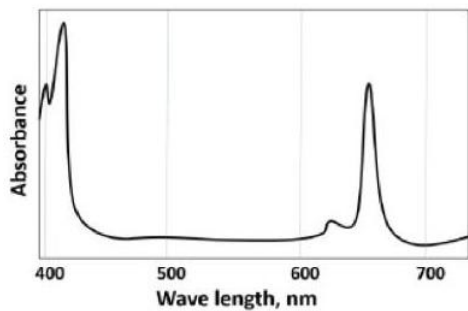
- (1) Outer membrane and they increase the surface area
- (2) Outer membrane and they decrease the surface area
- (3) Inner membrane and they increase the surface area
- (4) Inner membrane and they decrease the surface area

66. In biological nitrogen fixation the enzyme nitrogenase converts

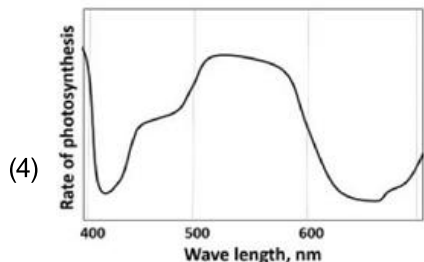
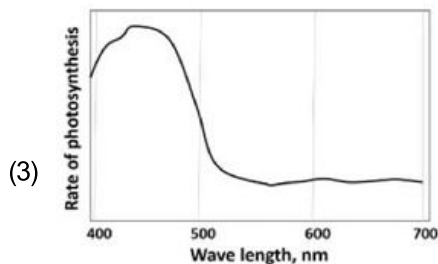
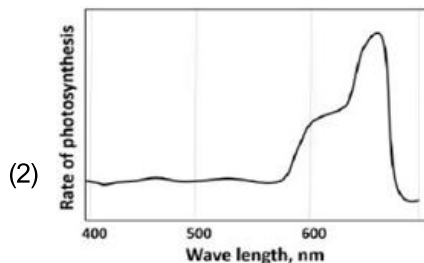
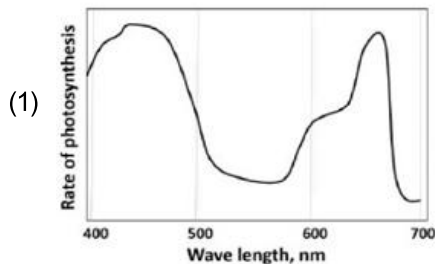
- (1) Nitrate to nitrite
- (2) Atmospheric nitrogen to nitrite
- (3) Nitrite to ammonia
- (4) Atmospheric nitrogen to ammonia

Space For Rough Work

67. The graph below represents the absorption spectrum of major pigment contributing to photosynthesis?



Which ONE of the following best represents the photosynthetic efficiency or the pigment?



68. Which ONE of the following properties of normal cell is lost during its transition to cancerous cell?

- (1) Glutamine utilization
- (2) Contact inhibition
- (3) Glucose utilization
- (4) Membrane fluidity

69. Which ONE of the following gases is produced during fermentation by yeast?

- (1) CO_2
- (2) O_2
- (3) H_2
- (4) N_2

70. Serine proteases are called so because they?

- (1) Require free serine for their activity
- (2) Cleave after serine residues in the substrate
- (3) Are inhibited by the presence of free serine
- (4) Have a serine residue at their active site

71. The maximum number of genotypes of the pollens produced by a tall pea plant with round, yellow seeds of the genotype TtRrYY , if the three loci are unlinked, would be :

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

72. ONE of the following statements is TRUE with respect to human ovary?

- (1) Estrogen is secreted by Graafian follicles and progesterone by corpus luteum
- (2) Estrogen is secreted by corpus luteum and progesterone by Graafian follicles
- (3) Both estrogen and progesterone are secreted by Graafian follicles
- (4) Both estrogen and progesterone are secreted by corpus luteum

73. Which ONE of the following statements is INCORRECT with respect to human antibodies?

- (1) They can neutralize microbes
- (2) They are synthesised by T cells
- (3) They are made up of four polypeptide chains
- (4) Milk contains antibodies

Space For Rough Work

- 74.** Concentration (%) of NaCl isotonic to human blood is
 (1) 0.085–0.09 % (2) 1.7 – 1.8 %
 (3) 3.4 – 3.6 % (4) 0.85–0.9 %
- 75.** Which ONE of the following statements is TRUE about the Golgi apparatus?
 (1) It is found only in animals
 (2) It is found only in prokaryotes
 (3) It modifies and targets proteins to the plasma membrane
 (4) It is a site for ATP production
- 76.** Creutzfeldt Jakob Disease (CJD) is a transmissible disease caused by a :
 (1) Virus (2) Bacterium
 (3) Fungus (4) misfolded protein
- 77.** A researcher found petrified dinosaur faeces. Which ONE of the following is unlikely to be found in this fossil?
 (1) Decayed conifer wood (2) Bamboo
 (3) Cycad (4) Giant fern
- 78.** Which ONE of the pairs of amino- acids contains two chiral centres?
 (1) Isoleucine and threonine
 (2) Leucine and valine
 (3) Valine and isoleucine
 (4) Threonine and leucine
- 79.** In photosynthetic carbon fixation, which ONE of the following reacts with CO₂?
 (1) Phosphoglycolate
 (2) 3-Phosphoglycerate
 (3) Ribulose-1,5-bisphosphate
 (4) Ribulose-5-phosphate
- 80.** Match the diseases in **Column-I** with the routes of infection in **Column-II**. Choose the CORRECT combination :
- | Column-I | Column-II |
|-----------------|--------------------------------|
| P. Tuberculosis | i. Contaminated food and water |
| Q. Dysentery | ii. inhalation of aerosol |
| R. Filariasis | iii. Contact via skin |
| S. Syphilis | iv. Sexual intercourse |
| | v. Mosquito bite |
- (1) P-ii, Q-i, R-v, S-iv
 (2) P-ii, Q-i, R-iii, S-v
 (3) P-i, Q-iii, R-v, S-iv
 (4) P-ii, Q-iii, R-iv, S-v

Space For Rough Work

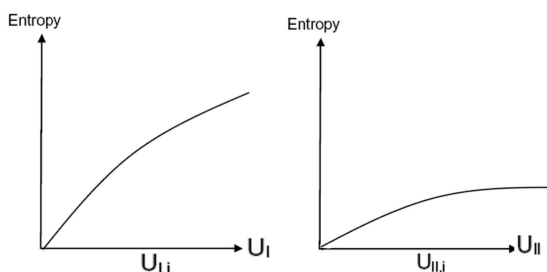
PART-II

Two Mark Questions

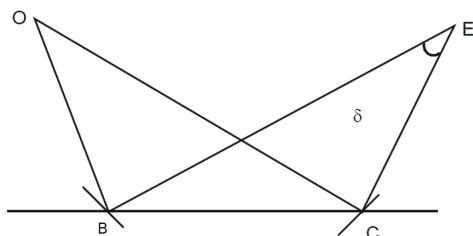
MATHEMATICS

- 81.** Let R be a rectangle, C be a circle, and T be a triangle in the plane. The maximum possible number of points common to the perimeters of R, C, and T is
- (1) 3 (2) 4
(3) 5 (4) 6
- 82.** The number of different possible values for the sum $x + y + z$, where x, y, z are real numbers such that $x^2 + 4y^4 + 16z^4 + 64 = 32xyz$ is
- (1) 1 (2) 2
(3) 4 (4) 8
- 83.** Let Γ be a circle with diameter AB and centre O. Let ℓ be the tangent to Γ at B. For each point M on Γ different from A, consider the tangent t at M and let it intersect ℓ at P. Draw a line parallel to AB through P intersecting Γ at Q. The locus of Q as M varies over Γ is
- (1) an arc of a circle
(2) a parabola
(3) an arc of an ellipse
(4) a branch of a hyperbola
- 84.** The number of solution x of the equation $\sin(x + x^2) - \sin(x^2) = \sin x$ in the interval $[2, 3]$ is
- (1) 0 (2) 1
(3) 2 (4) 3
- 85.** The number of polynomials $p: \mathbb{R} \rightarrow \mathbb{R}$ satisfying $p(0) = 0$, $p(x) > x^2$ for all $x \neq 0$, and $p''(0) = \frac{1}{2}$ is
- (1) 0 (2) 1
(3) more than 1, but finite (4) infinite
- 86.** Suppose the limit $L = \lim_{n \rightarrow \infty} \sqrt{n} \int_0^1 \frac{1}{(1+x^2)^n} dx$ exists and is larger than $\frac{1}{2}$. Then
- (1) $\frac{1}{2} < L < 2$ (2) $2 < L < 4$
(3) $3 < L < 4$ (4) $L \geq 4$
- 87.** Consider the set A_n of points (x, y) such that $0 \leq x \leq n$, $0 \leq y \leq n$ where n, x, y are integers. Let S_n be the set of all lines passing through at least two distinct points from A_n . Suppose we choose a line ℓ at random from S_n . Let P_n be the probability that ℓ is tangent to the circle $x^2 + y^2 = n^2 \left(1 + \left(1 - \frac{1}{\sqrt{n}} \right)^2 \right)$. Then the limit $\lim_{n \rightarrow \infty} P_n$ is
- (1) 0 (2) 1
(3) $1/\pi$ (4) $1/\sqrt{2}$
- 88.** Let $f: [0, 1] \rightarrow \mathbb{R}$ be an injective continuous function that satisfies the condition $-1 < f(0) < f(1) < 1$. Then the number of functions $g: [-1, 1] \rightarrow [0, 1]$ such that $(g \circ f)(x) = x$ for all $x \in [0, 1]$ is
- (1) 0 (2) 1
(3) more than 1, but finite (4) infinite
- 89.** The maximum possible area bounded by the parabola $y = x^2 + x + 10$ and a chord of the parabola of length 1 is
- (1) $\frac{1}{12}$ (2) $\frac{1}{6}$
(3) $\frac{1}{3}$ (4) $\frac{1}{2}$
- 90.** Suppose z is any root of $11z^8 + 20iz^7 + 10iz - 22 = 0$, where $i = \sqrt{-1}$. Then $S = |z|^2 + |z| + 1$ satisfies
- (1) $S \leq 3$ (2) $3 < S < 7$
(3) $7 \leq S < 13$ (4) $S \geq 13$

96. Graphs below show the entropy vs energy (U) of two systems I and II at constant volume. The initial energies of the systems are indicated by $U_{I,i}$ and $U_{II,i}$ respectively. Graphs are drawn to the same scale. The systems are then brought into thermal contact with each other. Assume that at all times the combined energy of the two systems remains constant. Choose the most appropriate option indicating the energies of the two systems and the total entropy after they achieve the equilibrium.



- (1) U_I increases and U_{II} decreases and the total entropy remains the same
 (2) U_I decreases and U_{II} increases and the total entropy remains the same.
 (3) U_I increases and U_{II} decreases and the total entropy increases.
 (4) U_I decreases and U_{II} increases and the total entropy increases.
97. The image of an object O due to reflection from the surface of a lake is elongated due to the ripples on the water surface caused by a light breeze. This is because the ripples act as tilted mirrors as shown. Consider the case where O and the observer E are at the same height above the surface of the lake. If the maximum angle that the ripples make with the horizontal is α , the angular extent δ of the image will be

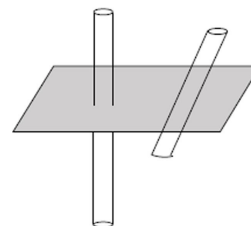


- (1) $\frac{\alpha}{2}$ (2) α
 (3) 2α (4) 4α

98. A spiral galaxy can be approximated as an infinitesimally thin disk of a uniform surface mass density (mass per unit area) located at $z = 0$. Two stars A and B start from rest from heights $2z_0$ and z_0 ($z_0 \ll$ radial extent of the disk), respectively, and fall towards the disk, cross over to the other side, and execute periodic oscillations. The ratio of time periods of A and B is

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

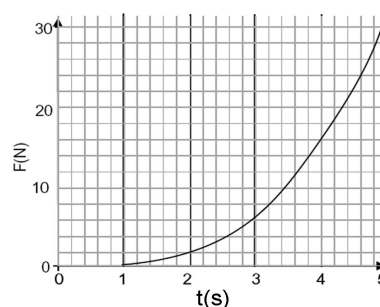
99. Two mutually perpendicular infinitely long straight conductors carrying uniformly distributed charges of linear densities λ_1 and λ_2 are positioned at a distance r from each other



Force between the conductors depends on r as

- (1) $1/r$ (2) $1/r^2$
 (3) r (4) r^0

100. The graph below shows the variation of a force (F) with time (t) on a body which is moving in a straight line. Dependence of force on time is $F \propto t^n$. Initially body is at rest.

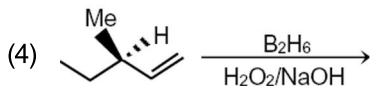
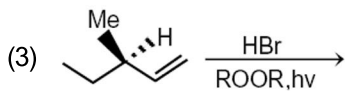
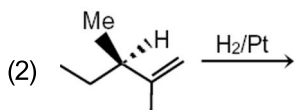
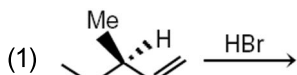


If the speed of the object is 2 m/s at 3 s, the speed at 4 s will be approximately (in m/s)

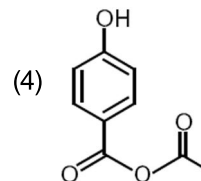
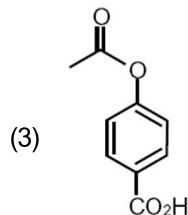
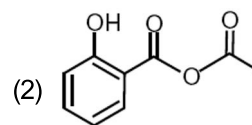
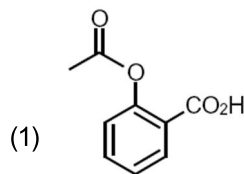
- (1) 2.5 (2) 6.5
 (3) 7.8 (4) 3.1

Space For Rough Work

108. Among the following reactions, a mixture of diastereomers is produced from



109. Reaction of phenol with NaOH followed by heating with CO_2 under high pressure, and subsequent acidification gives compounds X as the major product, which can be purified by steam distillation. When reacted with acetic anhydride in the presence of a trace amount of conc. H_2SO_4 compound X produces Y as the major product. Compound Y is



110. Tetrapeptide is made of naturally occurring alanine, serine, glycine and valine. If the C-terminal amino acid is alanine and the N-terminal amino acid is chiral, the number of possible sequences of the tetrapeptide is

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

BIOLOGY

111. What is the probability that a human individual would receive the entire haploid set of chromosomes from his/her grandfather?

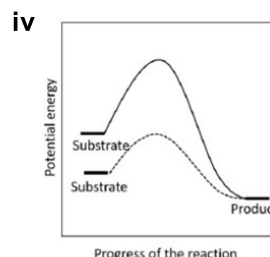
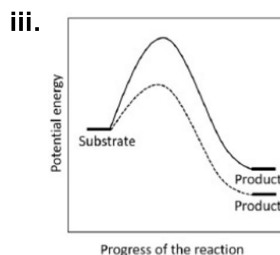
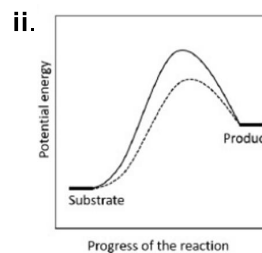
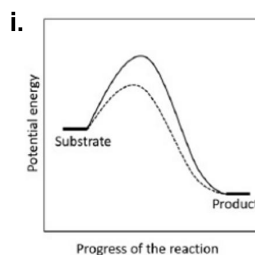
- (1) $1/2$ (2) $(1/2)^{23}$
(3) $(1/2)^2$ (4) $(1/2)^{46}$

112. Which ONE of the following primer pairs would amplify the fragment of DNA given below?

5'-CTAGTCGTCGAT-(N)₃₀₀-GACTGAGCTGAGCTG-3'
3'-GATCAGCAGCTA-(N)₃₀₀-CTGACTCGACTCGAC-5'

- (1) 5'-CTAGTCGTCGAT-3' and 5'-GACTGAGCTGAGCTG-3'
(2) 5'-CTGACTCGACTCGAC-3' and 5'-CTAGTCGTCGAT-3'
(3) 5'-CTAGTCGTCGAT-3' and 5'-CAGCTCAGCTCAGTC-3'
(4) 5'-CTAGTCGTCGAT-3' and 5'-GTCGAGTCGAGTCAG-3'

113. The following graphs with the solid and dotted lines correspond to the reactions without and with enzyme, respectively. Which of the following graph(s) correctly represent the concept of activation energy?



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

Space For Rough Work

ANSWERS
KVPY-SB/SX_2018

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

* Candidates who have attempted this section will be awarded one mark.