CLASS 12 LEVEL 2

NSO

SOF NATIONAL SCIENCE OLYMPIAD 2019-20

DO NOT OPEN THIS BOOKLET UNTIL ASKED TO DO SO

Total Questions: 50 | Time: 1 hr.

Guidelines for the Candidate

1. You will get additional ten minutes to fill up information about yourself on the OMR Sheet, before the start of the exam.
2. Write your **Name, School Code, Class, Section, Roll No.** and **Mobile Number** clearly on the **OMR Sheet** and do not forget to sign it. We will share your marks / result and other information related to SOF exams on your mobile number.
3. In the school code column in the OMR Sheet, please fill in code allocated to your school and not the exam center code.
4. The Question Paper comprises three sections :
   Section - 1: **Physics & Chemistry** (25 Questions)
   Section - 2: **Achievers Section** (5 Questions)
   Section - 3 : **Mathematics** (20 Questions) or **Biology** (20 Questions)
5. **Section-1 and 2 are compulsory for all**. In Section-3 opt for Mathematics OR Biology and mark the same on the OMR Sheet. Each question in Achievers Section carries 3 marks, whereas all other questions carry one mark each.
6. All questions are compulsory. There is no negative marking. Use of calculator / smart phone is not permitted.
7. There is only ONE correct answer. Choose only ONE option for an answer.
8. To mark your choice of answers by darkening the circles on the OMR Sheet, use **HB Pencil** or **Blue / Black ball point pen** only. E.g.

   Q.16: In the water cycle, condensation is the process of
   A. Water vapour cooling down and turning into a liquid
   B. Ice warming up and turning into a liquid
   C. Liquid cooling down and turning into ice
   D. Liquid warming up and turning into water vapour

   As the correct answer is option A, you must darken the circle corresponding to option A in the OMR Sheet. 16. ● Ⓑ Ⓒ Ⓓ
9. Rough work should be done in the blank space provided in this booklet.
10. Please fill in your personal details in the space provided on this page before attempting the paper.
11. **RETURN THE OMR SHEET AND QUESTION PAPER TO THE INVIGILATOR AT THE END OF THE EXAM.**

SOF
SCIENCE OLYMPIAD FOUNDATION
Inspiring Young Minds Through Knowledge Olympiads

Name:.....

Section:..... SOF Olympiad Roll No.:..... Contact No.:.....

1. Which of the following conditions is correct for an electromagnetic wave propagating in vacuum? (Symbols have usual notations.)

A. For an electromagnetic wave propagating in $+y$ direction the electric field is $\vec{E}=\frac{1}{\sqrt{2}}E_{yz}(x,t)\hat{z}$ and the magnetic field is $\vec{B}=\frac{1}{\sqrt{2}}B_{yz}(x,t)\hat{y}$.

B. For an electromagnetic wave propagating in $+y$ direction the electric fields is $\vec{E}=\frac{1}{\sqrt{2}}E_{yz}(x,t)\hat{y}$ and the magnetic field is $\vec{B}=\frac{1}{\sqrt{2}}B_{yz}(x,t)\hat{z}$.

C. For an electromagnetic wave propagating in $+x$ direction the electric field is $\vec{E}=\frac{1}{\sqrt{2}}E_{yz}(y,z,t)(\hat{y}+\hat{z})$ and the magnetic field is $\vec{B}=\frac{1}{\sqrt{2}}B_{yz}(y,z,t)(\hat{y}+\hat{z})$.

D. For an electromagnetic wave propagating in $+x$ direction the electric field is $\vec{E}=\frac{1}{\sqrt{2}}E_{yz}(x,t)(\hat{y}-\hat{z})$ and the magnetic field is $\vec{B}=\frac{1}{\sqrt{2}}B_{yz}(x,t)(\hat{y}+\hat{z})$.

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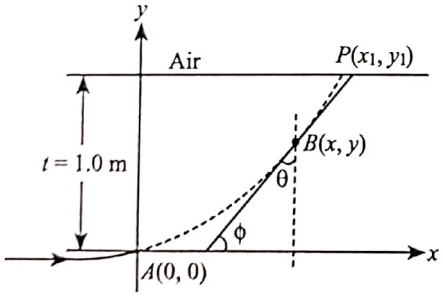
2. A ray of light travelling in air is incident at grazing angle (angle of incidence $\simeq 90°$) on a long rectangular slab of a transparent medium of thickness $t = 1.0$ m. The point of incidence is the origin $A(0, 0)$. The medium has a variable index of refraction given by $\mu(y)=(ky^{3/2}+1)^{1/2}$, where $k=1.0\ \text{m}^{-3/2}$. The refractive index of air is 1. Which of the following statements is/are incorrect?



I. Relation between the slope of the trajectory of the ray at a point $B(x, y)$ in the medium and the incidence angle at that point is $\sin\theta=\frac{dy}{dx}$.

II. The emerging ray at point P will be perpendicular to the boundary.

A. I only
B. II only
C. I and II only
D. Neither I nor II

3. The maximum intensity in a Young's double slit experiment is I_0. Distance between two slits is $d = 3\lambda$, where λ is the wavelength of light used in the experiment. What will be the intensity in front of one of the slits on the screen placed at a distance $D = 9d$?

A. $\frac{3}{4}I_0$
B. $\frac{I_0}{2}$
C. I_0
D. $\frac{I_0}{4}$

---

4. Read the given statements and select the correct option.

Statement 1 : In a Meter Bridge experiment, null point for an unknown resistance with positive temperature of coefficient is measured. Now the unknown resistance is put inside an enclosure maintained at a higher temperature. The null point can be obtained at the same point as before by increasing the value of the standard resistance.

Statement 2 : Resistance of a metal decreases with increase in temperature.

A. Statements 1 and 2 are true and statement 2 is a correct explanation for statement 1.
B. Statements 1 and 2 are true and statement 2 is not a correct explanation for statement 1.
C. Statement 1 is true but statement 2 is false.
D. Statement 1 is false but statement 2 is true.

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5. An inductor (L), a capacitor (C) and a resistor (R) may be connected to an AC source in different combinations of RC, RL and RLC in series. The frequency of the source is such that $X_L = X_C$, if power drawn by three combinations RC, RL and RLC are P_1, P_2 and P_3 respectively, then

A. $P_1 > P_2 > P_3$
B. $P_1 = P_2 > P_3$
C. $P_1 = P_2 < P_3$
D. $P_1 = P_2 = P_3$

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6. In a Bohr's hypothetical hydrogen atom electron is revolving in the n^{th} orbit. The magnetic field at the centre of the orbit is

A. Directly proportional to n
B. Inversely proportional to n
C. Inversely proportional to n^5
D. Directly proportional to n^5.

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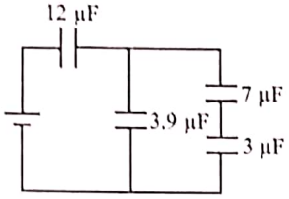
7. The collector of the photocell (in photoelectric experiment) is made of tungsten while the emitter is of platinum having work function of 10 eV. Monochromatic radiation of wavelength 124 Å and power 100 W is incident on emitter which emits photoelectrons with a efficiency of 1%. The accelerating voltage across the photocell is of 10,000 V. The minimum wavelength

of photoelectron at the tungsten target (collector) is (Use : hc = 12400 eV Å)

A. 124 Å B. 2.46 Å
C. 1.23 Å D. 62 Å

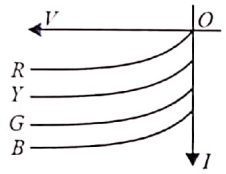
8. Four capacitors and a battery are connected as shown in the figure. If the potential difference across the 7 μF capacitor is 6 V, then which of the following statements are correct?

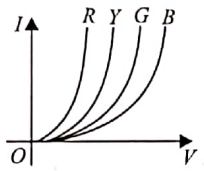


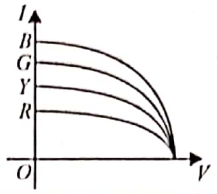
I. The potential drop across the 12 μF capacitor is 10 V.
II. The charge in the 3 μF capacitor is 42 μC.
III. The potential drop across the 3 μF capacitor is 10 V.
IV. The emf of the battery is 30 V.

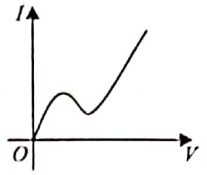
A. I and II only B. III and IV only
C. II, III and IV only D. I, II and IV only

9. The I-V characteristic of an LED is
(R: Red, Y: Yellow, G: Green, B: Blue)

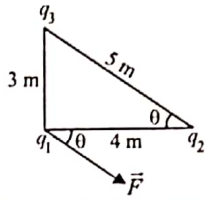
A. 

B. 

C. 

D. 

10. Three charges q_1 = 3 nC, q_2 = –3 nC and q_3 are kept at the vertices of a triangle as shown in the figure. If the net force acting on q_1 is $\vec{F}$, then find the value of charge on q_3 (in nC).



A. 6.28
B. 3.24
C. 1.26
D. 6.91

11. A solid conducting sphere having a charge Q is surrounded by an uncharged concentric conducting hollow spherical shell. Let the potential difference between the surface of the solid sphere and that of the outer surface of the hollow shell be V. If the shell is now given a charge $-3Q$ the new potential difference between the same two surfaces is

A. V B. $2V$
C. $4V$ D. $-2V$.

12. A nucleus of mass 20 u emits a γ photon of energy 6 MeV. If the emission assume to occur when nucleus is free and at rest, then the nucleus will have kinetic energy nearest to (Take 1 u = 1.6×10^{-27} kg)

A. 10 keV B. 1 keV
C. 0.1 keV D. 100 keV

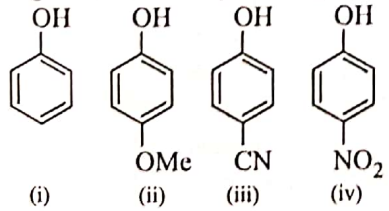
CHEMISTRY

13. Out of the given statements which statement(s) is/are incorrect?

I. A metal that crystallizes in *bcc* structure has a coordination number of 12.
II. A unit cell of an ionic crystal shares some of its ions with other unit cells.
III. The coordination number of each type of ion in CsCl crystal is 8.
IV. The length of the unit cell in NaCl is 552 pm if r_{Na^+} = 95 pm; r_{Cl^-} = 181 pm.

A. I only B. II, III and IV only
C. II and IV only D. I, II, III and IV

14. Which of the following options represents the correct decreasing order of acidity of the given compounds?



A. (ii) > (i) > (iii) > (iv)
B. (iv) > (iii) > (ii) > (i)
C. (iii) > (iv) > (ii) > (i)
D. (iv) > (iii) > (i) > (ii)

15. Read the given passage carefully and fill in the blanks by selecting an appropriate option.

An alkyl halide __X__ of formula, $C_6H_{13}Cl$ on treatment with potassium tertiary butoxide gives two isomeric alkenes __Y__ and __Z__ having formula, C_6H_{12}. Both alkenes on hydrogenation give 2,3-dimethylbutane.

	X	Y	Z
A.	$CH_3(CH_2)_4CH_2Cl$	$(CH_3)_2C{=}C(CH_3)_2$	$CH_2{=}C(CH_3)-CH(CH_3)_2$
B.	$(CH_3)_2C(Cl)CH(CH_3)_2$	$CH_2{=}CCH(CH_3)_2$	$(CH_3)_2C{=}C(CH_3)_2$
C.	$Cl(CH_2)_2C(CH_3)_3$	$(CH_3)_2C{=}C(CH_3)_2$	$(CH_3)_2C{=}C(CH_3)_2$
D.	None of these		

16. Which of the following is not correct?

A. Red phosphorus shows chemiluminescence.

B. A mixture of $CaCN_2$ and C is known as nitrolim.

C. A mixture of $Ca(H_2PO_4)_2$ and $CaSO_4 \cdot 2H_2O$ is known as superphosphate of lime.

D. Hydrolysis of NCl_3 gives NH_3 and HOCl.

17. If a 0.1 molar aqueous solution of tartaric acid freezes at $-0.205°C$, then the ionisation constant (K_a) of tartaric acid will be
(Assume that only the first ionisation is of importance and that 0.1 m = 0.1 M, $K_f = 1.86$ kg mol^{-1} K.)

A. 1.59×10^{-5} B. 2.34×10^{-3}

C. 1.16×10^{-3} D. 1.15×10^{-6}

18. Match column I with column II and select the correct option from the codes given below.

Column I (Metals)		Column II (Methods of extraction)
(a) Cu	(i)	Direct reduction of sulphide by heating
(b) Sn	(ii)	Electrolysis of fused chloride
(c) Hg	(iii)	Partial oxidation of sulphide ore
(d) Mg	(iv)	Reduction of oxide with carbon

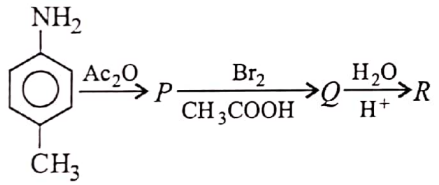
A. (a) → (iii), (b) → (i), (c) → (ii), (d) → (iv)

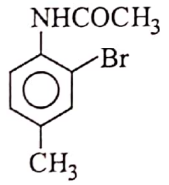
B. (a) → (iii), (b) → (iv), (c) → (i), (d) → (ii)

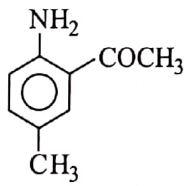
C. (a) → (i), (b) → (iii), (c) → (ii), (d) → (iv)

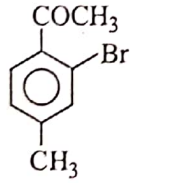
D. (a) → (iv), (b) → (i), (c) → (ii), (d) → (iii)

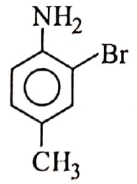
19. The final product '*R*' in the given reaction is



A. 

B. 

C. 

D. 

20. Calculate the EMF of the following cell at 25°C.
Pt, $Br_{2(l)}$| Br^-(0.010 M) | | H^+ (0.030 M) | H_2 (1 atm), Pt
($E°_{Br_2/2Br^-}$ = +1.08 V, R = 8.314 J K^{-1} mol^{-1}, F = 96,500 C mol^{-1})

A. – 1.08 V B. 1.288 V

C. 1.53 V D. –1.288 V

21. Ammonia forms the complex ion $[Cu(NH_3)_4]^{2+}$ with copper ions in alkaline solution but not in acidic solution. The probable reason for this is

A. In acidic solution, hydration protects Cu^{2+} ion.

B. In acidic solution, proton coordinates with ammonia molecules to form NH_4^+ ions and NH_3 molecules are not available.

C. In alkaline solution, insoluble $Cu(OH)_2$ is precipitated which is soluble in excess of any alkali.

D. Copper hydroxide is an amphoteric substance.

22. A compound '*X*' having the molecular formula, $C_5H_{12}O$ on oxidation gives a compound '*Y*' with molecular formula, $C_5H_{10}O$. Compound '*Y*' gave a 2,4-dinitrophenylhydrazine derivative but did not answer haloform test or silver mirror test. The structure of compound '*X*' is

A. $CH_3-CH_2-CH_2-CH_2-CH_2-OH$

B. $CH_3-CH_2-CH_2\underset{\displaystyle OH}{\underset{|}{C}}H-CH_3$

C. $CH_3-CH_2-\underset{\displaystyle OH}{\underset{|}{C}}HCH_2-CH_3$

D. $CH_3-CH_2-\underset{\displaystyle CH_3}{\underset{|}{C}}H-CH_2-OH$

23. Which of the following statements is/are correct?

I. Lower the critical temperature of a gas, greater the amount of gas adsorbed.

II. Physisorption results into unimolecular layer on adsorbent surface under high pressure.

III. Brownian motion of colloidal particles is independent of the nature of the colloid but depends on the size of the particles and viscosity of the solution.

IV. Chemisorption is more exothermic than physisorption, however it is very slow due to higher energy of activation.

A. III and IV only

B. III only

C. I and II only

D. I, II, III and IV

24. A dihalogen derivative '*P*' of a hydrocarbon with three carbon atoms on reaction with aqueous KOH gives an aldehyde and on reaction with alcoholic KOH produces another hydrocarbon which forms a red precipitate with ammoniacal Cu_2Cl_2. The compound '*P*' is

A. 1,3-Dichloropropane

B. 1,2-Dichloropropane

C. 2,2-Dichloropropane

D. 1,1-Dichloropropane.

25. For 'invert sugar', the incorrect statements are (Given : specific rotations of (+)-sucrose, (+)-maltose, *L*-(–)-glucose and *L*-(+)-fructose in aqueous solution are +66°, +140°, –52° and +92°, respectively)

I. 'Invert sugar' is prepared by acid catalyzed hydrolysis of maltose.

II. 'Invert sugar' is an equimolar mixture of *D*-(+)-glucose and *D*-(–)-fructose.

III. Specific rotation of 'invert sugar' is –20°.

IV. On reaction with Br_2-water, 'invert sugar' forms saccharic acid as one of the products.

A. I and III only

B. I and IV only

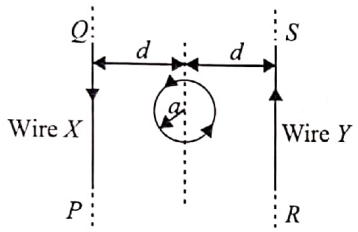
C. II and III only

D. I, II and III only.

SECTION-2
ACHIEVERS SECTION

Direction (Q. No. 26 and 27) : Refer to the given paragraph and answer the questions.

The figure shows a circular loop of radius a with two long parallel wires X and Y all in the plane of the paper. The distance of each wire from the centre of the loop is d. The loop and the wires are carrying the same current I. The current in the loop is in the counterclockwise direction if seen from above. Directions of current in wires are shown in the figure.



26. When $d \approx a$ but wires are not touching the loop, find the magnitude of net magnetic field on the axis of the loop at a height $h = a$ above the loop.

A. $\frac{\mu_0 I}{2a}\left(\frac{1}{2\sqrt{2}}-\frac{1}{\pi}\right)$ B. $\frac{\mu_0 I}{a}\left(\frac{1}{2\sqrt{2}}-\frac{1}{\pi}\right)$

C. $\frac{\mu_0 I}{2a}\left(\frac{1}{2\sqrt{2}}+\frac{1}{\pi}\right)$ D. None of these

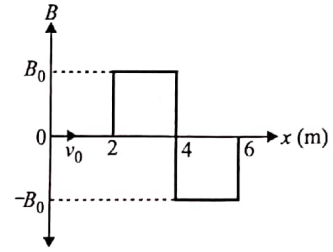
27. Consider $d >> a$, and the loop is rotated about its diameter parallel to the wires by 60° from the position shown in the figure. The torque on the loop at its new position will be (Assume that the net magnetic field due to the wires is constant over the loop.)

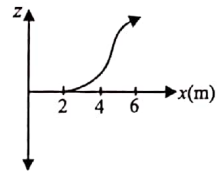
A. $\frac{\mu_0 I^2 a^2}{d}$ B. $\frac{\mu_0 I^2 a^2}{2d}$

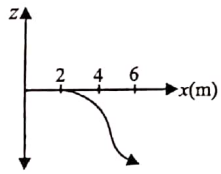
C. $\frac{\sqrt{3}\mu_0 I^2 a^2}{d}$ D. $\frac{\sqrt{3}\mu_0 I^2 a^2}{2d}$

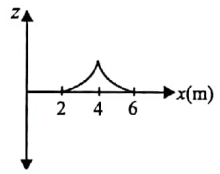
28. A magnetic field $\vec{B} = B_0 \hat{j}$ exists in the region $2\text{ m} < x < 4\text{ m}$ and $\vec{B} = -B_0 \hat{j}$ in the region $4\text{ m} < x < 6\text{ m}$, where B_0 is a positive constant.

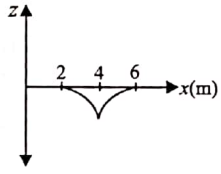
A negative point charge moving with a velocity $\vec{v} = v_0 \hat{i}$, where v_0 is a positive constant, enters the magnetic field at $x = 2$ m. The trajectory of the charge in this region can be like



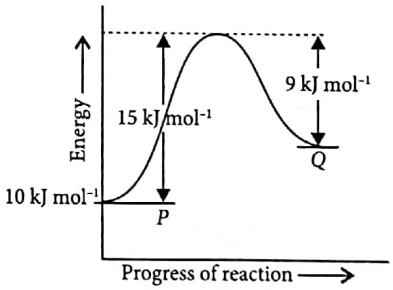
A. 

B. 

C. 

D. 

29. In a hypothetical reaction, $P \longrightarrow Q$, the activation energy for the forward and backward reactions are 15 and 9 kJ mol^{-1} respectively. The potential energy of P is 10 kJ mol^{-1}.



Now, fill in the blanks by selecting an appropriate option. In kJ mol^{-1}, the threshold energy of the reaction is __(i)__, the potential energy of Y is__(ii)__, heat of reaction is __(iii)__ and the type of reaction is __(iv)__.

	(i)	(ii)	(iii)	(iv)
A.	25	10	15	Exothermic
B.	37	25	10	Endothermic
C.	25	16	6	Endothermic
D.	14	16	8	Exothermic

30. Study the following sequence of reactions of two ores, ore I and ore II of metal '*M*'.

$$[\text{Ore I}] \xrightarrow[\text{Black}]{\text{Calcination}} [X]\downarrow + CO_2 + H_2O$$

$$\xrightarrow{KI/HCl} [Y]\downarrow + I_2 + KCl$$

$$[\text{Ore II}] \xrightarrow{\text{Roasting}} [Z]\uparrow + M$$

$$[Z] + K_2Cr_2O_7 \xrightarrow{H^+} \text{Green solution}$$

Now, fill in the blanks by selecting an appropriate option. The ore I and ore II of metal '*M*' are respectively (i) and (ii). *Y* and *Z* are (iii) and (iv) respectively.

	(i)	(ii)	(iii)	(iv)
A.	Cu_2S	$CuCO_3 \cdot Cu(OH)_2$	CuO	CO_2
B.	Cu_2O	$CuFeS_2$	CuI_2	SO_3
C.	$CuCO_3 \cdot Cu(OH)_2$	Cu_2S	Cu_2I_2	SO_2
D.	$PbCO_3$	PbS	PbI_2	SO_2

SECTION-3
MATHEMATICS

31. The equation of the plane perpendicular to the *yz*-plane and passing through the point (1, –2, 4) and (3, –4, 5), is

A. $y + 2z = 5$
B. $2y + z = 5$
C. $y + 2z = 6$
D. $2y + z = 6$

32. If *x*, *y*, *z* are in A.P. and $\tan^{-1}x$, $\tan^{-1}y$ and $\tan^{-1}z$ are also in A.P., then

A. $x = y = z$
B. $2x = 3y = 6z$
C. $6x = 3y = 2z$
D. $6x = 4y = 3z$

33. If $y = \sin x + e^x$, then $\frac{d^2x}{dy^2}$ equals

A. $(-\sin x + e^x)^{-1}$
B. $\frac{\sin x - e^x}{(\cos x + e^x)^2}$
C. $\frac{\sin x - e^x}{(\cos x + e^x)^3}$
D. $\frac{\sin x + e^x}{(\cos x + e^x)^3}$

34. $\int e^x \frac{(1-x)^2}{(1+x^2)^2} dx$ is equal to

A. $\frac{1}{x^2+1} + c$
B. $\frac{e^x}{x^2+1} + c$
C. $\frac{e^x - 1}{x^2+1} + c$
D. $\frac{1-e^x}{x^2+1} + c$

35. The volume of the tetrahedron whose vertices are the points with position vectors $\hat{i} - 6\hat{j} + 10\hat{k}$, $-\hat{i} - 3\hat{j} + 7\hat{k}$, $5\hat{i} - \hat{j} + \lambda\hat{k}$ and $7\hat{i} - 4\hat{j} + 7\hat{k}$ is 11 cubic units, if the value of λ is

A. –1
B. 8
C. –7
D. 7

36. Let *A* and *B* are two events such that $P(A) = \frac{3}{5}$ and $P(B) = \frac{2}{3}$, then

Statement-I : $\frac{4}{15} \le P(A \cap B) \le \frac{3}{5}$

Statement-II : $\frac{2}{5} \le P(A/B) \le \frac{9}{10}$

A. Both Statement-I and Statement-II are true.
B. Both Statement-I and Statement-II are false.
C. Statement-I is true but Statement-II is false.
D. Statement-I is false but Statement-II is true.

37. A box with a square base and a cover is to be made from 400 m^2 of lumber. If its volume is maximum, then the ratio of an edge of the base and height is

A. 1 : 1
B. 1 : 2
C. 2 : 1
D. $\sqrt{2}$: 1

38. The minimum value of $z = 3x + 5y$ subject to $x + y \ge 2$, $x + 3y \ge 3$, $x, y \ge 0$, is

A. 5
B. 7
C. 9
D. 11

39. The value of *x* for which the matrix

$$A = \begin{bmatrix} 2 & 0 & 7 \\ 0 & 1 & 0 \\ 1 & -2 & 1 \end{bmatrix}$$ is inverse of $$B = \begin{bmatrix} -x & 14x & 7x \\ 0 & 1 & 0 \\ x & -4x & -2x \end{bmatrix}$$

A. $\frac{1}{2}$ B. $\frac{1}{3}$

C. $\frac{1}{4}$ D. $\frac{1}{5}$

40. The value of $\int_{1/e}^{\tan x} \frac{t\,dt}{1+t^2} + \int_{1/e}^{\cot x} \frac{dt}{t(1+t^2)} =$

A. -1
B. 1
C. 0
D. None of these

41. Let the population of rabbits surviving at a time t be governed by the differential equation $\frac{dp(t)}{dt} = \frac{1}{2}p(t) - 200$. If $p(0) = 100$, then $p(t)$ equals

A. $600 - 500\,e^{t/2}$
B. $400 - 300\,e^{-t/2}$
C. $400 - 300\,e^{t/2}$
D. $300 - 200\,e^{-t/2}$

42. If $f(x) = \cos(\log x)$, then

$f(x^2)f(y^2) - \frac{1}{2}\left[f\left(\frac{x^2}{y^2}\right) + f(x^2y^2)\right]$ is equal to

A. -2
B. -1
C. $\frac{1}{2}$
D. None of these

43. If $f(x) = x^3 - 10x^2 + 200x - 10$, then

A. $f(x)$ is decreasing in $(-\infty, 10]$ and increasing in $[10, \infty)$
B. $f(x)$ is increasing in $(-\infty, 10]$ and decreasing in $[10, \infty)$
C. $f(x)$ is increasing throughout real line.
D. $f(x)$ is decreasing throughout real line.

44. The area of the region bounded by the curve $9x^2 + 4y^2 - 36 = 0$ is

A. 9π sq. units
B. 4π sq. units
C. 36π sq. units
D. 6π sq. units

45. The minimum number of elements that must be added to the relation $R = \{(1, 2), (2, 3)\}$ on the set of natural numbers so that it is an equivalence relation, is

A. 4 B. 7

C. 6 D. 5

46. If the area of the parallelogram with $\vec{a}$ and $\vec{b}$, as two adjacent sides is 15 sq. units, then the area of the parallelogram having $3\vec{a}+2\vec{b}$ and $\vec{a}+3\vec{b}$ as two adjacent sides is

A. 120 sq. units
B. 105 sq. units
C. 75 sq. units
D. 45 sq. units

47. The equation of the normal to the curve $y = e^{-2|x|}$ at the point where the curve cuts the line $x = \frac{1}{2}$, is

A. $2e(ex + 2y) = e^2 - 4$
B. $2e(ex - 2y) = e^2 - 4$
C. $2e(ey - 2x) = e^2 - 4$
D. None of these

48. The differential equation of the family of curves $y = e^x(A\cos x + B\sin x)$, where A and B are arbitrary constants, is

A. $\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + 2y = 0$
B. $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} - 2y = 0$
C. $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + 2y = 0$
D. None of these

49. The system of linear equations $x + y + z = 6$, $x + 2y + 3z = 14$ and $2x + 5y + \lambda z = \mu(\lambda, \mu \in R)$ has a unique solution, then

A. $\lambda \neq 8$
B. $\lambda = 8, \mu \neq 36$
C. $\lambda = 8, \mu = 36$
D. None of these

50. If $f(x) = \begin{cases} \sin\left(\frac{\pi}{2}(x - [x])\right), & x < 5 \\ 5(b-1), & x = 5 \\ ab^2\frac{\left|x^2 - 11x + 24\right|}{x-3}, & x > 5 \end{cases}$

is continuous at $x = 5$, $a, b \in R$, then find the value of a and b respectively. (where $[\cdot]$ denotes the greatest integer function)

A. $\frac{25}{108}, \frac{6}{5}$
B. $\frac{6}{13}, \frac{17}{29}$
C. $\frac{1}{2}, \frac{25}{36}$
D. None of these

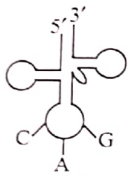
31. Refer to the given amino acid sequence of protein *X* in normal and diseased persons.

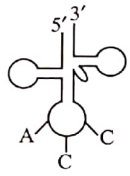
Protein *X* in normal person	**Protein *X* in diseased person**
...Lys-His-Pro-Asp-Thr...	...Lys-His-Pro-Gly-Thr...

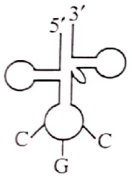
*m*RNA codons for the amino acids are given in the sequence as follows:

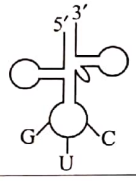
His - CAU, CAC	Gly - GGU, GGC, GGA, GGG
Thr - ACU, ACC, ACA, ACG	Lys - AAA, AAG
Asp - GAU, GAC	Pro - CCU, CCC, CCA, CCG

Select the option which correctly represents *t*RNA involved in forming the modified part of protein *X* in diseased person.

A. 

B. 

C. 

D. 

32. Read the given statements and select the option that correctly identifies them as true (T) and false (F) ones.

I. Vault cap is a device made of plastic and is used to cover penis before coitus.
II. Multiload 375 is a hormone releasing IUD that increases phagocytosis of sperms within the uterus.
III. Oral contraceptive pills alter the uterine endometrium, thus making it unsuitable for implantation.
IV. Norplant is a subcutaneous implant containing synthetic progesterone that blocks ovulation and thickens cervical mucus.
V. PILL-72 is a combined pill that inhibits ovulation.

	I	**II**	**III**	**IV**	**V**
A.	F	T	T	F	T
B.	F	F	T	T	F
C.	T	F	F	F	F
D.	F	T	F	T	F

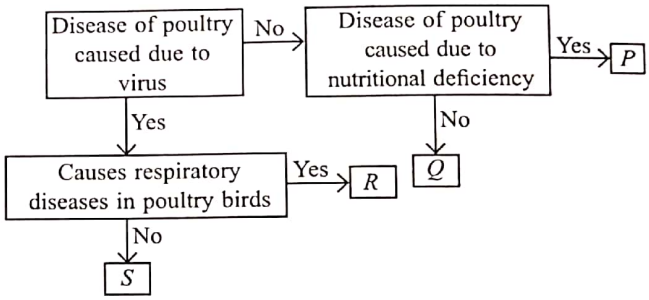
33. Consider the steps involved in the production of humulin given below.

I. Artificial synthesis of human insulin gene
II. Culturing recombinant *E.coli* in bioreactors
III. Purification of humulin
IV. Insertion of human insulin gene into plasmid
V. Introduction of recombinant plasmid into *E.coli*
VI. Extraction of recombinant gene product from *E.coli*

Select the option that correctly arranges these steps.

A. I → IV → V → II → VI → III
B. II → I → III → IV → VI → V
C. I → II → IV → III → V → VI
D. VI → V → III → IV → II → I

34. Refer to the given flow chart and select the correct statement regarding *P*, *Q*, *R* and *S*.



A. *P* could be perosis caused due to deficiency of calcium in diet.
B. *Q* could be pullorum disease caused by *Salmonella pullorum*.
C. *R* could be Marek's disease caused due to Paramyxovirus.
D. *S* could be coryza caused due to *Haemophilus gallinarum*.

35. How many of the given seeds are albuminous?

Castor, maize, groundnut, pea, wheat, barley, gram, rubber, coconut, bean

A. 5
B. 4
C. 6
D. 7

36. Select the option that correctly identifies the combination from the data given below.

	Biocontrol type	**Biocontrol agent**	**Effective against**
A.	Bioherbicide	*Chrysolina*	*Opuntia*
B.	Bioherbicide	*Cercospora rodmanii*	*Eichhornia*
C.	Bioherbicide	*Cactoblastis cactorum*	*Hypercium*
D.	Bioinsecticide	*Bacillus thuringiensis*	*Azadirachta*

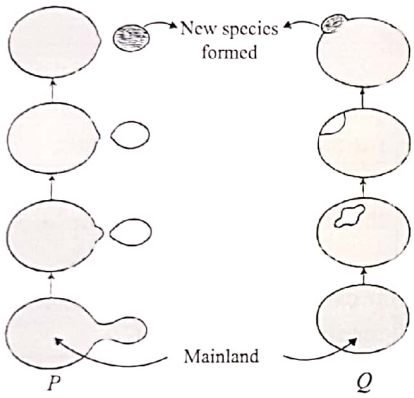
37. The nurses working in the maternity ward of a hospital suspect that they have accidentally mixed up three babies when tagging them after birth. Blood typing of the three couples and the three babies involved was done to match each baby to the right family. The following results were obtained:

Baby 1 : Type B	Baby 2 : Type A
Baby 3 : Type O	
Mr Singh : Type O	Mrs Singh : Type AB
Mr Sharma : Type A	Mrs Sharma : Type O
Mr Mehra : Type AB	Mrs Mehra : Type B

Which of the following cannot be true regarding the given data?

A. Baby 1 could belong to the Singh family.
B. Baby 2 could belong to the Mehra family.
C. Baby 3 could belong to the Sharma family.
D. None of these

38. Refer to the given figures depicting different mechanisms of speciation and identify speciation types, *P* and *Q*. Select the correct option regarding this.



(i) Barrier in *P* could be genetic whereas in *Q* it could be physical.
(ii) Speciation is rapid in *P* whereas it is slow in *Q*.
(iii) Barriers to interspecific crossing are fewer in *P* whereas they are more pronounced in *Q*.
(iv) In *P*, chances of breakdown of isolating mechanism are rare whereas in *Q* they are more pronounced.

A. (ii) and (iii) only
B. (iii) and (iv) only
C. (i) and (ii) only
D. (iii) only

39. Which of the following statements are incorrect?

(i) In r-selection natality is low, individual size is large, longevity is high so the population exists at the carrying capacity.
(ii) In k-selection, resources are abundant, natality is high, size of individual is small, but the population seldom reaches to carrying capacity.
(iii) Resources for growth for most animal populations become limited sooner or later, the logistic growth models is more realistic.
(iv) In some cases, population density is measured in terms of biomass rather than in terms of numbers.

A. (ii) and (iii) only
B. (i), (ii) and (iii) only
C. (iii) and (iv) only
D. (i) and (ii) only

40. Match column I with column II and select the correct option from the codes given below.

	Column I		**Column II**
(a)	CFC	(i)	Measurement of strength of sewage
(b)	MIC	(ii)	Ozone layer depletion
(c)	DDT	(iii)	Non-degradable pollutant
(d)	BOD	(iv)	Bhopal gas tragedy
		(v)	Global warming
		(vi)	Biomagnification

A. (a)-(v), (b)-(ii), (c)-(vi), (d)-(iv)
B. (a)-(ii), (b)-(v), (c)-(i), (d)-(iii)
C. (a)-(iii), (b)-(ii), (c)-(i), (d)-(vi)
D. (a)-(ii), (b)-(iv), (c)-(iii), (d)-(i)

41. The correct sequence of plants in a hydrosere is

A. *Volvox* → *Najas* → *Wolffia* → *Scirpus* → *Cyperus* → *Quercus*
B. *Wolffia* → *Volvox* → *Scirpus* → *Najas* → *Quercus* → *Cyperus*
C. *Quercus* → *Cyperus* → *Volvox* → *Najas* → *Wolffia* → *Scirpus*
D. *Quercus* → *Cyperus* → *Scirpus* → *Wolffia* → *Najas* → *Volvox*.

42. Given below are four statements (a-d) each with one or two blanks. Select the option which correctly fills up the blanks in any two statements.

(a) __(i)__ are substances which are incapable of inducing antibody formation by themselves, but are able to induce antibodies on combining with larger molecules called carriers; normally __(ii)__ serve as carriers.
(b) __(i)__ is the earliest immunoglobulin to be synthesised by the fetus.
(c) __(i)__ is the process in which opsonins coat the invading microbes which facilitates their __(ii)__.
(d) Colostrum secreted by mother during the initial days of lactation has abundant __(i)__ antibodies.

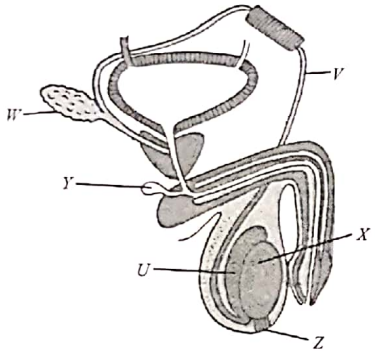
A. (a)-(i) Interleukins, (ii) Carbohydrates
(b)-(i) IgA
B. (b)-(i) IgM
(c)-(i) Neutralisation, (ii) Phagocytosis
C. (c)-(i) Opsonisation, (ii) Phagocytosis
(d)-(i) IgA
D. (a)-(i) Haptens, (ii) Lipids
(d)- (i) IgM

43. Refer to the given table and select the correct option for *P*, *Q*, *R*, *S* and *T*.

Crop	Variety	Resistance to diseases
Wheat	*P*	Leaf and stripe rust
Q	Pusa swarnim	*R*
Cowpea	*S*	Bacterial blight
T	Pusa sadabahar	Chilly mosaic virus, Tobacco mosaic virus

	P	*Q*	*R*	*S*	*T*
A.	Himgiri	*Brassica*	White rust	Pusa Komal	Chilli
B.	Pusa Shubhra	Flat bean	Black rot	Pusa Snowball	Cauli-flower
C.	Pusa Shubhra	Okra	White rust	Pusa Komal	Okra
D.	Himgiri	*Brassica*	Black rot	Pusa Snow-ball	Flat bean

44. Refer to the given figure of lateral view of human male reproductive system and select the correct statements.



(i) Part *U* stores sperms and secretes a fluid that nourishes them.
(ii) Part *V* carries sperms from *U*.
(iii) Part *W* produces 25% of the volume of semen and contains citric acid.
(iv) Part *X* represents primary sex organ of male that produces diploid gametes.
(v) Part *Y* secretes mucus that lubricates the end of penis.
(vi) Part *Z* represents a fibrous cord that extends from the caudal end of the testis to the scrotal wall.

A. (i), (iii) and (vi) only
B. (i), (ii), (v) and (vi) only
C. (ii), (iv) and (v) only
D. (i), (iii) and (v) only

45. In PCR, short primers are added to DNA molecules in a eppendorf tube and the appropriate enzymes are included to make copy of the DNA. Which of the following primers is needed for copying the single stranded DNA sequence 5′ TACGGTAGGTC 3′?

A. 5′ ATGCC 3′
B. 5′ GACCT 3′
C. 5′ TACGG 3′
D. 5′ GGCAT 3′

46. Select the option that correctly identifies the plants *P*, *Q*, *R* and *S* from the given statements.

P: Tap roots of the plant develop adventitious buds to form a new plant.
Q: Unbranched swollen underground stems of the plant having circular nodes have buds for growth of daughter plants.
R: Leaves of the plant are cut transversely and planted in vertical position into soil for vegetative propagation.
S: Cells, tissue and organs of the plant are used to propagate a new plant.

	P	*Q*	*R*	*S*
A.	Guava	*Colocasia*	*Sansevieria*	*Gladiolus*
B.	*Oxalis*	*Pistia*	*Begonia*	*Agave*
C.	Garlic	*Centella*	*Opuntia*	*Tapioca*
D.	Potato	*Cynodon*	*Dioscorea*	*Croton*

47. Refer to the given differences between two enzymes *X* and *Y*.

S.No.	*X*	*Y*
(i)	It requires a primer for its activity.	It does not require a primer.
(ii)	It is useful for both the strands of DNA.	It acts on only the template strand of DNA.
(iii)	It can perform proof reading.	Proof reading is absent.

Identify enzymes *X* and *Y* and select the incorrect statement.

A. Enzyme *X* takes part in synthesis of DNA from DNA whereas *Y* takes part in synthesis of RNA from DNA.
B. Prokaryotes have only one *Y* which synthesises all types of RNAs.
C. Prokaryotic *X* has one important sigma(δ) factor whereas prokaryotic *Y* has seven subunits, *viz.*, α, β, δ, γ, ε, θ and τ.
D. Both A and C

48. Refer to the given dichotomous key and select the correct statement regarding it.

I. (a) Disease is transmitted sexually. – Go to II
(b) Disease is transmitted through droplet infection. – Go to III
II. (a) Disease is characterised by occurrence of vesiculopustular lesions and erythematous ulcers over external genitalia and peri-anal region. – *L*
(b) Disease is characterised by urethritis epididymitis, cervicitis and proctitis. – *M*

III. (a) Disease is characterised by the appearance of reddish rash all over the body and Koplik's spots on the inner lining of the cheeks – *N*

(b) Disease is characterised by painful swelling of salivary glands of one or both sides. – *O*

A. *L* could be a viral disease caused by Human papilloma virus (HPV) which can be transmitted to neonates from infected mothers.

B. *M* could be a viral disease caused by *Chlamydia trachomatis* which is an extracellular pathogen that also causes swelling of lymph nodes.

C. *N* could be a viral disease caused by Rubeola virus that belongs to the Paramyxovirus family.

D. *O* could be a bacterial disease caused by *Corynebacterium diphtheriae* and is diagnosed by Schick test.

49. Fruit shape in shepherd's purse (*Capsella bursa-pastoris*) is of two types — triangular and top-shaped. Triangular fruit shape (T) is dominant over top-shape (t). Following table summarises the results of several crosses:

Cross	Result
Strain 1 × tt	All triangular
Strain 2 × tt	1 triangular : 1 top-shaped
Strain 3 × tt	All top-shaped
Strain 4 × Tt	3 triangular : 1 top-shaped

Which pair of strains possesses the genotype Tt?

A. Strains 2 and 3
B. Strains 2 and 4
C. Strains 1 and 3
D. Strains 1 and 4

50. Which of the following statements regarding genetically modified crops are correct?

I. Genetically modified crops are made more tolerant to abiotic stresses than normal crops.
II. Genetically modified crops have helped to reduce post harvest losses.
III. Genetically modified crops are more susceptible to herbicides.
IV. Genetic modification in crops decreases nutritional value of food.

A. I and II only
B. I and III only
C. II and IV only
D. I, II and III only

SPACE FOR ROUGH WORK