

SAMPLE CONTENT



MHT-CET

21

MODEL QUESTION PAPERS

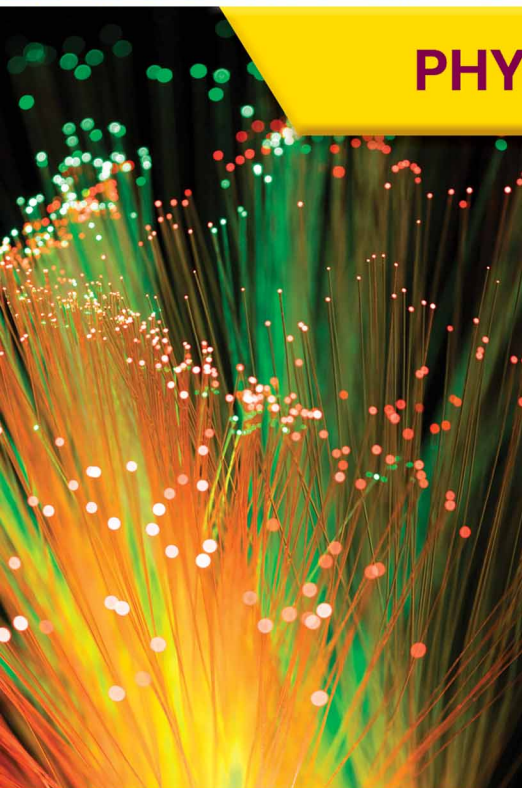
WITH SOLUTIONS

+3 Previous Years'
Original Exam Papers

PHYSICS

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MHT-CET 21 MODEL QUESTION PAPERS WITH SOLUTIONS

and

Three Original Question Papers of MHT-CET Examination

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Salient Features

- Set of 21 Model Question Papers (with answers and solutions) for Physics, Chemistry and Biology
- Three Original MHT-CET Question Papers with Answer Keys
25th September 2021, Shift-I, 17th August 2022, Shift-I, 15th May 2023, Shift-I
(Solutions provided through Q.R. codes)
- Prepared as per the latest paper pattern of MHT-CET examination
- Detailed Solutions provided to difficult MCQs for easy comprehension
- Multiple Study Techniques to enhance understanding of concepts and problem solving skills
Smart Keys (Smart Code, Caution, Thinking Hatke, Smart Tip)

Printed at: **Print to Print**, Mumbai

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PREFACE

In the enchanting world of education, where curiosity ignites minds and knowledge illuminates paths, we proudly present a compendium of intellectual challenges, ‘**MHT-CET: 21 Model Question Papers with Solutions (PCB)**’. It is a meticulously designed book to assess the threshold of knowledge imbibed by the students over a period of two years in the junior college.

The book charts out a compilation of Model Question Papers for the students appearing for the MHT-CET examination. Every question paper in this book has been created in line with the examination pattern and touches upon all the conceptual nodes of Physics, Chemistry and Biology. The core objective of this book is to gauge the student’s preparedness to appear for the examination.

To aid students, detailed solutions are provided to difficult MCQs. **Smart Keys** (Smart Code, Caution, Thinking Hatke and Smart Tip) are provided, which offer supplemental explanations for the tricky questions and are intended to help students approaching problems in novel ways in the shortest possible time with accuracy.

Smart Keys

- **Smart Code** showcases simple and smart mnemonic.
- **Caution** apprises students about mistakes often made while solving MCQs.
- **Thinking Hatke** reveals quick witted approach to crack the specific question.
- **Smart Tip** comprises of short tricks designed to effectively tackle MCQs.

Previous years’ examination papers have been provided to offer students a glimpse of the complexity of the questions asked in the examination.

MHT-CET Question Papers and Answer Keys

- 25th September, 2021 (Shift I), 17th August, 2022 (Shift I) and 15th May, 2023 (Shift I)
- Solutions provided through Q.R. codes

We hope that this book will enable students to optimize their time-management abilities to achieve high scores in the examination.

They say, ‘*With the right tools, even ordinary men achieve extraordinary results*’. We aspire this book to be the perfect tool that would help students to take off their career in the most extraordinary way possible.

Publisher

Edition: Fourth

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we’ve nearly missed something or want to applaud us for our triumphs, we’d love to hear from you.

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Disclaimer

This reference book is transformative work based on the latest editions of Std. XI and XII - Physics, Chemistry and Biology Textbooks published by the Maharashtra State Board of Secondary and Higher Secondary Education, Pune. We the publishers are making this book which constitutes as fair use of textual contents which are transformed in the form of Multiple Choice Questions and their relevant solutions; with a view to enable the students to understand memorize and reproduce the same in MHT-CET examination.

This work is purely inspired by the paper pattern prescribed by State Common Entrance Test Cell, Government of Maharashtra. Every care has been taken in the publication of this reference book by the Authors while creating the contents. The Authors and the Publishers shall not be responsible for any loss or damages caused to any person on account of errors or omissions which might have crept in or disagreement of any third party on the point of view expressed in the reference book.

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MHT-CET PAPER PATTERN

- There will be three papers of Multiple Choice Questions (MCQs) in ‘Mathematics’, ‘Physics and Chemistry’ and ‘Biology’ of 100 marks each.
- Duration of each paper will be 90 minutes.
- Questions will be based on the syllabus prescribed by Maharashtra State Board of Secondary and Higher Secondary Education with approximately 20% weightage given to Std. XI and 80% weightage will be given to Std. XII curriculum.
- Difficulty level of questions will be at par with JEE (Main) for Mathematics, Physics, Chemistry and at par with NEET for Biology.
- There will be no negative marking.
- Questions will be mainly application based.
- Details of the papers are as given below:

Paper	Subject(s)	No. of MCQs based on		Mark(s) Per Question	Total Marks	Duration in Minutes
		Std XI	Std XII			
Paper I	Mathematics	10	40	2	100	90
Paper II	Physics	10	40	1	100	90
	Chemistry	10	40			
Paper III	Biology	20	80	1	100	90

- Questions will be set on
 - the entire syllabus of Std. XII of Physics, Chemistry, Mathematics and Biology subjects prescribed by Maharashtra Bureau of Textbook Production and curriculum Research, Pune, and
 - chapters / units from Std. XI curriculum as mentioned below:

Sr.no	Subject	Chapters/Units of Std. XI
1	Physics	Motion in a Plane, Laws of Motion, Gravitation, Thermal Properties of Matter, Sound, Optics, Electrostatics, Semiconductors
2	Chemistry	Some Basic Concepts of Chemistry, Structure of Atom, Chemical Bonding, Redox Reactions, Elements of Group 1 and Group 2, States of Matter (Gaseous and Liquid States), Adsorption and Colloids (Surface Chemistry), Hydrocarbons, Basic Principles of Organic Chemistry
3	Mathematics	Trigonometry II, Straight Line, Circle, Measures of Dispersion, Probability, Complex Numbers, Permutations and Combinations, Functions, Limits, Continuity
4	Biology	Biomolecules, Respiration and Energy Transfer, Human Nutrition, Excretion and Osmoregulation

- **Language of Question Paper:**
The medium for examination shall be English / Marathi / Urdu for Physics, Chemistry and Biology. Mathematics paper shall be in English only.
 - **Duration of Online Computer Based Test (CBT):**
The duration of the examination for PCB is 180 minutes and PCM is 180 minutes.
 - For PCM** - This paper is having 2 Groups of Physics-Chemistry and Mathematics with total 180 Minutes Duration, first 90 minutes Physics and Chemistry will be enabled and only after completion of first 90 minutes’ time Physics-Chemistry group will be auto submitted and Mathematics group will be enabled with 90 minutes’ duration.
 - For PCB** - This paper is having 2 Groups of Physics-Chemistry and Biology with total 180 Minutes Duration, first 90 minutes Physics and Chemistry will be enabled and only after completion of time response for Physics-Chemistry group will be auto submitted and Biology group will be enabled with 90 minutes’ duration.
- [Note :** Candidate should note that if he/she appearing for both the groups i.e. PCM and PCB, the Percentile / Percentage score of Physics or Chemistry will not be interchanged among the groups.]

INDEX

Sr. No.	Question Paper	Page No.	
		Test	Answers and Solutions
1	Model Question Paper - 1	1	329
2	Model Question Paper - 2	19	341
3	Model Question Paper - 3	34	351
4	Model Question Paper - 4	49	360
5	Model Question Paper - 5	65	369
6	Model Question Paper - 6	80	378
7	Model Question Paper - 7	95	387
8	Model Question Paper - 8	110	396
9	Model Question Paper - 9	125	404
10	Model Question Paper - 10	142	413
11	Model Question Paper - 11	157	422
12	Model Question Paper - 12	172	430
13	Model Question Paper - 13	188	438
14	Model Question Paper - 14	204	448
15	Model Question Paper - 15	220	457
16	Model Question Paper - 16	236	465
17	Model Question Paper - 17	252	474
18	Model Question Paper - 18	268	483
19	Model Question Paper - 19	284	493
20	Model Question Paper - 20	299	502
21	Model Question Paper - 21	314	511
	MHT-CET 2021 Question Paper & Answer key (25 th September 2021, Shift-I)	521	-
	MHT-CET 2022 Question Paper & Answer key (17 th August 2022, Shift-I)	537	-
	MHT-CET 2023 Question Paper & Answer key (15 th May 2023, Shift-I)	552	-

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MODEL QUESTION PAPER

Time: 180 Minutes

Physics, Chemistry and Biology

Total Marks: 200

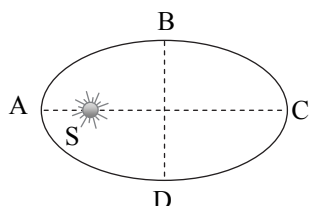
Physics and Chemistry

Time: 90 Minutes

Total Marks: 100

PHYSICS

1. A planet is revolving around the sun then which of the following is correct statement?



- (A) the time taken in travelling DAB is less than that for BCD.
 (B) the time taken in travelling DAB is greater than that for BCD.
 (C) The time taken in travelling CDA is less than that for ABC.
 (D) The time taken in travelling CDA is greater than that for ABC.
2. Velocity of efflux through an orifice is independent of _____.
 (A) acceleration due to gravity
 (B) height of the liquid level in the vessel
 (C) viscosity of the liquid
 (D) Both (B) and (C)
3. A cylinder of radius 4 mm and surface density of charge $0.25 \mu\text{C}/\text{m}^2$ is surrounded by a medium of dielectric constant 6.28. The magnitude of electric field at a point 2 m away from the axis of the cylinder is
 (A) 9 V/m (B) 12 V/m
 (C) 6 V/m (D) 4.5 V/m
4. A point object moves along an arc of a circle of radius 'R'. Its velocity depends upon the distance covered 'S' as $V = K\sqrt{S}$ where 'K' is a constant. If ' θ ' is the angle between the total acceleration and tangential acceleration, then
 (A) $\tan\theta = \frac{\sqrt{S}}{R}$ (B) $\tan\theta = \frac{\sqrt{S}}{2R}$
 (C) $\tan\theta = \frac{S}{2R}$ (D) $\tan\theta = \frac{2S}{R}$
5. Consider a reversible engine of efficiency $\frac{1}{6}$. When the temperature of the sink is reduced by 62°C , its efficiency gets doubled. The temperature of the source and sink respectively are

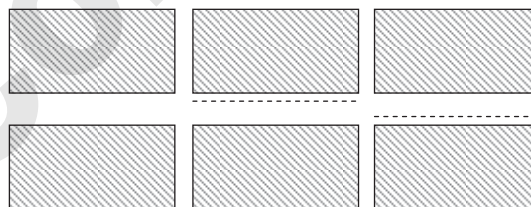
- (A) 372 K and 310 K (B) 273 K and 300 K
 (C) 99°C and 10°C (D) 200°C and 37°C

6. The susceptibility of a paramagnetic substance was found for different temperatures and a graph of χ against $\frac{1}{T}$ was plotted. From the graph, it was found that when $\chi = 0.5$, $\frac{1}{T} = 5 \times 10^{-3}/\text{K}$.

What is the curie constant for the substance?

- (A) 50 K (B) 75 K
 (C) 100 K (D) 125 K

7. The energy band diagram for three semiconductor samples of silicon are as shown. We can then assert that



- (A) sample X is undoped while Y and Z have been doped with a 'third group' and 'fifth group' impurity respectively.
 (B) sample X is undoped while both samples Y and Z have been with a 'fifth group' impurity.
 (C) sample X has been doped with equal amounts of 'third and fifth group' impurity while samples Y and Z are undoped.
 (D) sample X is undoped while samples Y and Z have been doped with a 'fifth group' and 'third group' impurity respectively.
8. An alternating voltage of frequency ω is induced in electric circuit consisting of an inductance L and capacitance C, connected in parallel. Then across the inductance coil, the
- (1) current is maximum, when $\omega^2 = \frac{1}{LC}$
 (2) current is minimum, when $\omega^2 = \frac{1}{LC}$
 (3) voltage is minimum, when $\omega^2 = \frac{1}{LC}$
 (4) voltage is maximum, when $\omega^2 = \frac{1}{LC}$

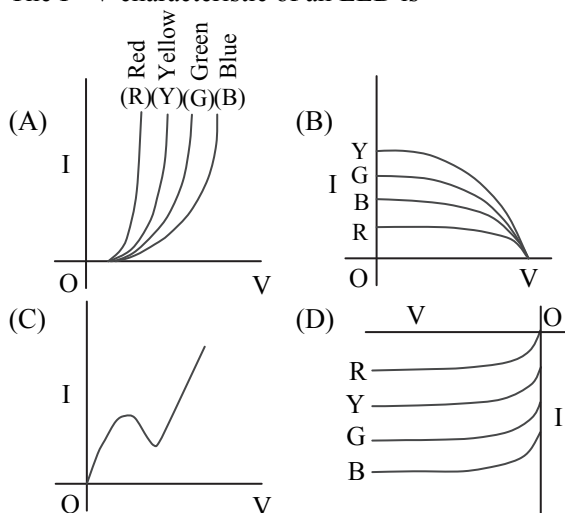


State if

- (A) (1) and (3) are correct
- (B) (1) and (4) are correct
- (C) (2) and (3) are correct
- (D) (2) and (4) are correct

9. A ball is rolled off the edge of a horizontal table at a speed of 4 m/second. It hits the ground after 0.4 second. Which statement given below is true?
(A) It hits the ground at a horizontal distance 2.6 m from the edge of the table.
(B) The speed with which it hits the ground is 4.0 m/second.
(C) Height of the table is 0.8 m.
(D) It hits the ground at an angle of 60° to the horizontal.
10. Water from a pipe is coming at a rate of 100 litres per minute. If the radius of the pipe is 5 cm, the Reynold's number for the flow is of the order of : (density of water = 1000 kg/m^3 , coefficient of viscosity of water = 1 m Pa s)
(A) 10^3 (B) 10^4
(C) 10^2 (D) 10^6
11. The angular velocities of three bodies in simple harmonic motion are $\omega_1, \omega_2, \omega_3$ with their respective amplitudes as A_1, A_2, A_3 . If all the three bodies have same mass and velocity, then
(A) $A_1\omega_1 = A_2\omega_2 = A_3\omega_3$
(B) $A_1\omega_1^2 = A_2\omega_2^2 = A_3\omega_3^2$
(C) $A_1^2\omega_1 = A_2^2\omega_2 = A_3^2\omega_3$
(D) $A_1^2\omega_1^2 = A_2^2\omega_2^2 = A_3^2\omega_3^2$
12. The human eye has an approximate angular resolution of 3×10^{-4} rad and typical photo printer prints 600 dpi (dots per inch). The minimum distance at which the printed page be held so that individual dots are not seen is (1 inch = 2.5 cm)
(A) 8 cm (B) 10 cm
(C) 12 cm (D) 14 cm
13. A crate of egg is located in the middle of the flat bed of a pick up truck as the truck negotiates an unbanked curve in the road. The curve may be regarded as an arc of circle of radius 35 m. If the coefficient of friction between the crate and the flat bed of the truck is 0.6, the speed with which the truck should turn so that the crate does not slide over the bed is
(A) 14.3 m/s (B) 10.3 m/s
(C) 12.3 m/s (D) 15.3 m/s
14. A radio transmitter operates at a frequency of 880 kHz and a power of 10 kW. The number of photons emitted per second are
(A) 1.72×10^{31} (B) 1327×10^{34}
(C) 13.27×10^{34} (D) 0.075×10^{-34}

15. Two persons of masses 55 kg and 65 kg respectively, are at the opposite ends of a boat. The length of the boat is 3.0 m and weighs 100 kg. The 55 kg man walks up to the 65 kg man and sits with him. If the boat is in still water, the centre of mass of the system shifts by
(A) 3.0 m (B) 2.3 m
(C) zero (D) 0.75 m
16. A long straight wire carrying current of 30 A is placed in an external uniform magnetic field of induction 4×10^{-4} T. The magnetic field is acting parallel to the direction of current. The magnitude of the resultant magnetic induction in tesla at a point 2.0 cm away from the wire is
(A) 10^{-4} (B) 3×10^{-4}
(C) 5×10^{-4} (D) 6×10^{-4}
17. A cube, which may be regarded as a perfectly black body, radiates heat at a rate of 57 watt, when its temperature is 127°C . Determine the approximate volume of the cube ($\sigma = 5.7 \times 10^{-8} \text{ J/m}^2\text{-K}^4, T_0 = 27^\circ\text{C}$)
(A) 10^{-3} cm^3 (B) 100 m^3
(C) 10^{-3} m^3 (D) 10^3 m^3
18. An alternating voltage $V(t) = 220 \sin 100\pi t$ volt is applied to a purely resistive load of 50Ω . The time taken for the current to rise from half of the peak value to the peak value is:
(A) 5 ms (B) 2.2 ms
(C) 7.2 ms (D) 3.3 ms
19. The I - V characteristic of an LED is



20. A particle performs S.H.M. of period $\frac{2\pi}{\sqrt{3}}$ second along a path 4 cm long. At what displacement are the velocity and acceleration of particle equal?
(A) 0.5 cm (B) 1 cm
(C) 1.5 cm (D) 2 cm



21. The magnetic flux linked with a coil (in Wb) is given by the equation $\phi = 5t^2 + 3t + 16$.

The magnitude of induced emf in the coil at the fourth second will be

- (A) 10 V (B) 33 V
(C) 43 V (D) 108 V

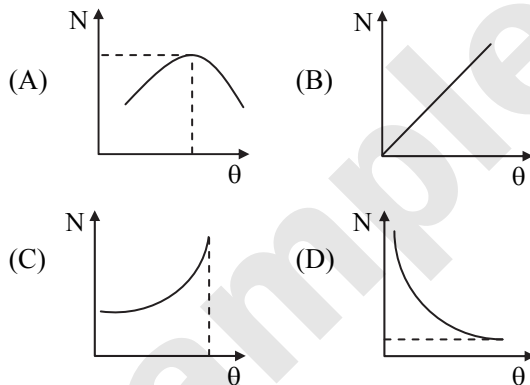
22. The three liquids A, B and C of specific heats s_A , s_B and s_C respectively are being cooled under identical circumstances. If $s_C < s_B < s_A$, then for which liquid will the time taken to cool through same temperature difference be maximum?

- (A) for C (B) for B
(C) for A (D) for all bodies

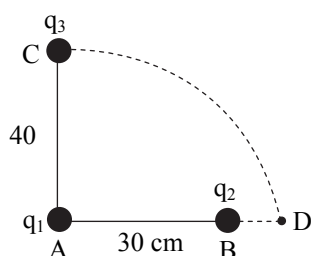
23. An A.C. ammeter is used to measure current in a circuit. When a given direct current passes through the circuit, the A.C. ammeter reads 3 A. When another alternating current passes through the circuit, the A.C. ammeter reads 4 A. Then the reading of this ammeter, if D.C. and A.C. flow through the circuit simultaneously, is

- (A) 3 A (B) 4 A
(C) 7 A (D) 5 A

24. Which of the following diagrams denotes the relation between the number of scattered particles and the angle of scattering?



25. Two charges q_1 and q_2 are placed 30 cm apart as shown in the figure. A third charge q_3 is moved along the arc of a circle of radius 40 cm from C to D. The change in the potential energy of the system is $\frac{q_3}{4\pi\epsilon_0}k$, where k is



- (A) $8q_2$ (B) $8q_1$
(C) $6q_2$ (D) $6q_1$

26. v_1 and v_2 are the velocities of sound at the same temperature in two monoatomic gases of densities ρ_1 and ρ_2 respectively. If $\rho_1/\rho_2 = \frac{1}{4}$

then the ratio of velocities v_1 and v_2 will be

- (A) 1 : 2 (B) 4 : 1
(C) 2 : 1 (D) 1 : 4

27. A thin bar magnet oscillates with a time period T. If it is cut into equal pieces along its axis, time period of oscillation of each piece is

- (A) T (B) 2T
(C) $\frac{T}{2}$ (D) $\frac{T}{4}$

28. The de-Broglie wavelength of an electron is the same as that of a 50 keV X-ray photon. The ratio of the energy of the photon to the kinetic energy of the electron is (the energy equivalent of electron mass is 0.5 MeV)

- (A) 1 : 50 (B) 1 : 20
(C) 20 : 1 (D) 50 : 1

29. A string of radius 4 mm and density 2 kg/m^3 when tuned starts vibrating with a frequency of 6 Hz. If another string of density one third of the square of density of the first string, vibrates with frequency 20% greater than that of first, then radius of the second string will be,

- (A) 5.2 mm (B) 6.2 mm
(C) 4.1 mm (D) 3.8 mm

30. A radioactive element has rate of disintegration 10,000 disintegrations per minute at a particular instant. After four minutes it becomes 2500 disintegrations per minute. The decay constant per minute is

- (A) $0.2 \log_e 2$ (B) $0.5 \log_e 2$
(C) $0.6 \log_e 2$ (D) $0.8 \log_e 2$

31. **Statement-1:** In a metre bridge experiment, null point for an unknown resistance is measured. Now the unknown resistance is placed inside an enclosure maintained at a higher temperature. The null point can be obtained at the same point as before by decreasing the value of the standard resistance.

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



- (A) Statement - I is true, Statement - II is true, Statement - II is the correct explanation of Statement-I.
 (B) Statement - I is true, Statement - II is true, Statement - II is not the correct explanation of Statement-I.
 (C) Statement - I is true, Statement - II is false.
 (D) Statement - I is false, Statement - II is true.
32. A clock which keeps correct time at 20°C is subjected to 40°C . If coefficient of linear expansion of the pendulum is 12×10^{-6} per $^\circ\text{C}$, then how much time will it lose in one day?
 (A) 5.6 s (B) 10.4 s
 (C) 15.3 s (D) 20.6 s
33. If the refractive indices of crown glass for red, yellow and violet colours are 1.5140, 1.5170 and 1.5318 respectively and for flint glass these values are 1.6434, 1.6499 and 1.6852 respectively, then the dispersive powers for crown and flint glass are respectively
 (A) 0.034 and 0.064
 (B) 0.064 and 0.034
 (C) 1.00 and 0.064
 (D) 0.034 and 1.0
34. The input resistance of a common emitter transistor amplifier, if the output resistance is $500\ \Omega$, the current gain $\alpha = 0.98$ and power gain is 6.0625×10^6 , is
 (A) $198\ \Omega$ (B) $300\ \Omega$
 (C) $100\ \Omega$ (D) $400\ \Omega$
35. A wire having a linear mass density $5.0 \times 10^{-3}\ \text{kg/m}$ is stretched between two rigid supports with a tension of 450 N. The wire resonates at a frequency of 420 Hz. The next higher frequency at which the same wire resonates is 490 Hz. The length of the wire is
 (A) 1.4 m (B) 2.1 m
 (C) 2.8 m (D) 3.5 m
36. From Brewster's law, except for polished metallic surfaces, the polarising angle
 (A) depends on wavelength and is different for different colours
 (B) independent of wavelength and is different for different colours
 (C) independent of wavelength and is same for different colours
 (D) depends on wavelength and is same for different colours
37. A micro-ammeter has a resistance of $100\ \Omega$ and a full scale range of $50\ \mu\text{A}$. It can be used as a voltmeter or as a higher range ammeter, provided a resistance is added to it. Pick the correct range and resistance combination from the following.
 (A) 50 V range with $10\ \text{k}\Omega$ resistance in series.
 (B) 10 V range with $200\ \text{k}\Omega$ resistance in series.
 (C) 5 mV range with $10\ \text{k}\Omega$ resistance in parallel.
 (D) 10 mA range with $1\ \Omega$ resistance in parallel.
38. Three point charges q , $-2q$ and $-2q$ are placed at the vertices of an equilateral triangle of side r . The work done to increase their separation to $2r$ is
 (A) zero (B) $\frac{Q^2}{4\pi\epsilon_0 r}$
 (C) $\frac{2Q^2}{4\pi\epsilon_0 r}$ (D) $\frac{\sqrt{2}Q^2}{4\pi\epsilon_0 r}$
39. The critical velocity of a satellite near the Earth's orbit is about
 (A) 8000 km/s (B) 800 km/s
 (C) 11.2 km/s (D) 8 km/s
40. A liquid of density $850\ \text{kg/m}^3$ has an unknown surface tension. However, it is observed that it rises three times high in a capillary tube as compared to pure water. If the contact angles for both are same, then the surface tension of liquid is
 (Surface tension of water = $7.0 \times 10^{-2}\ \text{N/m}$)
 (A) 0.10 N/m (B) 0.18 N/m
 (C) 0.24 N/m (D) 0.32 N/m
41. The lengths of two organ pipes open at both ends are L and $L + d$. If they are sounded together, then the beat frequency will be
 (A) $\frac{2Vd}{L(L+d)}$ (B) $\frac{Vd}{L(L+d)}$
 (C) $\frac{2L(L+d)}{Vd}$ (D) $\frac{Vd}{2L(L+d)}$
42. A gas mixture consists of 3 moles of oxygen and 5 moles of argon at temperature T . Assuming the gases to be ideal and the oxygen bond to be rigid, the total internal energy (in units of RT) of the mixture is:
 (A) 15 (B) 13
 (C) 11 (D) 20

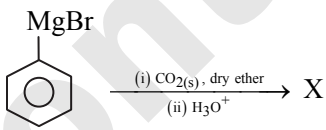
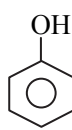
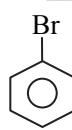
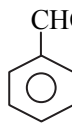
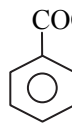
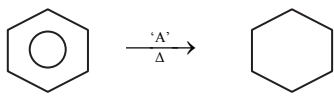


43. A beam of 8 mW power and wavelength 6000 Å has aperture 2 mm. If it is focused by a lens of focal length 6 cm, the intensity of the image ($\times 10^3$) is
(A) $0.52 \frac{\text{kW}}{\text{m}^2}$ (B) $1.32 \frac{\text{kW}}{\text{m}^2}$
(C) $2.63 \frac{\text{kW}}{\text{m}^2}$ (D) $5.20 \frac{\text{kW}}{\text{m}^2}$
44. Identify the option that does not correctly match among the given advanced concepts in Electrostatics.
(A) Maxwell's Equations: A set of four fundamental equations that describe how electric and magnetic fields interact and propagate through space.
(B) Electric Flux Density: Represents the flow of electric field through a surface per unit area, including both free and bound charges.
(C) Dielectric Polarisation: The alignment of the dipole moments of the permanent or induced dipoles with the direction of the applied electric field.
(D) Electric Dipole Moment: A measure of the separation between positive and negative charges in an electric dipole, defined as the product of the charge magnitude and the distance between them.
45. A toroidal solenoid with an air core has an average radius of 15 cm, area of cross-section 12 cm^2 and 1200 turns. Obtain the self inductance of the toroid. [Ignore field variations across the cross-section of the toroid.]
(A) 4.304×10^{-3} henry
(B) 2.304×10^{-3} henry
(C) 2.304×10^{-6} henry
(D) 4.304×10^{-6} henry
46. Consider an ideal gas at pressure P, volume V and temperature T. The mean free path for molecules of the gas is L. If the radius of gas molecules, as well as pressure, volume and temperature of the gas are doubled, then the mean free path will be
(A) $\frac{5L}{2}$ (B) $\frac{L}{4}$ (C) $\frac{L}{8}$ (D) $2L$
47. A gas for which $\gamma = 1.5$ is suddenly compressed to $\left(\frac{1}{4}\right)^{\text{th}}$ of the initial volume. Then the ratio of the final to the initial pressure is
(A) 1 : 16 (B) 1 : 8
(C) 1 : 4 (D) 8 : 1
48. The radius of gyration of a disc rotating about an axis passing through its centre and perpendicular to its plane is 2×10^{-2} m. The radius of gyration of the same disc when rotating about an axis coincident with a diameter of its face would be
(A) 4×10^{-2} m (B) 2×10^{-2} m
(C) 4.14×10^{-2} m (D) 1.414×10^{-2} m
49. A astronomical telescope has objective and eyepiece of focal length 40 cm and 4 cm respectively. To view an object 200 cm away from the objective, the lenses must be separated by a distance
(A) 50.0 cm (B) 54.0 cm
(C) 37.3 cm (D) 46.0 cm
50. When a proton is released from rest in a room, it starts with an initial acceleration a_0 towards west. When it is projected towards north with a speed v_0 it moves with an initial acceleration $3a_0$ towards west. The electric and magnetic fields in the room are
(A) $\frac{ma_0}{e}$ west, $\frac{2ma_0}{ev_0}$ up
(B) $\frac{ma_0}{e}$ west, $\frac{2ma_0}{ev_0}$ down
(C) $\frac{ma_0}{e}$ east, $\frac{3ma_0}{ev_0}$ up
(D) $\frac{ma_0}{e}$ east, $\frac{3ma_0}{ev_0}$ down



CHEMISTRY

1. If 15.0 L of neon at 25.0 °C is allowed to expand to 45.0 L, what must be the new temperature to maintain constant pressure?
(A) 348 K (B) 621 K
(C) 894 K (D) 1167 K
2. For the reaction,
 $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l})$
find the value for the work done at 300 K.
(A) 2.5 kJ (B) -7.5 kJ
(C) 7.5 kJ (D) -2.5 kJ
3. The rate of formation of B at time t for reaction $2\text{A} \longrightarrow 3\text{B}$ is equal to _____.
(A) $-\frac{3}{2} \frac{d[\text{A}]}{dt}$ (B) $-\frac{2}{3} \frac{d[\text{A}]}{dt}$
(C) $-\frac{1}{3} \frac{d[\text{A}]}{dt}$ (D) $+2 \frac{d[\text{A}]}{dt}$
4. What does magnetic quantum number describe?
(A) Orientation of an orbital in the given subshell
(B) Spin of an electron
(C) Shape of an orbital
(D) Size of an orbital
5. Which of the following is CORRECT about ferromagnetic materials?
(A) Weakly attracted by the magnetic field.
(B) Strongly repelled by the magnetic field.
(C) Loss of magnetism when the external magnetic field is removed.
(D) Presence of large number of unpaired electrons.



6. Which of the following form the electrolyte paste in the Leclanche' cell?
 (A) Ammonium chloride (NH_4Cl) and zinc chloride (ZnCl_2)
 (B) Manganese dioxide (MnO_2) and carbon black
 (C) Zinc and graphite
 (D) Zinc chloride (ZnCl_2) and starch
7. Which among the following sugars is called as laevulose?
 (A) Maltose (B) Galactose
 (C) Glucose (D) Fructose
8. Which among the following compounds is NOT used for the preparation of aromatic carboxylic acids from alkyl benzene?
 (A) Diborane
 (B) Dilute nitric acid
 (C) Alkaline potassium permanganate
 (D) Chromic acid
9. A certain buffer solution contains equal concentration of the weak acid (HX) and its salt with strong base (NaX). If the dissociation constant of the acid is 10^{-4} , find the pH of buffer solution.
 (A) 3 (B) 4
 (C) 5 (D) 6
10. In which of the following elements, the observed and expected electronic configuration of the atom in ground state remains same as $[\text{Ar}] 3d^1 4s^2$?
 (A) Co (B) Ti
 (C) Sc (D) V
11. Which among the following compounds converts alkyl halides to nitro alkanes?
 (A) Silver nitrite
 (B) alc. Potassium cyanide
 (C) alc. Silver cyanide
 (D) Potassium nitrite
12. Bakelite, the oldest synthetic polymer, is obtained from the reaction of:
 (A) Phenol and formaldehyde
 (B) Melamine and formaldehyde
 (C) Cellulose and conc. NaOH
 (D) Phenol and butadiene
13. Which among the following salts is formed of strong base and weak acid?
 (A) CuSO_4 (B) NaNO_3
 (C) NaCl (D) KCN
14. Calculate the amount of solute dissolved in 3 dm^3 water having osmotic pressure 0.3 atm at 300 K . (Molar mass of solute = 108 g mol^{-1} , $R = 0.0821 \text{ atm dm}^3 \text{ K}^{-1} \text{ mol}^{-1}$)
 (A) 4.51 g (B) 3.95 g
 (C) 3.45 g (D) 5.26 g
15. What is the oxidation state of nitrogen in N_3H ?
 (A) $-\frac{1}{3}$ (B) -1
 (C) $+\frac{1}{3}$ (D) $+3$
16. Calculate the edge length of a bcc unit cell. (Radius of atom = $2.17 \times 10^{-8} \text{ cm}$, $\sqrt{3} = 1.732$)
 (A) $4.3 \times 10^{-8} \text{ cm}$
 (B) $2.5 \times 10^{-8} \text{ cm}$
 (C) $5.0 \times 10^{-8} \text{ cm}$
 (D) $3.1 \times 10^{-8} \text{ cm}$
17. For a chemical reaction, the value of ΔG is positive regardless of temperature, if _____.
 (A) ΔH is negative and ΔS is positive
 (B) ΔH is positive and ΔS is positive
 (C) ΔH is negative and ΔS is negative
 (D) ΔH is positive and ΔS is negative
18. 
 In the above reaction, product X is _____.
 (A)  (B) 
 (C)  (D) 
19. Find the EAN of Fe in $[\text{Fe}(\text{CN})_6]^{4-}$.
 (A) 37 (B) 34
 (C) 35 (D) 36
20. How many moles of nitrogen gas at STP is equivalent to 5.6 dm^3 ?
 (A) $\frac{1}{2} \text{ mol}$ (B) $\frac{1}{4} \text{ mol}$
 (C) $\frac{1}{8} \text{ mol}$ (D) $\frac{1}{6} \text{ mol}$
21. Identify the reagent required for the following conversion:

 (A) NaOH/CaO
 (B) $\text{O}_3, \text{Zn}/\text{H}_2\text{O}$
 (C) Fuming H_2SO_4
 (D) H_2/Ni

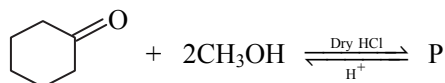


22. What is the half life period of a first order reaction if rate constant of the reaction is 0.002 min^{-1} ?
- (A) 346.5 min (B) 456.3 min
(C) 319.5 min (D) 138.6 min
23. IUPAC name of the following compound
- $$\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3 - \text{C} - \text{CH}_2\text{CH}_3 \\ | \\ \text{OH} \end{array}$$
- is _____.
- (A) 2-methylbutan-1-ol
(B) 1-methylbutan-2-ol
(C) 2-methylbutan-2-ol
(D) 1-methylbutan-1-ol
24. Which of the following is CORRECT?
- (A) Valine and alanine are acidic α -amino acids.
(B) Lysine and arginine are neutral α -amino acids.
(C) Glycine and alanine are essential α -amino acids.
(D) Tryptophan and histidine are essential α -amino acids.
25. Identify the weakest base among the following:
- (A)  $\text{N}(\text{CH}_3)_2$ (B) NH_3
- (C) $(\text{CH}_3)_3\text{N}$ (D)  CH_2NH_2
26. Identify the compound 'P' in the following reaction:
- $$\text{P} + \text{CH}_3\text{MgI} \xrightarrow{\text{dry ether}} \text{Intermediate} \xrightarrow{\text{H}_3\text{O}^+} \text{CH}_3\text{CH}_2\text{OH} + \text{Mg}(\text{OH})\text{I}$$
- (A) Acetic acid (B) Acetaldehyde
(C) Formaldehyde (D) Acetone
27. When hydrogen sulphide gas is passed through acidified $\text{K}_2\text{Cr}_2\text{O}_7$ solution, _____.
- (A) H_2S is reduced to pale yellow precipitate of sulphur
(B) the colour of the solution turns green
(C) potassium dichromate is oxidised to chromic sulphate
(D) the colour of the solution turns brown
28. Identify the INCORRECT statement about β -sulfur.
- (A) It is a bright yellow solid.
(B) It is soluble in CS_2 .
(C) It is stable above 369 K.
(D) It consists of S_6 molecule having chair form.
29. Two lone pairs of electrons and two bond pairs of electrons are present in _____.
- (A) BrF_3 (B) BeBr_2
(C) H_2S (D) SO_2
30. Calculate the molal elevation constant of solvent if boiling point elevation of solution of nonvolatile solute is 0.105 K and molality of solution is 0.05 m.
- (A) $0.47 \text{ K kg mol}^{-1}$ (B) $1.5 \text{ K kg mol}^{-1}$
(C) $2.1 \text{ K kg mol}^{-1}$ (D) $2.7 \text{ K kg mol}^{-1}$
31. One mole of an ideal gas is compressed from a volume of 1 m^3 to 5 dm^3 at a pressure of 0.2 bar. What is the value of work obtained during the process?
- (A) -19.9 kJ (B) -201 kJ
(C) $+497 \text{ kJ}$ (D) $+19.9 \text{ kJ}$
32. Which of the following is a CORRECT statement?
- (A) All alkali metals have positive values of standard reduction potential (E°).
(B) The alkali metals are soluble in liquid ammonia giving deep blue coloured solutions.
(C) Among alkali metals, sodium is the most powerful reducing.
(D) Lithium reacts vigorously but sodium and potassium react slowly with water.
33. Calculate standard cell potential for a cell having the following reaction,
- $$2\text{Al}_{(\text{s})} + 3\text{Ni}^{2+} \rightarrow 2\text{Al}^{3+} + 3\text{Ni}_{(\text{s})}$$
- ($E^\circ_{\text{Ni}} = -0.25 \text{ V}$, $E^\circ_{\text{Al}} = -1.66 \text{ V}$)
- (A) 1.91 V (B) 1.41 V
(C) -1.91 V (D) 0.41 V
34. Which among the following compounds have highest boiling point?
- (A) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$
(B) $\text{CH}_3\text{CH}_2\text{Br}$
(C) $\text{CH}_3\text{CH}(\text{Br})\text{CH}_2\text{CH}_3$
(D) $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$
35. What percentage of a radioactive substance will persist after 60 minutes if its half life is 30 minutes?
- (A) 12.5% (B) 25%
(C) 30% (D) 75%
36. _____ is prepared by air-oxidation of 2-ethylanthraquinol.
- (A) Lithium aluminium hydride
(B) Calcium carbonate
(C) Hydrogen peroxide
(D) Sodium hydroxide

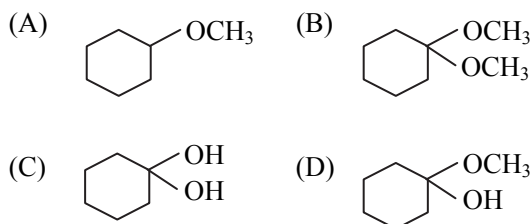


37. What is the concentration of H_3O^+ ions in a solution having pOH value equal to 10?
 (A) $1.0 \times 10^{-4} \text{ M}$
 (B) $1.0 \times 10^{-5} \text{ M}$
 (C) $1.5 \times 10^{-4} \text{ M}$
 (D) $2.5 \times 10^{-5} \text{ M}$

38.

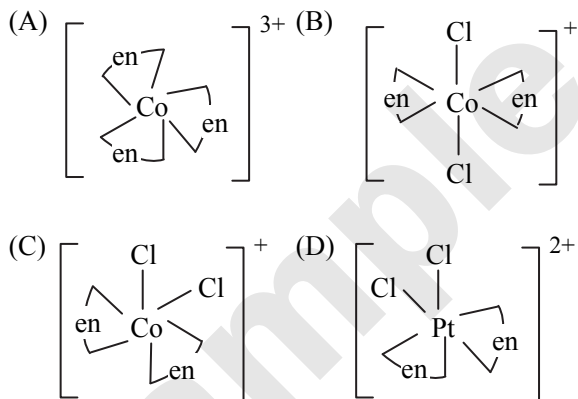


Product 'P' is _____.



39. Carbon black is a nanostructured material that is used in tyres of car _____.
 (A) to increase the weight of tyre
 (B) to impart various colours
 (C) to increase the life of tyre
 (D) to increase the friction

40. Which of the following does NOT show optical isomerism?



41. Which of the following is a positively charged sol?

- (A) Acid dye stuff
 (B) Clay sol
 (C) Methylene blue sol
 (D) Congo red sol

42. A set of solutions are prepared using 200 g of water as a solvent and 1 g of different non-volatile, non-electrolyte solutes A, B and C. Molar mass of A, B and C are 100 g mol^{-1} , 250 g mol^{-1} and 5000 g mol^{-1} respectively. The relative lowering of vapour pressure in the presence of these solutes in water is in the order:
 (A) $A > C > B$ (B) $A > B > C$
 (C) $C > B > A$ (D) $C > A > B$

43. Which group shows -R (negative resonance) effect?

- (A) -CHO (B) -OH
 (C) -OR (D) -Cl

44. The quantity of electricity required to produce 0.27 g Ag at cathode during electrolysis of AgNO_3 solution is _____.

- (Molar mass of Ag = 108 g mol^{-1})
 (A) 241.25 C (B) 482.50 C
 (C) 723.75 C (D) 965.00 C

45. The orange dye test is used to detect the presence of _____.

- (A) aromatic carboxylic acid group
 (B) aromatic primary amino group
 (C) secondary amino group
 (D) primary hydroxyl group

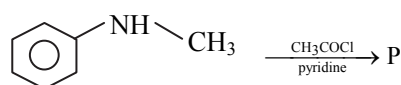
46. What is the number of unpaired electrons present in f-orbital at +3 oxidation state of Lu ($Z = 71$)?

- (A) 0 (B) 4
 (C) 2 (D) 7

47. Which of the following statements accurately describes the litmus test for alcohols and phenols?

- (A) Aqueous solutions of alcohols turn blue litmus red.
 (B) Aqueous solutions of phenols do not cause any color change in litmus paper.
 (C) Aqueous solutions of alcohols are neutral to litmus paper.
 (D) Aqueous solutions of phenols turn red litmus blue.

48.



The functional group present in 'P' is _____.

- (A) aromatic primary amine
 (B) carboxylic acid
 (C) ketone
 (D) amide

49. Which of the following halogen does NOT form perhalic acid?

- (A) F (B) Cl
 (C) Br (D) I

50. What is the number of -COOH groups present in aspirin and phthalic acid respectively?

- (A) 1, 3 (B) 2, 2
 (C) 1, 2 (D) 2, 1



Time: 90 Minutes

Total Marks: 100

1. Match the following monosaccharides with their corresponding number of carbon atoms:

	Monosaccharides		Number of carbon atoms
i	Ribose	a	3 carbons
ii	Fructose	b	7 carbons
iii	Sedoheptulose	c	6 carbons
iv	Glyceraldehyde	d	5 carbons

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

2. Match the germ layer with the correct structure or organ it gives rise to:

	Germ layer		Structure/Organs
i.	Ectoderm	a.	Connective tissues, blood vessels, dermis of skin
ii.	Mesoderm	b.	Urinary bladder, trachea, bronchi
iii.	Endoderm	c.	Epidermis of skin, enamel of teeth, mammary glands

- (A) i – c, ii – a, iii – b
(B) i – a, ii – c, iii – b
(C) i – b, ii – c, iii – a
(D) i – a, ii – b, iii – a

3. Which of the following statement about genes or alleles is incorrect?

- (A) Genes are responsible for the inheritance and expression of a character.
(B) Alleles are alternative forms of a given gene and occupy identical loci on homologous chromosomes.
(C) Dominant alleles express their traits even in the presence of an alternative allele.
(D) Recessive alleles express their traits in the presence of an alternative dominant allele.

4. What is the correct order of electron transfer in the electron transport chain during oxidative phosphorylation?

- (A) NADH dehydrogenase → Succinate dehydrogenase → Cytochrome bc_1 complex → Cytochrome C oxidase → F_0 part of oxysome
(B) Succinate dehydrogenase → NADH dehydrogenase → Cytochrome C oxidase → Cytochrome bc_1 complex → F_0 part of oxysome

- (C) NADH dehydrogenase → Cytochrome bc_1 complex → Cytochrome C oxidase → Succinate dehydrogenase → F_0 part of oxysome
(D) Succinate dehydrogenase → Cytochrome bc_1 complex → Cytochrome C oxidase → NADH dehydrogenase → F_0 part of oxysome

5. Which of the following pairs is incorrect regarding asexual reproduction in organisms?

- (A) Fragmentation - *Spirogyra*
(B) Budding - *Protosiphon*
(C) Spore formation - *Chlamydomonas*
(D) Root cutting - *Bougainvillea*

6. Select the correct statement/s regarding small intestine.

- i. Small intestine in human, is about 6 meters long and 2.5 cm broad tube coiled within thoracic cavity.
ii. Duodenum is about 26 cm long 'L' shaped structure.
iii. Jejunum is about 2.5 meters long, coiled middle portion of small intestine.
iv. Ileum is about 3.5 meters long, it is highly coiled and little broader than jejunum.
v. In small intestine the coils are held together by mesenteries, supporting the blood vessels, lymph vessels and nerves.
(A) iv only (B) i and v only
(C) iii, iv and v only (D) i and ii only

7. Select the incorrect statement/s regarding Griffith's experiment.

- i. Frederick Griffith's experiments with *Streptococcus pneumoniae* demonstrated that the non-virulent R strain bacteria transformed into the virulent S strain bacteria.
ii. The mice injected with live strain R bacteria did not develop pneumonia and survived.
iii. Griffith's experiments confirmed that the genetic material from the heat-killed S strain bacteria was responsible for transforming the R strain into the S strain.
iv. The mice injected with heat-killed strain S bacteria died because the heat-killed bacteria became active and multiplied.
v. Griffith's experiments demonstrated the phenomenon of bacterial conjugation.
(A) i only
(B) iv and v only
(C) iii and v only
(D) i and iii only



8. Match the following excretion mechanisms with their corresponding characteristics:

	Excretory substance		Characteristics
i.	Ammonia	a.	Least toxic, least soluble in water, minimal or no water needed for elimination.
ii.	Urea	b.	Basic in nature, requires large quantity of water for elimination.
iii.	Uric acid	c.	Less toxic and less water-soluble than ammonia, suitable for water conservation

- (A) i – a, ii – b, iii – c
(B) i – a, ii – c, iii – b
(C) i – b, ii – c, iii – a
(D) i – c, ii – b, iii – a

9. Match the theories or hypotheses related to the origin of life with their descriptions:

	Theories/Hypotheses		Descriptions
i.	Theory of special creation	a.	Advocates that life originated from non-living (inanimate) material spontaneously.
ii.	Cosmozoic theory/Theory of Panspermia	b.	States that all living organisms are created by a supernatural power.
iii.	Theory of spontaneous generation (Abiogenesis)	c.	Proposes that life may have descended to Earth from other planets in the form of spores or microorganisms.
iv.	Theory of biogenesis	d.	Living organisms are always produced from pre-existing living forms by the process of reproduction.

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

10. What is the relationship between osmotic pressure (OP), turgor pressure (TP), and diffusion pressure deficit (DPD) in a fully turgid cell?

- (A) $OP = TP$
(B) $DPD = OP + TP$
(C) $DPD = OP$
(D) $TP = DPD - OP$

11. Match the correct methods for the measurement of linear growth of stem and radicle with its description:

	Measurement Methods		Description
i.	Direct method	a.	Used for precise measurement of linear growth of shoot
ii.	Horizontal microscope	b.	Measures growth in fields
iii.	Auxanometer	c.	Records primary growth accurately with high magnification
iv.	Crescograph	d.	Simple method using an ordinary measuring scale

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

12. Identify the correctly matched pair of column/s:

	Organism	Habitat	Respiratory surface/organ
a.	Protists, Sponges and Coelenterates	Terrestrial	Book lungs
b.	<i>Limulus</i> (Arthropod)	Aquatic	Book gills
c.	Turtles	Underwater	Cloaca
d.	Arachnids like spiders and scorpions	Aquatic	Plasma membrane

- (A) Both b and d (B) only c
(C) only d (D) both b and c

13. Match the types of spinal nerves with the corresponding number of pairs:

	Types of spinal nerves		Number of pairs
i	Cervical	a	1
ii	Thoracic	b	8
iii	Lumbar	c	12
iv	Coccygeal	d	5

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

14. Given below are two statements:

Statement I: Any foreign substance invading body and capable of stimulating an immune response, is called an antibody.

Statement II: The protective chemicals produced by immune cells in response to antigens are called acute phase proteins.



In the light of above two statements, choose the most appropriate answer from the options given below.

- (A) Both statement I and statement II are correct.
- (B) Both statement I and statement II are incorrect.
- (C) Statement I is correct but statement II is incorrect.
- (D) Statement I is incorrect but statement II is correct.

15. Given below are two statements:

Statement I: Intervarietal hybridization is hybridization between two varieties of the different species.

Statement II: Interspecific hybridization is hybridization between two species of the same genus.

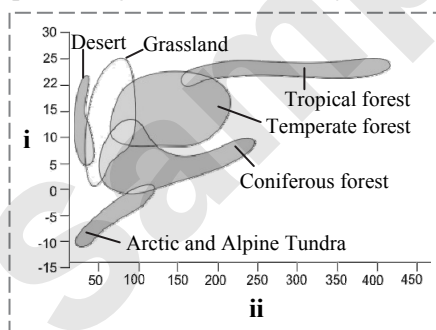
In the light of above two statements, choose the most appropriate answer from the options given below.

- (A) Both statement I and statement II are correct.
- (B) Both statement I and statement II are incorrect.
- (C) Statement I is correct but statement II is incorrect.
- (D) Statement I is incorrect but statement II is correct.

16. At the end of how many cycles in an automatic thermal cyler would 128 copies of DNA segments be produced?

- (A) 5 (B) 6 (C) 7 (D) 8

17. Identify label 'i' and 'ii' in the given figure representing distribution of major biomes.



	i	ii
(A)	Mean annual snowfall	Mean annual humidity
(B)	Mean annual precipitation/rainfall	Mean annual temperature
(C)	Mean annual humidity	Mean annual snowfall
(D)	Mean annual temperature	Mean annual precipitation/rainfall

18. Given below are two statements:

Statement I: The prosthetic group is firmly bound to the protein component by chemical bonds and is not removed by hydrolysis.

Statement II: Proteinous part of enzyme is called apoenzyme.

In the light of above two statements, choose the most appropriate answer from the options given below.

- (A) Both statement I and statement II are correct.
- (B) Both statement I and statement II are incorrect.
- (C) Statement I is correct but statement II is incorrect.
- (D) Statement I is incorrect but statement II is correct.

19. Which of the following ecosystem services is primarily responsible for the fixation of atmospheric CO₂ and release of O₂?

- (A) Nutrient cycling
- (B) Habitat provision
- (C) Pollination
- (D) Photosynthetic activity

20. How many carbon atoms are released as carbon dioxide during one turn of the Krebs cycle?

- (A) 1 (B) 2 (C) 3 (D) 4

21. What is the term used to describe the phenomenon where rich diversity leads to lesser variation in biomass production over time?

- (A) Species-Abundance Hypothesis
- (B) Stability-Diversity Hypothesis
- (C) Productivity-Stability Hypothesis
- (D) Biomass-Variation Hypothesis

22. Select the incorrect statement/s regarding structure of microspore.

- i. The inner layer exine is thick and made up of complex, non-biodegradable, substance called sporopollenin.
 - ii. At some places exine is very thin showing thin areas known as germ-pores.
 - iii. The outer wall layer, intine consists of cellulose and pectin.
 - iv. Typical pollen grain is a non-motile, haploid, unicellular body with single nucleus.
 - v. Germ-spores are meant for the growth of emerging pollen tube during germination of pollen grain.
- (A) iv only (B) i and v only
 - (C) iii, iv and v only (D) i and iii only

23. In which order, from innermost to outermost, are the layers of the gastrointestinal tract arranged?

- (A) Mucosa, Submucosa, Muscularis, Serosa
- (B) Submucosa, Mucosa, Serosa, Muscularis
- (C) Muscularis, Submucosa, Serosa, Mucosa
- (D) Mucosa, Serosa, Submucosa, Muscularis



24. Identify the correct order of cleavages during embryonic development in humans:
(A) Longitudinal, meridional, horizontal
(B) Meridional, longitudinal, horizontal
(C) Horizontal, meridional, longitudinal
(D) Horizontal, longitudinal, meridional
25. Given below are two statements:
Statement I: Metanephridia are network of dead end tubes called flame cells.
Statement II: Protonephridia are unbranched coiled tubes that connect to body cavity through funnel like structures called nephrostomes.
In the light of above two statements, choose the most appropriate answer from the options given below.
(A) Both statement I and statement II are correct.
(B) Both statement I and statement II are incorrect.
(C) Statement I is correct but statement II is incorrect.
(D) Statement I is incorrect but statement II is correct.
26. In humans, how many pairs of chromosomes are involved in sex determination?
(A) 1 pair (B) 22 pairs
(C) 23 pairs (D) 24 pairs
27. In prokaryotes, the nucleoid, a small, circular, highly folded ring of DNA, is approximately _____ in perimeter.
(A) 1100 μm (B) 350 μm
(C) 30 μm (D) 2 μm

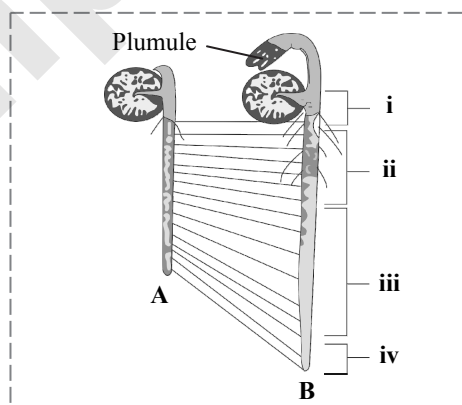
28. Given below are two statements:
Statement I: The original members that drifted and established the new population become 'founders' and the effect is called founder effect.
Statement II: The Sewall Wright effect is a type of genetic drift which is seen when much of a population is killed due to a natural disaster (tsunami, floods, tornado, disease epidemic, etc.) and only a few individuals are left to begin a new population.
In the light of above two statements, choose the most appropriate answer from the options given below.
(A) Both statement I and statement II are correct.
(B) Both statement I and statement II are incorrect.
(C) Statement I is correct but statement II is incorrect.
(D) Statement I is incorrect but statement II is correct.

29. Identify the correctly matched pair of column/s:

	Leaf Types	Distribution of Stomata	Example of Plants
a.	Hydrophytes	Stomata on upper epidermis (epistomatic)	Lotus
b.	Xerophytes	Stomata on lower epidermis (amphistomatic)	Grass
c.	Mesophytes	Stomata on both surfaces (hypostomatic)	<i>Nerium</i>

- (A) Only b (B) Only a
(C) Both b and c (D) Both a and b

30. Identify label 'i', 'ii', 'iii' and 'iv' in the given figure representing zones of growth phases in root.



Position of radicle at the beginning (A) and at the end (B)

	i	ii	iii	iv
(A)	Zone of cell formation	Zone of cell elongation	Zone of cell differentiation	Zone of mature cells
(B)	Zone of cell elongation	Zone of cell formation	Zone of mature cells	Zone of cell differentiation
(C)	Zone of mature cells	Zone of cell differentiation	Zone of cell elongation	Zone of cell formation
(D)	Zone of cell differentiation	Zone of mature cells	Zone of cell formation	Zone of cell elongation



31. The nasal cavity is divisible into right and left nasal chambers by a _____ cartilage.
(A) Zygomatic (B) Ethmoid
(C) Mesethmoid (D) Palatine
32. Which statement about the central nervous system (CNS) is incorrect?
(A) The dura mater is the outermost tough, non-vascular layer attached to the inner side of the cranium.
(B) The arachnoid mater is the innermost delicate, highly vascular membrane in close contact with the CNS.
(C) CSF is secreted by the pia mater, the choroid plexuses, and the ependymal cells lining the ventricles.
(D) The meninges and CSF act as a shock absorber and protect the brain and spinal cord from mechanical injuries.
33. Why is Rh (D) antigen considered a significant factor in hemolytic diseases of the newborn (HDN)?
(A) It induces a weak immune response in Rh-negative individuals.
(B) It causes anemia in Rh-positive individuals.
(C) It leads to the destruction of erythrocytes in the foetus during pregnancy.
(D) It is not involved in blood transfusion reactions.
34. What is the pre-inoculation treatment for explants to maintain aseptic conditions?
(A) Use of detergents
(B) Hot air oven
(C) Autoclave
(D) 20% ethyl alcohol and 0.1% HgCl₂ treatment
35. Which bacterium is used for the production of the flu vaccine that can be administered by placing it under the tongue?
(A) *Bacillus anthracis*
(B) *Bacillus subtilis*
(C) *Bacillus cereus*
(D) *Bacillus thuringiensis*
36. What is the difference between a fundamental niche and a realized niche?
(A) The fundamental niche represents the niche in the absence of competitors, while the realized niche considers the presence of competition.
(B) The fundamental niche is the niche occupied by a species in its optimal environment, while the realized niche represents its adaptation to diverse environments.
(C) The fundamental niche accounts for biotic and abiotic factors, while the realized niche focuses only on abiotic factors.
(D) The fundamental niche is a multidimensional space, whereas the realized niche is a unidimensional gradient.
37. Unlike the carbon cycle, which cycle does not involve the respiratory release of its element into the atmosphere?
(A) Nitrogen cycle (B) Water cycle
(C) Phosphorus cycle (D) Oxygen cycle
38. What is the estimated rate of the current loss of biodiversity compared to pre-human times?
(A) 10 to 100 times faster
(B) 50 to 500 times faster
(C) 100 to 1000 times faster
(D) 1000 to 10,000 times faster
39. Which of the following secondary metabolite is primarily composed of carbon and hydrogen, synthesized from mevalonic acid?
(A) Terpenes
(B) Phenolics
(C) Nitrogen-containing compounds
(D) Tannins
40. Each cell of the sporogenous tissue in the anther is capable of giving rise to a _____.
(A) pollen grain
(B) microspore tetrad
(C) seed
(D) tapetum
41. What is the term used to describe the process where the placenta is separated from the uterus and expelled out after the delivery of the baby?
(A) Postpartum (B) Dilation
(C) After birth (D) Placentation
42. Which molecule enters the Krebs cycle by combining with acetyl-CoA?
(A) Pyruvate (B) Oxaloacetate
(C) Citrate (D) Fumarate
43. What type of inheritance pattern is observed in the transmission of color blindness from a colorblind father to his grandson through his daughter?
(A) Autosomal dominant inheritance
(B) Autosomal recessive inheritance
(C) X-linked dominant inheritance
(D) X-linked recessive inheritance
44. Which of the following statements about the Human Genome Project (HGP) are true?
i. The main goal of the HGP was to determine the complete DNA sequence of the human genome.
ii. The HGP aimed to estimate the number of human genes, which is approximately 33,000.



- iii. The HGP included sequencing the genomes of various organisms, such as *E. coli*, yeast, fruit fly, and mouse.
- iv. Comparative studies using complete genome sequences of model organisms can help researchers understand gene functions.
(A) i and iv only (B) iv and ii only
(C) i, ii, iii and iv (D) i and iii only
45. Which of the following pair of secretion and cell is incorrect?
(A) Mucus - Mucus cells
(B) HCl - Parietal or oxyntic cells
(C) Rennin - Peptic or chief cells
(D) Bile juice - Parietal or oxyntic cells
46. In a population that follows Hardy-Weinberg equilibrium, if the frequency of allele 'A' is 0.6, what would be the expected frequency of individuals with the genotype 'Aa'?
(A) 0.12 (B) 0.36
(C) 0.48 (D) 0.72
47. What is the role of the walls of the capillaries in the glomerulus?
(A) They secrete macromolecules like proteins
(B) They control the diameter of the arterioles
(C) They regulate the osmotic pressure in the glomerulus
(D) They become permeable under high pressure to allow plasma filtration
48. Identify X and Y in the below given reaction catalyzed by enzyme phosphorylase with respect to starch-sugar inter-conversion theory given by Steward in 1964.
- Starch $\xrightarrow{\text{Day}}$ Sugar

← $\xrightarrow{\text{Night}}$

X Y
- | | X | Y |
|-----|--------------|--------------|
| (A) | Stoma closes | Stoma closes |
| (B) | Stoma closes | Stoma opens |
| (C) | Stoma opens | Stoma closes |
| (D) | Stoma opens | Stoma opens |
49. Which process of nitrogen fixation occurs under the influence of electric discharge and thunderstorms, producing nitric oxide?
(A) Industrial nitrogen fixation
(B) Physical nitrogen fixation
(C) Haber-Bosch nitrate process
(D) Nitrogen peroxide production
50. What is the term used to describe the streaming movement of cytoplasm in living organisms?
(A) Cytokinesis (B) Cyclosis
(C) Cytolysis (D) Cytoskeleton

51. What is the name of the area on the retina that lacks rod and cone cells and is the location where the optic nerve and blood vessels leave the eyeball?
(A) Blind spot (B) Yellow area
(C) Macula lutea (D) Fovea centralis
52. How many subtypes of filariasis are there?
(A) 1 (B) 2 (C) 3 (D) 4
53. Which of the following statements about streptokinase and statins is incorrect?
(A) Streptokinase is an enzyme produced by *Streptococcus spp.* and has a fibrinolytic effect.
(B) Streptokinase is used as a blood clot-dissolving agent for heart attack patients.
(C) Statins are produced by the yeast *Monascus purpureus* and act as competitive inhibitors of the enzyme responsible for cholesterol synthesis.
(D) Statins are used to increase blood cholesterol levels.
54. Given below are two statements:
Statement I: 3' end of DNA is end of polynucleotide chain with sugar molecule not connected to another nucleotide with C-3 which is not connected to phosphate group
Statement II: 5' end of DNA is end of polynucleotide chain with sugar molecule with C-5 which is not connected to any more phosphate group.
In the light of above two statements, choose the most appropriate answer from the options given below.
(A) Both statement I and statement II are correct.
(B) Both statement I and statement II are incorrect.
(C) Statement I is correct but statement II is incorrect.
(D) Statement I is incorrect but statement II is correct.
55. **Statement I:** Mammals from warmer climates generally have shorter snout, ears, tail and limbs to minimize the loss of body heat.
Statement II: In the polar seas, aquatic mammals like seals have a thin layer of fat (blubber) below their skin acting as an insulator to reduce loss of body heat.
In the light of above two statements, choose the most appropriate answer from the options given below.
(A) Both statement I and statement II are correct.
(B) Both statement I and statement II are incorrect.
(C) Statement I is correct but statement II is incorrect.
(D) Statement I is incorrect but statement II is correct.



56. What is the process called when bacterial and fungal enzymes degrade detritus into simpler inorganic substances?
(A) Leaching (B) Catabolism
(C) Precipitation (D) Percolation
57. Exposure to sound levels of _____ or higher, such as those generated during a jet plane or rocket takeoff, may result in permanent hearing loss.
(A) 100 decibels (B) 60 decibels
(C) 150 decibels (D) 80 decibels
58. mRNA synthesis begins at the _____ end of the DNA strand and terminates at the _____ end.
(A) 3', 3' (B) 5', 5'
(C) 3', 5' (D) 5', 3'
59. Which part of the mouth is involved in the absorption of substances like certain painkillers?
(A) Upper side of the tongue
(B) Palate
(C) Mucosa of the mouth and lower side of the tongue
(D) Salivary glands
60. During which period does organogenesis, the development of body organs, mainly occur in the embryo?
(A) Second Trimester (B) Third Trimester
(C) First Trimester (D) Fourth Trimester
61. Which of the following is a characteristic feature of individuals with Klinefelter's syndrome?
(A) Development of breast tissue (Gynaecomastia)
(B) Tall height and long arms
(C) Harsh voice pitch
(D) All of the above
62. What type of stones can be caused by a genetic disorder that leads to the excessive excretion of certain amino acids by the kidneys?
(A) Calcium oxalate stones
(B) Calcium phosphate stones
(C) Struvite stones
(D) Cystine stones
63. Given below are two statements:
Statement I: A narrow opening at the apex of the ovule is called micropyle.
Statement II: Chalaza is the base of ovule directly opposite to micropyle.
In the light of above two statements, choose the most appropriate answer from the options given below.
(A) Both statement I and statement II are correct.
(B) Both statement I and statement II are incorrect.
(C) Statement I is correct but statement II is incorrect.
(D) Statement I is incorrect but statement II is correct.
64. Arrange the following steps involved in DNA fingerprinting in chronological order:
i. Gel electrophoresis
ii. Isolation of DNA
iii. Selection of DNA probe
iv. Southern blotting
v. Hybridization
vi. Restriction digestion
vii. Photography
(A) ii → iii → v → vi → iv → i → vii
(B) ii → vi → i → iv → iii → v → vii
(C) i → ii → iii → iv → v → vi → vii
(D) vii → vi → v → iv → iii → i → ii
65. Which type of fossil is represented by a Woolly Mammoth found preserved in the permafrost of Siberia?
(A) Cast (B) Mould
(C) Actual remains (D) Compressions
66. Given below are two statements:
Statement I: In vertical (longitudinal) transport, food is translocated in downward direction from leaves (source) to stem and root (sink).
Statement II: When food is translocated from phloem to pith, it is called tangential translocation and from phloem to cortex, it is called radial translocation.
In the light of above two statements, choose the most appropriate answer from the options given below.
(A) Both statement I and statement II are correct.
(B) Both statement I and statement II are incorrect.
(C) Statement I is correct but statement II is incorrect.
(D) Statement I is incorrect but statement II is correct.
67. Vitamins are absorbed in
(A) lacteals
(B) rectum
(C) blood capillaries in the villi
(D) lacteals and blood capillaries in villi
68. Given below are two statements:
Statement I: In pulmonary circulation, heart pumps deoxygenated blood to lungs for oxygenation and it returns to heart as oxygenated blood.
Statement II: In systemic circulation, oxygenated blood is pumped from the heart towards various body parts (except lungs) and returns back to the heart as deoxygenated blood.

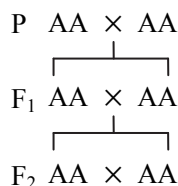


In the light of above two statements, choose the most appropriate answer from the options given below.

- (A) Both statement I and statement II are correct.
 (B) Both statement I and statement II are incorrect.
 (C) Statement I is correct but statement II is incorrect.
 (D) Statement I is incorrect but statement II is correct.
69. What is the time interval during which a nerve fails to respond to a second stimulus, regardless of its strength?
 (A) Synaptic delay
 (B) Synaptic fatigue
 (C) Refractory period
 (D) Neurotransmitter release
70. What is the purpose of anaerobic sludge digesters in wastewater treatment plants?
 (A) To promote the growth of aerobic bacteria for further digestion of sludge.
 (B) To add gases such as methane, hydrogen sulfide, and CO₂ to the sludge.
 (C) To release effluents directly into natural water bodies without further treatment.
 (D) To allow anaerobic bacteria to digest the bacteria and fungi in the sludge.
71. Given below are two statements:
Statement I: One transgenic cow would be more than sufficient for production of annual world supply of factor IX (plasma thromboplastin component) that is used in the treatment of haemophilia.
Statement II: Bacterial genes, *cys E* and *cys M*, are concerned with biosynthesis of cysteine amino acids involved in formation of keratin protein found in wool.
 In the light of above two statements, choose the most appropriate answer from the options given below.
 (A) Both statement I and statement II are correct.
 (B) Both statement I and statement II are incorrect.
 (C) Statement I is correct but statement II is incorrect.
 (D) Statement I is incorrect but statement II is correct.
72. The most common evolutionary stable strategy (ESS) regarding the ratio of males and females is _____.
 (A) 1:2 (B) 2:1
 (C) 1:1 (D) 1:4
73. Which of the following statements about a pond ecosystem is FALSE?
 (A) The abiotic component of a pond includes water, dissolved substances, and soil deposits.
 (B) The solar input and climatic conditions have no impact on the functioning of a pond ecosystem.
 (C) Phytoplankton, algae, and aquatic plants are examples of producers in a pond ecosystem.
 (D) Decomposers such as fungi and bacteria are found at the bottom of the pond.
74. If the ozone layer is intact, which of the following UV radiations will be almost completely absorbed by the Earth's atmosphere?
 (A) UV-A (B) UV-B
 (C) UV-C (D) UV-D
75. How many carbon atoms are present in a single molecule of acetyl-CoA produced in the aerobic respiration?
 (A) 2 (B) 4
 (C) 6 (D) 8
76. What causes the yellow discoloration of the conjunctiva of eyes and skin in jaundice?
 (A) Increased bilirubin level in the blood
 (B) Decreased bilirubin level in the blood
 (C) Excessive red blood cell production
 (D) Obstruction in the flow of bile from the liver to the pancreas
77. Which type of cells make up the visceral wall of Bowman's capsule and are in close contact with the walls of the glomerular capillaries?
 (A) Cuboidal epithelial cells
 (B) Podocytes
 (C) Ciliated epithelial cells
 (D) Parietal cells
78. The term used to describe the process in apomixis where a diploid sporophyte cell produces a diploid gametophyte without undergoing meiosis is _____.
 (A) apospory (B) apogamy
 (C) syngamy (D) sporogenesis
79. The process of _____ involves the thinning of the acrosome membrane, entry of Ca⁺⁺ ions into the sperm, and rapid whiplash movements of sperm tails, making them extra active and capable of swimming towards the egg.
 (A) fertilization (B) capacitation
 (C) ovulation (D) implantation



80. Consider the following cross showing the traits of plants:



Based on the given cross, what can be inferred about the plants?

- (A) false breeding plants
(B) heterozygous plants
(C) self-breeding plants
(D) true breeding plants
81. What is the term used for adaptive enzymes in bacteria that are synthesized depending upon the substrate present?
(A) Restriction enzymes
(B) Inducible enzymes
(C) DNA polymerases
(D) Ribozymes
82. During which era did the dominant plant life consist of ferns, cycads, and advanced conifers, while the animal life included amphibians and winged insects?
(A) Cenozoic (B) Mesozoic
(C) Paleozoic (D) Proterozoic
83. Imbibition is the swelling up of hydrophilic colloids due to the adsorption of _____. The substance that adsorbs water/liquid is called the _____, and the water/liquid that gets imbibed is called the _____.
(A) Water, imbibant, imbibate
(B) Solution, imbibate, imbibant
(C) Imbibant, imbibate, solution
(D) Imbibate, imbibant, water
84. During the dark period, the conversion of P_{fr} (far red form of phytochrome) to P_r (red form) _____ flowering in short-day plants (SDP) and _____ flowering in long-day plants (LDP).
(A) stimulates, inhibits
(B) inhibits, stimulates
(C) activates, delays
(D) promotes, enhances
85. What is the approximate range of haemoglobin content in the blood of men and women, respectively?
(A) Men: 14 - 17 gm%, Women: 13 - 15 gm%
(B) Men: 13 - 15 gm%, Women: 14 - 17 gm%
(C) Men: 17 - 20 gm%, Women: 15 - 18 gm%
(D) Men: 15 - 18 gm%, Women: 14 - 16 gm%
86. The midbrain contains two thick fibrous tracks called _____, which connect the cerebrum to the midbrain.
(A) Cerebral peduncles
(B) Corpora quadrigemina
(C) Superior colliculi
(D) Red nucleus
87. Which marker gene in the pBR322 plasmid vector is knocked out by the PstI restriction enzyme?
(A) Ampicillin resistant gene
(B) Tetracycline resistant gene
(C) Both Ampicillin and Tetracycline resistant genes
(D) None of the above
88. What is represented by the number pyramid, biomass pyramid, and energy pyramid in an ecosystem?
(A) Number of individuals, amount of biomass, and accumulated energy at each trophic level.
(B) Relative size of organisms, total biogas, and energy flow in the ecosystem.
(C) Number of species, diversity of organisms, and energy conversion efficiency.
(D) Ratio of primary producers to consumers, trophic levels, and heat production.
89. In plants like black pepper and beet, the persistent nucellus in the ovule forms a thin, papery layer known as _____.
(A) Perisperm (B) Endosperm
(C) Tegmen (D) Embryospore
90. Which of the following statements about the secretory phase/luteal phase is incorrect?
(A) The secretory phase lasts for 14 days, from the 15th to the 28th day of the cycle.
(B) The corpus luteum releases progesterone, small amounts of estrogens, and inhibin.
(C) The endometrial glands grow, become coiled, and start uterine secretions under the influence of hormones like progesterone, estrogen and inhibin.
(D) The corpus luteum can survive for more than two weeks in the absence of fertilization.
91. Select the correct statement/s about the white blood corpuscles.
i. Temporary increase in number of WBCs is called as leucopenia.
ii. Decrease in number of WBCs (<4000) is called leukemia.
iii. Uncontrolled increase in number of WBCs is a type of blood cancer called leukocytosis.



- iv. Due to their amoeboid movement WBCs can move out of the capillary walls by a process called diapedesis.
- v. A normal adult has on an average, 5000-11000 WBCs per cm^3 of blood.
- (A) iv only (B) iv and v only
(C) i, ii, iii and iv (D) i and iii only

92. Identify the incorrect pairing of the secretion type with its corresponding description:
- (A) Autocrine - Cells release secretion to stimulate itself.
(B) Paracrine - Cells release secretion to stimulate neighbouring cells.
(C) Endocrine - Cells release secretion to stimulate distant cells.
(D) Pheromones - Organs release secretions to stimulate themselves.

93. The fungal hyphae of Endomycorrhizae form finely branched _____ intracellularly and vesicles mostly in the intercellular spaces of cortical cells.
- (A) appressoria (B) mycelia
(C) arbuscules (D) stomata

94. Why is the establishment of a genomic library in eukaryotes not meaningful?
- (A) Eukaryotic DNA contains introns, regulatory genes, and repetitive DNA.
(B) cDNA libraries are more efficient for studying eukaryotic organisms.
(C) Genomic libraries are only applicable to prokaryotic organisms.
(D) mRNA cannot be isolated from eukaryotic organisms.

95. How many seconds does an average adult's heart take to complete 10 cardiac cycles (heartbeats) at rest?
- (A) 8 seconds (B) 80 seconds
(C) 0.8 seconds (D) 800 seconds

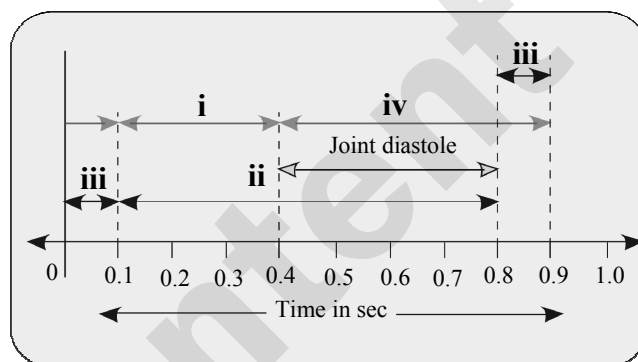
96. Match the digestive hormone with its correct function:

	Digestive hormone		Function
i.	Gastrin	a.	Slows gastric contractions and inhibits the secretion of gastric juice.
ii.	Secretin	b.	Stimulate the pancreas to release its enzymes and also stimulates gall bladder to release bile.
iii.	Cholecystokinin (CCK) and Pancreozymin (PZ)	c.	Responsible for secretion of pancreatic juice and bile from pancreas and liver respectively.

iv.	Entero-gastrone / Gastric inhibitory peptide (GIP)	d.	Stimulates gastric glands to produce gastric juice.
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- (A) i - a, ii - b, iii - c, iv - d
(B) i - d, ii - c, iii - b, iv - a
(C) i - a, ii - c, iii - b, iv - d
(D) i - c, ii - b, iii - a, iv - d

97. Identify label 'i', 'ii', 'iii' and 'iv' in the given diagrammatic representation of cardiac cycle.



	i	ii	iii	iv
(A)	Ventricular systole	Ventricular diastole	Atrial systole	Atrial diastole
(B)	Atrial systole	Atrial diastole	Ventricular diastole	Ventricular systole
(C)	Atrial diastole	Atrial systole	Ventricular systole	Ventricular diastole
(D)	Ventricular systole	Atrial diastole	Atrial systole	Ventricular diastole

98. Which type of diabetes mellitus is characterized by failure of insulin to facilitate the movement of glucose into cells?

- (A) Insulin dependent diabetes mellitus/Type I (IDDM)
(B) Non-insulin dependent diabetes mellitus/Type II (NIDDM)
(C) Gestational diabetes
(D) Hypoglycemic diabetes

99. What is the structure formed when the negatively charged DNA helix wraps around the positively charged histone octamer?

- (A) Solenoid
(B) Nucleosome
(C) Chromosome
(D) Non-Histone Chromosomal protein

100. Hyposecretion of parathormone leads to which condition characterized by muscle twitching and spasms?

- (A) Hyperthyroidism
(B) Hypothyroidism
(C) Parathyroid tetany
(D) Cushing's syndrome

ANSWERS AND SOLUTIONS

Model Question Paper 01

PHYSICS

1. (A)

During path DAB, planet is nearer to sun in comparison with path BCD. So time taken in travelling DAB is less than that for BCD because velocity of planet will be more in region DAB.

2. (D)

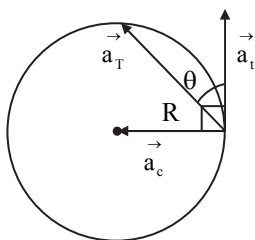
3. (A)

$$E = \frac{\sigma R}{k\epsilon_0 r} = \frac{\sigma R 4\pi}{4\pi\epsilon_0 \times k \times r}$$

$$= \frac{0.25 \times 10^{-6} \times 4 \times 10^{-3} \times 4 \times 3.14 \times 9 \times 10^9}{6.28 \times 2}$$

$$= 9 \text{ V/m}$$

4. (D)



Velocity of object is given as

$$V = K\sqrt{S} \quad \dots(i)$$

Centripetal acceleration of the object is,

$$a_c = \frac{V^2}{R} \quad \dots(ii)$$

Tangential acceleration is given by,

$$a_t = \frac{dV}{dt} = \frac{dV}{dS} \frac{dS}{dt}$$

$$= V \frac{dV}{dS}$$

$$= K\sqrt{S} \frac{d}{dS}(K\sqrt{S}) \quad \dots\text{from (i)}$$

$$= K^2 \sqrt{S} \frac{1}{2\sqrt{S}}$$

$$a_t = \frac{K^2}{2} \quad \dots(iii)$$

from figure,

$$\tan \theta = \frac{a_c}{a_t} = \left(\frac{V^2}{R}\right) \frac{2}{K^2} \quad \dots\text{From (ii) and (iii)}$$

$$\therefore \tan \theta = \frac{2 K^2 S}{R K^2} \quad \dots\text{from (i)}$$

$$\therefore \tan \theta = \frac{2S}{R}$$

5. (A)

$$\eta = 1 - \frac{T_c}{T_H} = \frac{1}{6}$$

$$\therefore \frac{T_c}{T_H} = 1 - \frac{1}{6} = \frac{5}{6} \quad \dots(i)$$

When T_2 is reduced by 62°C ,

$$\eta' = 2 \times \eta = \frac{2}{6} = \frac{1}{3}$$

$$\therefore \frac{1}{3} = 1 - \frac{(T_c - 62)}{T_H}$$

$$\therefore \frac{T_c - 62}{T_H} = \frac{2}{3}$$

$$\therefore \frac{5(T_c - 62)}{6 \times T_c} = \frac{2}{3} \quad \dots[\text{From (i)}]$$

$$\therefore T_c = 310 \text{ K and } T_H = \frac{6 \times 310}{5} = 372 \text{ K}$$

6. (C)

$$\text{When } \chi = 0.5, \frac{1}{T} = 5 \times 10^{-3} / \text{K}$$

$$\therefore T = \frac{1}{5 \times 10^{-3}} = \frac{1000}{5} = 200 \text{ K}$$

$$\text{According to Curie's law, } \chi = \frac{C}{T}$$

$$\therefore C = \chi T = 0.5 \times 200 = 100 \text{ K}$$

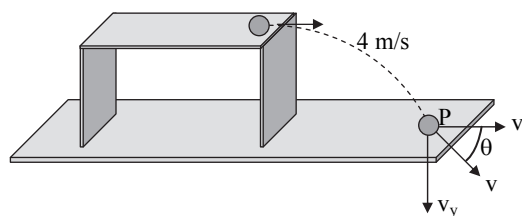
7. (D)

In figure Y, donor levels are shown. This is for n-type semiconductor.

In figure Z, acceptor levels are shown. This is for p-type semiconductor.

8. (D)

9. (C)



For a projectile given horizontal projection, Motion along X-axis is given by,

$$x = x_0 + u_x t + \frac{1}{2} a_x t^2$$

Here $x_0 = 0$, $u_x = u = 4 \text{ m/s}$, $a_x = 0$, $t = 0.4 \text{ s}$

Hence horizontal distance covered by the ball,

$$x = ut = 4 \times 0.4 = 1.6 \text{ m}$$

Thus, option (A) is incorrect.



The speed with which it hits the ground,

$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{u^2 + g^2 t^2} \quad \dots(i)$$

$$= \sqrt{16 + 10^2 + (0.4)^2} \approx 5.66 \text{ m/s}$$

Thus, option (B) is incorrect.

Motion along Y-axis is given by

$$y = y_0 + u_y t + \frac{1}{2} a_y t^2$$

Here $y_0 = 0$, $u_y = 0$, $a_y = g$, $t = 0.4 \text{ s}$

Hence height of the table

$$h = y = \frac{1}{2} g t^2 = \frac{1}{2} \times 10 \times 0.4^2 = 0.8 \text{ m}$$

Thus, option (C) is correct.

The angle body makes with horizontal is

$$\beta = \tan^{-1} \left(\frac{v_y}{v_x} \right)$$

$$= \tan^{-1} \left(\frac{16}{16} \right) \quad \dots \text{Using equation (i)}$$

$$= 45^\circ.$$

Thus, option (D) is incorrect.

10. (B)

Flow of water (Q) = 100 litres per minutes

$$= \frac{100 \times 10^{-3}}{60} = \frac{5}{3} \times 10^{-3} \text{ m}^3/\text{s}$$

$$\text{Velocity of water, } v = \frac{Q}{A} = \frac{5 \times 10^{-3}}{3 \times \pi (5 \times 10^{-2})^2}$$

$$\therefore v = \frac{2}{3\pi} \approx 0.2 \text{ m/s}$$

$$\text{Reynold's number } (N_R) = \frac{v\rho D}{\eta}$$

$$= \frac{0.2 \times 1000 \times (10 \times 10^{-2})}{1 \times 10^{-3}}$$

$$\approx 2 \times 10^4$$

$$\therefore \text{order of } N_R = 10^4$$

11. (A)

Velocity is same. So by using $v = A\omega$,

$$A_1\omega_1 = A_2\omega_2 = A_3\omega_3$$

12. (D)

$$\text{Printer prints } 600 \text{ dpi} = \frac{600}{2.5} \text{ dots cm}^{-1}$$

$$\therefore \text{Distance between two dots } x = \frac{2.5 \times 10^{-2}}{600}$$

$$= 4.17 \times 10^{-5} \text{ m}$$

Now,

angular resolution = $\theta = 3 \times 10^{-4} \text{ rad}$... (given)

$$\text{As, } \theta = \frac{\text{distance between two dots}}{\text{minimum distance of page from eye}} = \frac{x}{d}$$

$$\Rightarrow d = \frac{x}{\theta} = \frac{4.17 \times 10^{-5}}{3 \times 10^{-4}} \approx 0.14 \text{ m} = 14 \text{ cm}$$

13. (A)

For the crate not to slide, the centripetal force should be $\frac{mv^2}{r} = \mu mg$

$$\therefore v^2 = \mu rg = 0.6 \times 35 \times 9.8 = 205.8$$

$$\therefore v = 14.3 \text{ m/s}$$

14. (A)

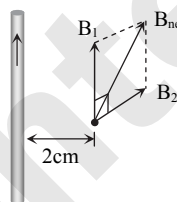
Number of photons emitted per second

$$n = \frac{P}{h\nu} = \frac{10 \times 10^3}{6.6 \times 10^{-34} \times 880 \times 10^3} = 1.72 \times 10^{31}$$

15. (C)

No external force is acting on the system so C.M. will not shift.

16. (B)



At the point, magnetic induction due to external magnetic field be $B_1 = 4 \times 10^{-4} \text{ T}$.

Now, due to wire carrying current magnetic induction produced at that point be $B_2 = \frac{\mu_0 I}{2\pi a}$

$$= \frac{4\pi \times 10^{-7} \times 30}{2\pi \times 2 \times 10^{-2}}$$

$$= 3 \times 10^{-4} \text{ T}$$

17. (C)

$$\frac{dQ}{dt} = \sigma A (T^4 - T_0^4) = \sigma (6r^2) (T^4 - T_0^4)$$

$$T = 273 + 127 = 400 \text{ K}$$

$$T_0 = 273 + 27 = 300 \text{ K}$$

$$\therefore 57 = 5.7 \times 10^{-8} \times 6r^2 \times (256 - 81) \times 10^8$$

$$\therefore 10 = r^2 \times 6 \times 175 \text{ or } 10 = 1050 r^2$$

$$\therefore r^2 \approx 0.01 \text{ or } r \approx 0.1 = 10^{-1} \text{ m}$$

$$\therefore \text{Volume} = r^3 = 10^{-3} \text{ m}^3$$

18. (D)

$$V(t) = 220 \sin 100\pi t$$

$$\therefore I(t) = \frac{220}{50} \sin 100\pi t$$

$$\therefore I = I_m \sin(100\pi t)$$

For $I = I_m$

$$I_m = I_m \sin(100\pi t_1)$$

$$\therefore \sin(100\pi t_1) = 1$$

$$\therefore 100\pi t_1 = \frac{\pi}{2} \quad \dots [\because \sin(\pi/2) = 1]$$

$$\therefore t_1 = \frac{\pi}{2} \times \frac{1}{100\pi} = \frac{1}{200} \text{ s}$$



For $I = \frac{I_m}{2}$

$$\frac{I_m}{2} = I_m \sin(100\pi t_2)$$

$$\therefore 100\pi t_2 = \frac{\pi}{6}$$

$$\therefore t_2 = \frac{1}{600} \text{ s}$$

$$\therefore t_{\text{req}} = t_1 - t_2 = \frac{1}{200} - \frac{1}{600} = \frac{2}{600} = \frac{1}{300} = 3.3 \text{ ms}$$

19. (A)

The energy gap values for different colours are different.

$$(E_g)_{\text{red}} < (E_g)_{\text{yellow}} < (E_g)_{\text{green}} < (E_g)_{\text{blue}}$$

Hence, their knee voltages are different accordingly.

20. (B)

$$T = \frac{2\pi}{\sqrt{3}} \text{ s}, 2A = 4 \text{ cm} \Rightarrow A = 2 \text{ cm}$$

$$v = A \dots (\text{Given})$$

$$\therefore \omega\sqrt{A^2 - x^2} = \omega^2 x \dots (\text{Numerically})$$

$$\therefore A^2 - x^2 = \omega^2 x^2 \Rightarrow x^2 = \frac{A^2}{\omega^2 + 1}$$

$$\therefore x^2 = \frac{A^2}{\left(\frac{4\pi^2}{T^2} + 1\right)} = \frac{(2)^2}{\left(\frac{4\pi^2 \times 3}{4\pi^2} + 1\right)} = \frac{4}{4} = 1$$

$$\Rightarrow x = 1 \text{ cm}$$

21. (C)

The magnitude of induced emf is given by

$$|e| = \frac{d\phi_B}{dt} = \frac{d}{dt} (5t^2 + 3t + 16) \\ = 10t + 3 + 0 = 10t + 3$$

At $t = 4 \text{ s}$,

$$|e| = 10 \times 4 + 3 = 43 \text{ V}$$

22. (C)

Under identical conditions, rate of cooling $\propto \frac{1}{s}$

23. (D)

Quantity of heat liberated in the ammeter of resistance R

i. due to direct current of 3 ampere
 $= [(3)^2 R/J]$

ii. due to alternating current of 4 ampere
 $= [(4)^2 R/J]$

\therefore Total heat produced per second

$$= \frac{(3)^2 R}{J} + \frac{(4)^2 R}{J} = \frac{25R}{J}$$

Let the equivalent alternating current be I virtual ampere; then

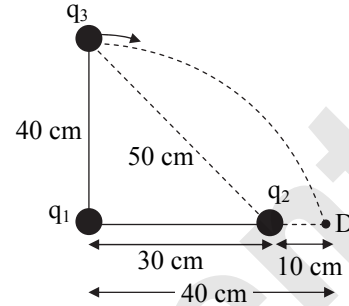
$$\frac{I^2 R}{J} = \frac{25R}{J} \text{ or } I = 5 \text{ A}$$

24. (D)

$$N \propto \frac{1}{\sin^4\left(\frac{\theta}{2}\right)}$$

25. (A)

Change in potential energy $(\Delta U) = U_f - U_i$



$$\therefore \Delta U = \frac{1}{4\pi\epsilon_0} \left[\left(\frac{q_1 q_3}{0.4} + \frac{q_2 q_3}{0.1} \right) - \left(\frac{q_1 q_3}{0.4} + \frac{q_2 q_3}{0.5} \right) \right]$$

$$\therefore \Delta U = \frac{1}{4\pi\epsilon_0} [8q_2 q_3] = \frac{q_3}{4\pi\epsilon_0} (8q_2)$$

$$\therefore k = 8q_2$$

26. (C)

At given temperature and pressure

$$v \propto \frac{1}{\sqrt{\rho}} \Rightarrow \frac{v_1}{v_2} = \sqrt{\frac{\rho_2}{\rho_1}} = \sqrt{\frac{4}{1}} = 2:1$$

27. (A)

When magnet is cut along its axis,

$$\therefore \mu' = \frac{\mu}{2} \dots (1)$$

New moment of inertia,

$$I' = \left(\frac{m}{2}\right) l^2 = \frac{I}{2} \dots (2)$$

\therefore New time period,

$$T' = 2\pi \sqrt{\frac{I'}{\mu' B}} \\ = 2\pi \sqrt{\frac{I}{\mu B}} \dots [\text{From (1) and (2)}] \\ = T$$

28. (C)

$$\text{Using } \lambda = \frac{h}{\sqrt{2mE}},$$

$$E_{\text{electron}} = \frac{h^2}{(\lambda^2 \times 2m)} \text{ and } E_{\text{photon}} = \frac{hc}{\lambda}$$

$$\therefore \frac{E_{\text{photon}}}{E_{\text{electron}}} = \left[\frac{hc}{\lambda} \cdot \frac{\lambda^2 \times 2m}{h^2} \right] = \frac{2mc^2}{\left(\frac{hc}{\lambda}\right)} = \frac{2 \times 5 \times 10^5}{(50 \times 10^3)} = \frac{20}{1}$$



29. (C)

Let frequency of vibration of first string be n_1 , its radius be r_1 and its density be ρ_1 .

Let frequency of vibration of second string be n_2 , its radius be r_2 and its density be ρ_2 .

According to second law of vibrating string,

$$n_1 \sqrt{\rho_1 \pi r_1^2} = n_2 \sqrt{\rho_2 \pi r_2^2}$$

$$n_1 = 6 \text{ Hz}$$

$$\rho_1 = 2 \text{ kg/m}^3$$

$$r_1 = 4 \text{ mm} = 4 \times 10^{-3} \text{ m}$$

$$\rho_2 = \frac{1}{3} \times \rho_1^2 = \frac{1}{3} \times 2^2 = \frac{1}{3} \times 4 = 1.33$$

$$\therefore n_2 = 20\% \text{ of } n_1 + n_1$$

$$= \frac{20}{100} \times 6 + 6$$

$$= 1.2 + 6 = 7.2 \text{ Hz}$$

$$\therefore n_1 \sqrt{\rho_1 \pi r_1^2} = n_2 \sqrt{\rho_2 \pi r_2^2}$$

$$\therefore 6 \sqrt{2 \times \pi \times (4 \times 10^{-3})^2} = 7.2 \sqrt{1.33 \times \pi \times r_2^2}$$

$$\therefore r_2 = 4.08 \times 10^{-3} \text{ m}$$

$$\therefore r_2 = 4.1 \text{ mm}$$

30. (B)

Let rate of disintegration 10,000 dis/min be taken as initial rate (N_0) and let $N = 2500$ dis/min.

$$\frac{N}{N_0} = e^{-\lambda t}$$

$$\therefore \frac{2500}{10000} = e^{-\lambda \times 4} \quad \dots (\text{Given : } t = 4 \text{ min})$$

$$\therefore \frac{1}{4} = e^{-4\lambda} \quad \therefore e^{4\lambda} = 4$$

$$\therefore 4\lambda = \log_e 4 \quad \therefore 4\lambda = \log_e 2^2$$

$$\therefore 4\lambda = 2 \log_e 2 \quad \therefore \lambda = \frac{2}{4} \log_e 2$$

$$\therefore \lambda = 0.5 \log_e 2$$

31. (D)

With increase in temperature, the value of unknown resistance will increase.

For balanced Wheatstone bridge condition, $\frac{R}{X} = \frac{l_1}{l_2}$

To take null point at same point or $\frac{l_1}{l_2}$ to remain

unchanged, $\frac{R}{X}$ should also remain unchanged.

Therefore, if X is increasing R should also increase.

32. (B)

Considering effect of temperature on length of the pendulum,

$$\frac{T}{T_0} = \sqrt{\frac{l}{l_0}}$$

$$\therefore \frac{dT}{T} = \frac{1}{2} \frac{dl}{l}$$

$$\therefore \frac{dl}{l} = \alpha(40 - 20) = \alpha(20)$$

$$\therefore dT = T \times \frac{1}{2} \left(\frac{dl}{l} \right) = T \times \frac{1}{2} \times \alpha \times 20$$

$$= 86400 \times \frac{1}{2} \times 12 \times 10^{-6} \times 20$$

$$= 86400 \times 10^{-5} \times 12$$

$$= 0.864 \times 12 = 10.368$$

$$\approx 10.4 \text{ s.}$$

33. (A)

The dispersive power for crown glass

$$\omega = \frac{n_v - n_r}{n_y - 1}$$

$$= \frac{1.5318 - 1.5140}{(1.5170 - 1)} = \frac{0.0178}{0.5170} = 0.034$$

Dispersive power for flint glass,

$$\omega' = \frac{1.6852 - 1.6434}{(1.6499 - 1)} = 0.064$$

34. (A)

Voltage gain = $A_V = \beta \frac{R_2}{R_1}$ and

$$\text{Current gain } \beta = \frac{\alpha}{1 - \alpha} = \frac{0.98}{1 - 0.98} = 49$$

$$\therefore A_V = (49) \left[\frac{500 \times 10^3}{R_1} \right]$$

$$\therefore \text{Power gain} = \beta A_V$$

$$\therefore 6.0625 \times 10^6 = 49 \times \left[\frac{500 \times 10^3}{R_1} \right] \times 49$$

$$\therefore R_1 = \frac{49^2 \times 500 \times 10^3}{6.0625 \times 10^6}$$

$$\therefore R_1 \approx 198 \Omega$$

35. (B)

Stretched wire produces integral number of harmonics

$$\text{Let } 420 = 6 \times 70 \text{ Hz}$$

$$490 = 7 \times 70 \text{ Hz}$$

$$\therefore \text{Fundamental frequency of wire is } 70 \text{ Hz}$$

$$n = \frac{1}{2L} \sqrt{\frac{T}{m}}$$

$$\therefore L = \frac{1}{2n} \sqrt{\frac{T}{m}}$$

$$\therefore L = \frac{1}{2 \times 70} \sqrt{\frac{450}{5 \times 10^{-3}}}$$

$$= \frac{1}{2 \times 70} \times 3 \times 100 = \frac{30}{14} = 2.1 \text{ m}$$



36. (A)

37. (B)

For voltmeter,

$$R = \frac{V}{I_g} - G$$

$$= \frac{50}{50 \times 10^{-6}} - 100$$

$$= 10^6 - 10^2 \approx 10^3 \text{ k}\Omega$$

Hence, option (A) is incorrect.

$$R = \frac{V}{I_g} - G$$

$$= \frac{10}{50 \times 10^{-6}} - 100$$

$$= 199.9 \text{ k}\Omega \approx 200 \text{ k}\Omega.$$

Hence, option (B) is correct.

Option (C) is incorrect, as to change an ammeter to a voltmeter, a high resistance R is to be connected in series.

From option (D),

$$S = \left(\frac{I_g}{I - I_g} \right) G = \frac{50 \times 10^{-6}}{10 \times 10^{-3} - 50 \times 10^{-6}} (100)$$

$$S \approx 0.5 \Omega$$

 \therefore option (D) is incorrect.

38. (A)

Work done = final P.E. - initial P.E.

$$W = U_f - U_i$$

$$U_i = \frac{1}{4\pi\epsilon_0 r} [(q)(-2q) + q(-2q) + (-2q)(-2q)]$$

$$= 0$$

$$U_f = \frac{1}{4\pi\epsilon_0 (2r)} [(q)(-2q) + q(-2q) + (-2q)(-2q)]$$

$$= 0$$

 $\therefore W = 0.$

39. (D)

$$v_0 = \sqrt{gR} = \sqrt{9.8 \times 6400 \times 10^3}$$

 $\therefore v_0 \approx 8 \text{ km/s}$

40. (B)

$$h = \frac{2T \cos \theta}{r \rho g} \Rightarrow T = \frac{hr \rho g}{2 \cos \theta}$$

$$\therefore \frac{T_l}{T_w} = \frac{\rho_l}{\rho_w} \times \frac{h_l}{h_w}$$

$$= \frac{850}{1000} \times 3.0 = 2.55$$

 $\therefore T_l = 7.0 \times 10^{-2} \times 2.55 = 0.18 \text{ N/m}$

41. (D)

For pipe open at both ends,

$$n_o = \frac{V}{2L}$$

$$\therefore n_1 = \frac{V}{2L}, n_2 = \frac{V}{2(L+d)}$$

$$\therefore \text{beat frequency } n_b = n_1 - n_2 = \frac{V}{2L} - \frac{V}{2(L+d)}$$

$$\therefore n_b = V \left[\frac{2(L+d) - 2L}{4L(L+d)} \right] = V \frac{2d}{4L(L+d)}$$

$$\therefore n_b = \frac{Vd}{2L(L+d)}$$

42. (A)

Number of moles of oxygen, $n_1 = 3$ Number of moles of Argon, $n_2 = 5$ Degree of freedom of oxygen, $f_1 = 5$ Degree of freedom of Argon, $f_2 = 3$ \therefore Total energy associated with oxygen (E_1)

$$= n_1 \frac{f_1}{2} RT = 3 \times \frac{5}{2} RT = \frac{15}{2} RT$$

 \therefore Total energy associated with Argon (E_2)

$$= n_2 \frac{f_2}{2} RT = 5 \times \frac{3}{2} RT = \frac{15}{2} RT$$

 \therefore Total energy of the mixture = $E_1 + E_2$

$$= \frac{15}{2} RT + \frac{15}{2} RT$$

$$= 15 RT$$

43. (D)

For diffraction at circular aperture,

$$\theta = \frac{1.22\lambda}{d}$$

$$= \frac{1.22 \times (6 \times 10^{-7} \text{ m})}{(2 \times 10^{-3} \text{ m})} = 3.66 \times 10^{-4} \text{ rad}$$

If r is the radius of the image formed by the lensat its focus, then $\theta = \left(\frac{r}{f} \right)$

$$\therefore r = f \theta = (6 \times 10^{-2} \text{ m}) (3.66 \times 10^{-4} \text{ rad})$$

$$= 21.96 \times 10^{-6} \text{ m}$$

$$A = \pi r^2 = (3.14) (21.96 \times 10^{-6} \text{ m})^2$$

$$= 15.14 \times 10^{-10} \text{ m}^2$$

$$I = \frac{P}{S} = \frac{8 \times 10^{-3} \text{ W}}{15.14 \times 10^{-10} \text{ m}^2} \approx 5.2 \frac{\text{ kW}}{\text{ m}^2}$$

44. (D)

The definition of electric dipole moment (option D) mentioned here is incorrect. The electric dipole moment is actually defined as the product of the magnitude of the charge and the displacement vector separating the charges, not just the distance between them. The other options (A, B, and C) accurately represent advanced concepts within Electrostatics.

45. (B)

Here, $a = 15 \text{ cm} = 0.15 \text{ m}$,

$$A = 12 \text{ cm}^2 = 12 \times 10^{-4} \text{ m}^2$$

Total no. of turns, $N = 1200$

Length of toroidal solenoid,

$$l = 2 \pi a = (2\pi \times 0.15) \text{ m} = 0.3\pi \text{ m}$$



For a solenoid without any magnetic material in the core,

$$L = \mu_0 \frac{N^2}{l} A$$

$$L = 4\pi \times 10^{-7} \times \frac{(1200)^2 \times 12 \times 10^{-4}}{0.3\pi}$$

$$\therefore L = 2.304 \times 10^{-3} \text{ henry.}$$

46. (B)

Mean free path of gas molecules is,

$$\bar{\lambda} = \frac{1}{\sqrt{2}} \frac{k_B T}{\pi d^2 P}$$

$$\therefore L = \frac{1}{\sqrt{2}} \frac{k_B T}{4\pi r^2 P}$$

According to given conditions,

$$L' = \frac{1}{\sqrt{2}} \frac{k_B T'}{4\pi (r')^2 P'}$$

$$\frac{L'}{L} = \frac{T'}{(r')^2 P'} \times \frac{r^2 P}{T} = \frac{2T}{(2r)^2 \times (2P)} \times \frac{r^2 P}{T} = \frac{1}{4}$$

$$\therefore L' = \frac{L}{4}$$

47. (D)

As the change is sudden, the process is adiabatic

$$\therefore P_1 V_1^\gamma = P_2 V_2^\gamma$$

$$\therefore \frac{P_2}{P_1} = \left[\frac{V_1}{V_2} \right]^\gamma = \left[\frac{4}{1} \right]^{3/2} = \frac{8}{1}$$

48. (D)

M.I of disc about axis perpendicular to plane

$$= \frac{MR^2}{2} = MK_1^2$$

$$\text{or } R^2 = 2K_1^2$$

M.I. of disc about axis in its plane

$$= \frac{MR^2}{4} = MK_2^2$$

$$\therefore K_2^2 = \frac{R^2}{4} = \frac{2K_1^2}{4} = \frac{K_1^2}{2}$$

$$\text{or } K_2 = \frac{K_1}{\sqrt{2}} = \frac{2 \times 10^{-2}}{\sqrt{2}} = \sqrt{2} \times 10^{-2} \\ = 1.414 \times 10^{-2} \text{ m}$$

49. (B)

Given $f_o = 40 \text{ cm}$

$f_e = 4 \text{ cm}$

For objective,

$$\frac{1}{v_o} - \frac{1}{u_o} = \frac{1}{f_o}$$

$$\therefore \frac{1}{v_o} - \frac{1}{-200} = \frac{1}{40}$$

$$\frac{1}{v_o} = \frac{1}{40} - \frac{1}{200} = \frac{5-1}{200} = \frac{1}{50}$$

$v_o = 50 \text{ cm}$

For normal adjustment, $L = v_o + f_e = 54 \text{ cm}$

Caution - 49

For the length of the tube of a telescope in normal adjustments, the formula $L_\infty = f_o + f_e$ can only be used when the object is at infinite distance. When object is kept at finite distance from objective lens, formula, $L_\infty = v_o + f_e$ is used.

50. (B)

$$\text{Electric field} = \frac{\text{Force}}{\text{Charge}} = \frac{ma_0}{e} \text{ (in west direction)}$$

$$\text{Magnetic force} = F_m = 3ma_0 - ma_0 \\ = 2ma_0 \text{ (in west direction)}$$

$$\therefore \vec{v} \times \vec{B} \text{ is directed towards west.}$$

Since, \vec{v} is directed towards north for positive charge, \vec{B} is directed vertically down.

$$\text{Now, } \vec{F}_m = q(\vec{v} \times \vec{B})$$

$$\therefore 2ma_0 = ev_0 \times B$$

$$\therefore B = \frac{2ma_0}{ev_0} \text{ (vertically down)}$$

Thinking Hatke - 50

The electric field is established to be in the west direction and the magnetic field in the downward direction. This condition is satisfied only in option (B).

CHEMISTRY

1. (C)

Using Charles' law,

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \text{ (at constant pressure)}$$

$$\therefore \frac{15.0 \text{ L}}{298 \text{ K}} = \frac{45.0 \text{ L}}{T_2}$$

$$\therefore T_2 = \frac{45.0 \times 298}{15.0} = 894 \text{ K}$$

2. (C)

$T = 300 \text{ K}$

$$\Delta n_g = 0 - (2 + 1) = -3 \text{ mol}$$

$$R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$$

$$W = -\Delta n_g RT$$

$$= -(-3 \text{ mol}) \times 8.314 \text{ J mol}^{-1} \text{ K}^{-1} \times 300 \text{ K}$$

$$= 7482.6 \text{ J} = 7.5 \text{ kJ}$$

3. (A)

$$\text{Rate} = -\frac{1}{2} \frac{d[A]}{dt} = +\frac{1}{3} \frac{d[B]}{dt}$$

$$\therefore \frac{d[B]}{dt} = \frac{3}{2} \frac{d[A]}{dt}$$



4. (A) 5. (D) 6. (A)

7. (D)

8. (A)

Aromatic carboxylic acids can be prepared by oxidation of alkyl benzene with dilute HNO_3 or alkaline / acidic KMnO_4 or chromic acid.

9. (B)

For acidic buffer,

$$\text{pH} = \text{pK}_a + \log_{10} \frac{[\text{Salt}]}{[\text{Acid}]} = \text{pK}_a + \log_{10} \frac{1}{1} = \text{pK}_a$$

$$\text{pK}_a = -\log_{10} K_a = -\log_{10} (10^{-4}) \\ = -(-4) = 4$$

Therefore, pH of buffer solution = 4

10. (C)

Sc ($Z = 21$): $[\text{Ar}] 3d^1 4s^2$

Observed and expected electronic configuration is same.

11. (A) 12. (A) 13. (D)

14. (B)

$$\pi = \frac{n_2}{V} RT = \frac{W_2}{M_2} \frac{RT}{V}$$

$$\therefore W_2 = \frac{\pi M_2 V}{RT} \\ = \frac{0.3 \text{ atm} \times 108 \text{ g mol}^{-1} \times 3 \text{ dm}^3}{0.0821 \text{ atm L mol}^{-1} \text{ K}^{-1} \times 298 \text{ K}} = 3.95 \text{ g}$$

15. (A)

Oxidation state of H + 3 × Oxidation state of N = 0

$$\therefore +1 + (3 \times x) = 0$$

$$\therefore (3x) = -1$$

$$\therefore x = -1/3$$

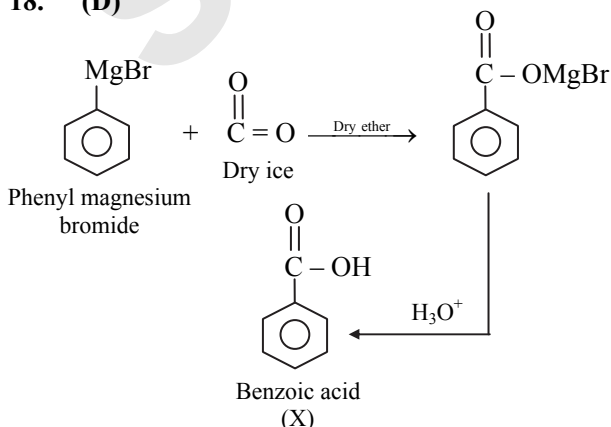
16. (C)

For bcc unit cell, $r = \frac{\sqrt{3}}{4} a$

$$\therefore a = \frac{4r}{\sqrt{3}} = \frac{4 \times 2.17 \times 10^{-8}}{1.732} = 5.0 \times 10^{-8} \text{ cm}$$

17. (D)

18. (D)



19. (D)

EAN = Atomic number – oxidation state + 2
× coordination number

$$\therefore \text{EAN of Fe in } [\text{Fe}(\text{CN})_6]^{4-} = 26 - 2 + 12 = 36$$

20. (B)

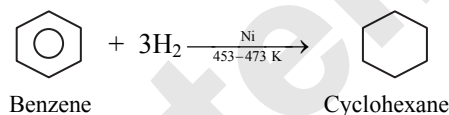
One mole of any gas occupies a volume of 22.4 dm^3 at standard temperature (0°C) and pressure (1 atm) (STP).

$$22.4 \text{ dm}^3 = 1 \text{ mol}$$

$$5.6 \text{ dm}^3 = ? \text{ mol}$$

$$\text{Moles of nitrogen gas at STP} = \frac{5.6}{22.4} = \frac{1}{4} \text{ mol}$$

21. (D)



22. (A)

For a first order reaction, the expression relating rate constant (k) and half life ($t_{1/2}$) is $k = \frac{0.693}{t_{1/2}}$.

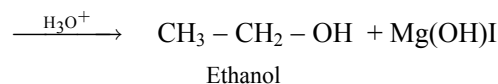
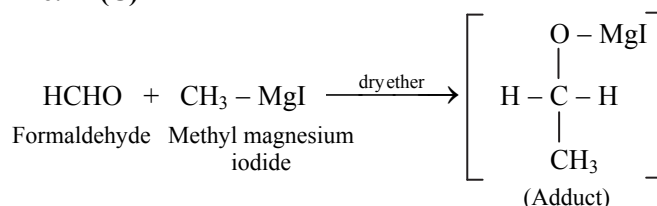
$$\therefore t_{1/2} = \frac{0.693}{k} = \frac{0.693}{0.002} = 346.5 \text{ min}$$

23. (C) 24. (D)

25. (A)

Arylamines are weaker bases than aliphatic amines and ammonia. Hence, option (A) is the weakest base.

26. (C)

**Thinking Hatke - 26**

Only formaldehyde gives primary alcohol on reaction with Grignard reagent. Hence, the starting compound 'P' is formaldehyde.

27. (B)

In this reaction, potassium dichromate is reduced to chromic sulphate, which is reflected as colour change of solution from orange to green.



28. (D)
β-Sulfur consists of S₈ molecules with puckered ring structure.

29. (C)

30. (C)

$$\Delta T_b = K_b m$$

$$\therefore K_b = \frac{\Delta T_b}{m} = \frac{0.105 \text{ K}}{0.05 \text{ mol kg}^{-1}} = 2.1 \text{ K kg mol}^{-1}$$

31. (D)

$$1 \text{ m}^3 = 1000 \text{ dm}^3$$

$$W = -P_{\text{ext}} \times \Delta V$$

$$= -0.2 \text{ bar} \times (5 \text{ dm}^3 - 1000 \text{ dm}^3)$$

$$= -0.2 \text{ bar} \times (-995 \text{ dm}^3)$$

$$= 199 \text{ bar dm}^3$$

$$1 \text{ dm}^3 \text{ bar} = 100 \text{ J}$$

$$W = 19900 \text{ J} = 19.9 \text{ kJ}$$

32. (B)

(A) All alkali metals have high negative values of standard reduction potential (E⁰).

(C) Among alkali metals, lithium is the most powerful reducing.

(D) Lithium reacts slowly but sodium and potassium react vigorously with water.

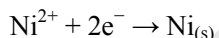
33. (B)

For the given cell reaction, Al undergoes oxidation and Ni²⁺ undergoes reduction.

Reaction at anode:



Reaction at cathode:



$$E_{\text{cell}}^{\circ} = E_{\text{cathode}}^{\circ} - E_{\text{anode}}^{\circ}$$

$$= -0.25 - (-1.66) = 1.41 \text{ V}$$

34. (A)

For the given halogen, boiling point increases with increasing carbon number. For isomeric alkyl halides, boiling point decrease with increased branching. Hence, CH₃CH₂CH₂CH₂Br has the highest boiling point among the given compounds.

35. (B)

Radioactive decay follows first order kinetics.

$$\text{No. of half-lives (n)} = 60 / 30 = 2$$

$$100\% \xrightarrow{t_{1/2}} 50\% \xrightarrow{t_{1/2}} 25\%$$

$$[A]_t \quad [A]_t \quad [A]_t$$

36. (C)

37. (A)

$$\text{pH} + \text{pOH} = 14$$

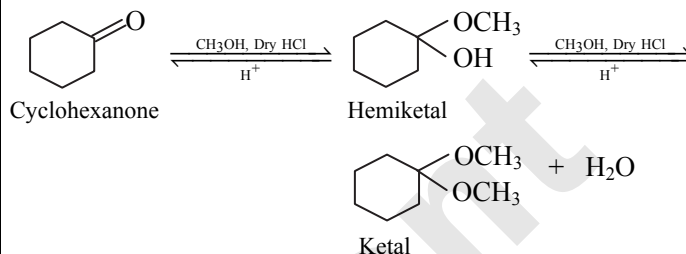
$$\therefore \text{pH} = 14 - 10 = 4$$

$$\text{pH} = -\log_{10} [\text{H}_3\text{O}^+]$$

$$\therefore 4 = -\log_{10} [\text{H}_3\text{O}^+]$$

$$\therefore [\text{H}_3\text{O}^+] = 1.0 \times 10^{-4} \text{ M}$$

38. (B)



39. (C)

40. (B)

41. (C)

42. (B)

Relative lowering of vapour pressure

$$= \frac{\Delta P}{P_1^{\circ}} = \frac{W_2 M_1}{M_2 W_1}$$

W₂, M₁ and W₁ are same for all the given three solutions.

$$\frac{\Delta P}{P_1^{\circ}} \propto \frac{1}{M_2}$$

Relative lowering of vapour pressure is inversely proportional to molar mass of the solute.

$$M_A > M_B > M_C \quad [\text{Given}]$$

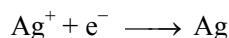
∴ Relative lowering of vapour pressure follows the order: A > B > C

43. (A)

44. (A)

$$\begin{aligned} \text{Moles of Ag} &= \frac{\text{Mass of Ag}}{\text{Molar mass of Ag}} \\ &= \frac{0.27}{108} = 0.0025 \text{ mol} \end{aligned}$$

The half reaction for reduction of Ag⁺ is:

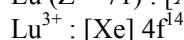
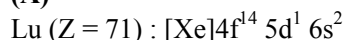


Therefore, one mole of Ag is produced by the passage of 1 Faraday = 95600 C.

∴ Quantity of electricity required to produce 0.0025 mol of Ag = 0.0025 × 95600 = 241.25 C

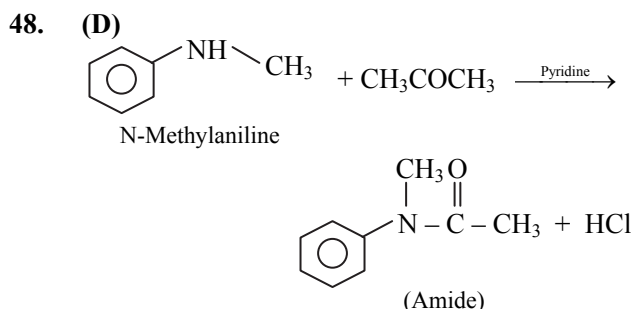
45. (B)

46. (A)



The number of unpaired electrons present in f-orbital = 0

47. (C)

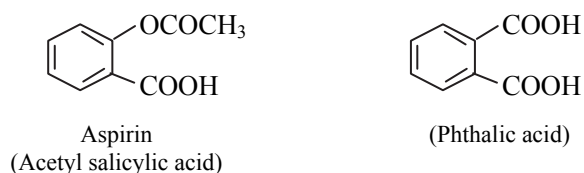


49. (A)

Thinking Hatke - 49

Among halogens, fluorine forms only one oxoacid, HOF (hypohalous acid). Hence, the correct answer is option (A).

50. (C)



BIOLOGY

1. (B)

Thinking Hatke - 1

In the given question, it is easy to identify ribose which is a 5 carbon compound. This combination (i-d) is observed in only option (B). Hence, the probability of having answer from other options is eliminated and the correct answer is (B).

2. (A)

3. (D)

Recessive alleles only express their traits in the presence of another identical allele.

4. (A)

Complex I (NADH dehydrogenase) → Complex II (Succinate dehydrogenase) → Complex III (Cytochrome bc_1 complex) → Complex IV (Cytochrome C oxidase) → Complex V (F_0 part of oxysome)

5. (D)

Bougainvillea is correctly associated with "stem cutting" as a method of asexual reproduction.

6. (C)

- (i) Small intestine in human, is about 6 meters long and 2.5 cm broad tube coiled within abdominal cavity.
- (ii) Duodenum is about 26 cm long 'U' shaped structure.

7. (B)

- (iv) In Griffith's third experiment, the mice injected with heat-killed S bacteria survived. The heat-killed bacteria were not capable of causing infection or multiplying in the mice.
- (v) Griffith's experiments did not involve bacterial conjugation, but rather the transfer of genetic material between the heat-killed S bacteria and the live R bacteria, leading to transformation.

Thinking Hatke - 7

In the given question, statement (iv) is a incorrect statement. Any option representing (iv) as correct statement cannot be the answer hence (B) is the only option representing all the incorrect statement.

8. (C)

Thinking Hatke - 8

In the given question, it is easy to identify ammonia which requires large quantity of water for elimination. This combination (i-b) is observed in only option (C). Hence, the probability of having answer from other options is eliminated and the correct answer is (C).

9. (A)

10. (A)

In a fully turgid cell $T.P. = O.P.$ hence, DPD is always zero.

11. (B)

12. (D)

	Organism	Habitat	Respiratory surface/organ
a.	Protists, Sponges and Coelenterates	Aquatic	Plasma membrane
d.	Arachnids like spiders and scorpions	Terrestrial	Book lungs

13. (B)

14. (B)

- I: Any foreign substance invading body and capable of stimulating an immune response, is called an antigen.
- II: The protective chemicals produced by immune cells in response to antigens are called antibodies. Infection on injury leads to a sudden increase in concentration of certain plasma proteins, collectively called acute phase proteins.



15. (D)
I: Intervarietal hybridization is hybridization between two varieties of the same species.
16. (C)
In an automatic thermal cycler, the number of DNA segments doubles with each cycle. Starting with 1 copy, after 'n' cycles, 2^n copies are produced. Thus, at the end of 7 cycles (2^7), 128 copies of DNA segments would be produced.
17. (D) 18. (A) 19. (D)
20. (B)
During one turn of the Krebs cycle, two carbon atoms are released as carbon dioxide. This occurs during the conversion of oxalosuccinic acid to alpha-ketoglutarate and during the conversion of alpha-ketoglutarate to succinyl-CoA.
21. (C)
22. (D)
(i) The outer layer exine is thick and made up of complex, non-biodegradable, substance called sporopollenin.
(iii) The inner wall layer, intine consists of cellulose and pectin.
23. (A)
24. (B)
The 1st cleavage in the zygote is meridional and occurs at about 30 hours after fertilization. The 2nd cleavage is longitudinal but at the right angle to the 1st one and occurs after 30 hours of 1st cleavage. The 3rd cleavage is horizontal.
25. (B)
I: Protonephridia are network of dead end tubes called flame cells.
II: Metanephridia are unbranched coiled tubes that connect to body cavity through funnel like structures called nephrostomes.
26. (A)
In humans, only one pair of chromosomes is involved in sex determination, with the remaining 22 pairs being autosomes.
27. (A)
28. (C)
II: The bottle neck effect is a type of genetic drift which is seen when much of a population is killed due to a natural disaster (tsunami, floods, tornado, disease epidemic, etc.) and only a few individuals are left to begin a new population. Any alteration in allele frequency of a natural population by chance, is called genetic drift. Concept of genetic drift was first given by Sewall Wright, hence, called Sewall Wright effect.

29. (B)

	Leaf Types	Distribution of Stomata	Example of Plants
b.	Xerophytes	Stomata on lower epidermis (hypostomatic)	<i>Nerium</i>
c.	Mesophytes	Stomata on both surfaces (amphistomatic)	Grass

30. (C)

31. (C)

32. (B)

Arachnoid mater is the middle, thin and non-vascular layer of connective tissue having web like appearance.

Pia mater is the innermost delicate, highly vascular membrane that lies in close contact with the CNS.

33. (C)

When Rh-negative mother conceives an Rh-positive foetus, The Rh +ve RBCs from the foetus may enter the mother's circulatory system during child birth, causing her to produce anti-Rh antibodies. As a result, subsequent Rh+ve foetuses will be exposed to the anti-Rh antibodies produced by mother, which result in HDN. In order to prevent HDN, Rh -ve mother is injected with the anti-Rh antibody during all pregnancies.

34. (D)

35. (B)

36. (A)

37. (C)

Phosphorus primarily cycles through geological processes, weathering of rocks, and transfers between land and water ecosystems.

38. (C)

39. (A)

40. (B)

41. (C)

42. (B)

43. (D)

44. (C)

45. (D)

Hepatic cells produce bile juice.

46. (C)

In a population that follows Hardy-Weinberg equilibrium, the expected frequency of individuals with the genotype Aa can be calculated using the equation:

$$p^2 + 2pq + q^2 = 1$$

where:

p = frequency of allele 'A'

q = frequency of allele 'a'

In this case, the frequency of allele 'A' is given as 0.6.

Since there are only two alleles ('A' and 'a'), the frequency of allele 'a' can be calculated as

$$a = 1 - p = 1 - 0.6 = 0.4.$$



Now, let's substitute the values into the equation: $(0.6)^2 + 2(0.6)(0.4) + (0.4)^2$
 $= 0.36 + 0.48 + 0.16 = 1$

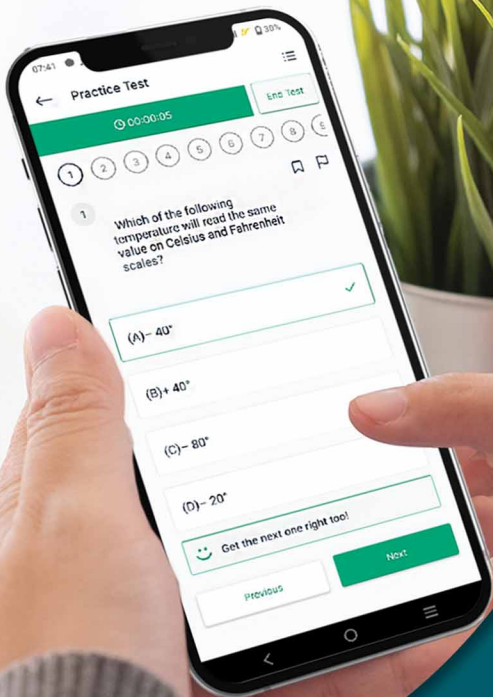
The expected frequency of individuals with the genotype Aa is 0.48.

47. (D)
The walls of the capillaries in the glomerulus are extremely thin and become permeable under the effect of high pressure. This allows for the filtration of plasma, excluding blood cells and macromolecules like proteins.
48. (B)
According to starch-sugar inter-conversion theory (Steward 1964), during day time, enzyme phosphorylase converts starch to sugar, thus increasing osmotic potential of guard cells closing entry of water thereby guard cells are stretched and stoma widens. The reverse reaction occurs at night bringing about the closure of stoma.
49. (B) 50. (B) 51. (A)
52. (C)
Filariasis can be classified into three subtypes: Lymphatic Filariasis, Subcutaneous Filariasis, and Serous Cavity Filariasis.
53. (D)
Statins are used to lower blood cholesterol levels.
54. (A)
55. (B)
I: Mammals from colder climates generally have shorter snout, ears, tail and limbs to minimize the loss of body heat.
II: In the polar seas, aquatic mammals like seals have a thick layer of fat (blubber) below their skin acting as an insulator to reduce loss of body heat.
56. (B) 57. (C)
58. (D)
- Caution – 58**
The RNA polymerase moves along the DNA strand in the 3' to 5' direction, synthesizing an mRNA molecule in the 5' to 3' direction.
59. (C)
The absorption of substances, including certain painkillers, occurs through the mucosa of the mouth and the lower side of the tongue as these areas have blood capillaries close to the surface, allowing for direct absorption into the bloodstream.

60. (C) 61. (D) 62. (D)
63. (A) 64. (B) 65. (C)
66. (C)
II: When food is translocated from phloem to pith, it is called radial translocation and from phloem to cortex, it is called tangential translocation.
67. (C) 68. (A) 69. (C)
70. (D)
Anaerobic sludge digesters are used to allow anaerobic bacteria to digest the bacteria and fungi present in the sludge, breaking it down further and producing gases such as methane, hydrogen sulfide, and CO₂.
71. (A) 72. (C)
73. (B)
The solar input, the cycle of temperature, day-length and other climatic conditions regulate the rate of function of the entire pond.
74. (B) 75. (A) 76. (A)
77. (B) 78. (A) 79. (B)
80. (D)
True-breeding plants are homozygous for a specific trait, meaning they carry two identical alleles for that trait. When self-pollinated or cross-pollinated with another true-breeding plant for the same trait, they consistently produce offspring with the same trait as the parents, generation after generation.
81. (B)
Inducible enzymes are synthesized by bacteria based on the presence of a specific substrate in their chemical environment, enabling them to adapt and metabolize the new substrate.
82. (C) 83. (A) 84. (A)
85. (A) 86. (A)
87. (A)
The PstI restriction enzyme removes the Ampicillin resistant gene from the plasmid, making the recombinant cell sensitive to Ampicillin.
88. (A) 89. (A)
90. (D)
The corpus luteum can survive for only two weeks in the absence of fertilization before degenerating into a white scar called corpus albicans.



91. (A)
- (i) Temporary increase in number of WBCs is called as leucocytosis.
 - (ii) Decrease in number of WBCs (<4000) is called leucopenia.
 - (iii) Uncontrolled increase in number of WBCs is a type of blood cancer called leukemia.
 - (v) A normal adult has on an average, 5000-11000 WBCs per mm^3 of blood.
92. (D)
- Pheromones are actually chemical substances released by organisms to communicate with individuals of the same species. They are secreted by specialized cells or glands, such as skin glands.
93. (C)
94. (A)
- The non-coding regions make the genomic library less efficient for studying eukaryotic organisms, while cDNA libraries, which are derived from mRNA, provide a more focused representation of expressed genes.
95. (A)
- To find the time taken for 10 cardiac cycles:
Time taken = Number of cardiac cycles \times Duration of each cardiac cycle
= 10 cycles \times 0.8 seconds/cycle
= 8 seconds
96. (B) 97. (D)
98. (B)
- Type II diabetes, also known as non-insulin dependent diabetes mellitus (NIDDM), is caused due to insulin resistance, where the cells fail to respond effectively to insulin, leading to increased blood glucose levels.
99. (B)
100. (C)
- Parathyroid tetany, also known as hypocalcemic tetany, is caused by a decrease in the concentration of calcium in the blood due to hyposecretion of parathormone. This leads to increased excitability of nerves and muscles, resulting in muscle twitching and spasms.



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