**Time : 3 Hours**   **Max. Marks : 720**

Important Instructions:

1. *The test is of 3 hours duration and test contains 180 questions. Each question carries 4 marks. For each correct response, the candidate will get 4 marks.*
2. *For each incorrect response, one mark will be deducted from the total scores.*

PHYSICS

1. A spring of force constant k is cut into lengths of ratio $1 : 2 : 3$. They are connected in series and the new force constant is k'. Then they are connected in parallel and force constant is k''. Then $k' : k''$ is

   (a) $1 : 14$ (b) $1 : 6$ (c) $1 : 9$ (d) $1 : 11$

2. Thermodynamic processes are indicated in the following diagram
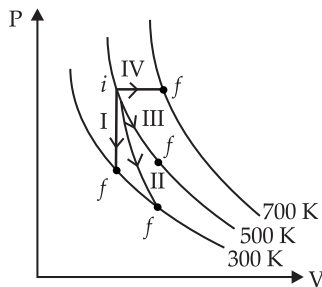
   Match the following :

Column-I		Column-II	
P.	Process I	**a.**	Adiabatic
Q.	Process II	**b.**	Isobaric
R.	Process III	**c.**	Isochoric
S.	Process IV	**d.**	Isothermal

   (a) P → d, Q → b, R → a, S → c
   (b) P → a, Q → c, R → d, S → b
   (c) P → c, Q → a, R → d, S → b
   (d) P → c, Q → d, R → b, S → a

3. A capacitor is charged by a battery. The battery is removed and another identical uncharged capacitor is connected in parallel. The total electrostatic energy of resulting system

   (a) increases by a factor of 2.
   (b) increases by a factor of 4.
   (c) decreases by a factor of 2.
   (d) remains the same.

4. A U tube with both ends open to the atmosphere, is partially filled with water. Oil, which is immiscible with water, is poured into one side until it stands at a distance of 10 mm above the water level on the other side. Meanwhile the water rises by 65 mm from its original level (see diagram). The density of the oil is
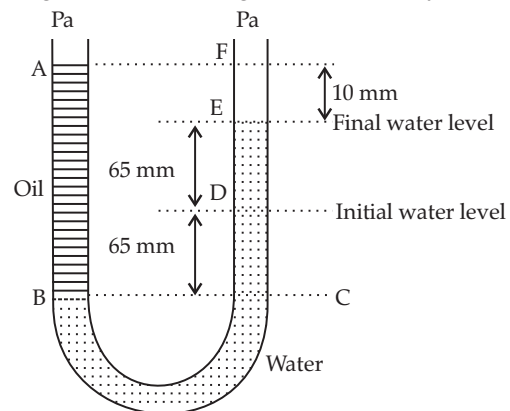
   (a) 928 kg m^{-3} (b) 650 kg m^{-3}
   (c) 425 kg m^{-3} (d) 800 kg m^{-3}

5. The de-Broglie wavelength of a neutron in thermal equilibrium with heavy water at a temperature T (Kelvin) and mass m, is

   (a) $\dfrac{2h}{\sqrt{mkT}}$ (b) $\dfrac{h}{\sqrt{mkT}}$

   (c) $\dfrac{h}{\sqrt{3mkT}}$ (d) $\dfrac{2h}{\sqrt{3mkT}}$

6. The acceleration due to gravity at a height 1 km above the earth is the same as at a depth d below the surface of earth. Then

   (a) $d = 2$ km   (b) $d = \dfrac{1}{2}$ km

   (c) $d = 1$ km   (d) $d = \dfrac{3}{2}$ km

7. The x and y coordinates of the particle at any time are $x = 5t - 2t^2$ and $y = 10t$ respectively, where x and

y are in meters and t in seconds. The acceleration of the particle at $t = 2$ s is

(a) -8 m/s^2 (b) 0 (c) 5 m/s^2 (d) -4 m/s^2

8. In a common emitter transistor amplifier the audio signal voltage across the collector is 3 V. The resistance of collector is 3 kΩ. If current gain is 100 and the base resistance is 2 kΩ, the voltage and power gain of the amplifier is   `Out of Syllabus`

(a) 20 and 2000   (b) 200 and 1000

(c) 15 and 200   (d) 150 and 15000

9. An arrangement of three parallel straight wires placed perpendicular to plane of paper carrying same current 'I' along the same direction is shown in Fig. Magnitude of force per unit length on the middle wire 'B' is given by
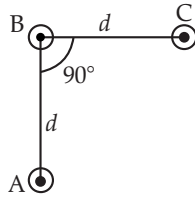
(a) $\dfrac{\mu_0 I^2}{\sqrt{2}\pi d}$ (b) $\dfrac{\mu_0 I^2}{2\pi d}$ (c) $\dfrac{2\mu_0 I^2}{\pi d}$ (d) $\dfrac{\sqrt{2}\mu_0 I^2}{\pi d}$

10. Two astronauts are floating in gravitational free space after having lost contact with their spaceship. The two will

(a) become stationary.

(b) keep floating at the same distance between them.

(c) move towards each other.

(d) move away from each other.

11. A Carnot engine having an efficiency of $\dfrac{1}{10}$ as heat engine, is used as a refrigerator. If the work done on the system is 10 J, the amount of energy absorbed from the reservoir at lower temperature is   `Out of Syllabus`
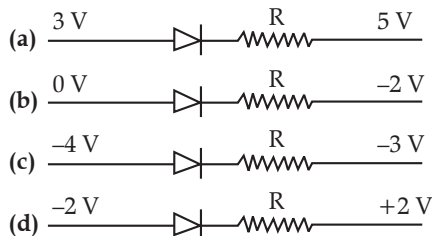
(a) 100 J   (b) 1 J   (c) 90 J   (d) 99 J

12. A 250-Turn rectangular coil of length 2.1 cm and width 1.25 cm carries a current of 85 μA and subjected to a magnetic field of strength 0.85 T. Work done for rotating the coil by 180° against the torque is

(a) 1.15 μJ   (b) 9.1 μJ   (c) 4.55 μJ   (d) 2.3 μJ

13. Which one of the following represents forward bias diode ?

14. The ratio of wavelengths of the last line of Balmer series and the last line of Lyman series is

(a) 0.5   (b) 2   (c) 1   (d) 4

15. Figure shows a circuit contains three identical resistors with resistance R = 9.0 Ω each, two identical inductors with inductance L = 2.0 mH each, and an ideal battery with emf E = 18 V. The current 'i' through the battery just after the switch closed is
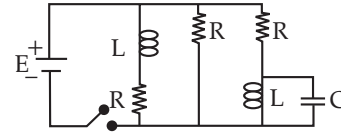
(a) 0 A   (b) 2 mA   (c) 0.2 A   (d) 2 A

16. Two blocks A and B of masses $3m$ and m respectively are connected by a massless and inextensible string. The whole system is suspended by a massless spring as shown in figure. The magnitudes of acceleration of A and B immediately after the string is cut, are respectively

(a) $\dfrac{g}{3}$, $\dfrac{g}{3}$ (b) g, $\dfrac{g}{3}$ (c) $\dfrac{g}{3}$, g (d) g, g

17. A long solenoid of diameter 0.1 m has 2×10^4 turns per metre. At the centre of the solenoid, a coil of 100 turns and radius 0.01 m is placed with its axis coinciding with the solenoid axis. The current in the solenoid reduces at a constant rate to 0 A from 4 A in 0.05 s. If the resistance of the coil is $10\pi^2$ Ω, the total charge flowing through the coil during this time is

(a) 16π μC   (b) 32π μC   (c) 16 μC   (d) 32 μC

18. A physical quantity of the dimensions of length that can be formed out of c, G and $\dfrac{e^2}{4\pi\varepsilon_0}$ is : [c is velocity of light, G is universal constant of gravitation and e is charge]
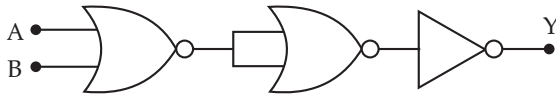
(a) $\dfrac{1}{c}G\dfrac{e^2}{4\pi\varepsilon_0}$ (b) $\dfrac{1}{c^2}\left[G\dfrac{e^2}{4\pi\varepsilon_0}\right]^{1/2}$

(c) $c^2\left[G\dfrac{e^2}{4\pi\varepsilon_0}\right]^{1/2}$ (d) $\dfrac{1}{c^2}\left[\dfrac{e^2}{G4\pi\varepsilon_0}\right]^{1/2}$

19. In an electromagnetic wave in free space the root mean square value of the electric field is $E_{rms} = 6$ V/m. The peak value of the magnetic field is

(a) 4.23×10^{-8} T   (b) 1.41×10^{-8} T

(c) 2.83×10^{-8} T   (d) 0.70×10^{-8} T

20. The resistance of a wire is 'R' ohm. If it is melted and stretched to 'n' times its original length, its new resistance will be

(a) $\dfrac{R}{n^2}$ (b) nR   (c) $\dfrac{R}{n}$ (d) n^2R

21. The ratio of resolving powers of an optical microscope for two wavelengths $\lambda_1 = 4000$ Å and $\lambda_2 = 6000$ Å is

(a) 16 : 81   (b) 8 : 27   (c) 9 : 4   (d) 3 : 2

22. A thin prism having refracting angle 10° is made of glass of refractive index 1.42. This prism is combined with another thin prism of glass of refractive index 1.7. This combination produces dispersion without deviation. The refracting angle of second prism should be

(a) 10°   (b) 4°   (c) 6°   (d) 8°

23. Two Polaroids P_1 and P_2 are placed with their axis perpendicular to each other. Unpolarized light I_0 is incident on P_1. A third polaroid P_3 is kept in between P_1 and P_2 such that its axis makes an angle 45° with that of P_1. The intensity of transmitted light through P_2 is

(a) $\dfrac{I_0}{16}$ (b) $\dfrac{I_0}{2}$ (c) $\dfrac{I_0}{4}$ (d) $\dfrac{I_0}{8}$

24. A potentiometer is an accurate and versatile device to make electrical measurements of E.M.F., because the method involves   `Out of Syllabus`

(a) a combination of cells, galvanometer and resistances.

(b) cells.

(c) potential gradients.

(d) a condition of no current flow through the galvanometer.

25. The two nearest harmonics of a tube closed at one end and open at other end are 220 Hz and 260 Hz. What is the fundamental frequency of the system ?

(a) 40 Hz   (b) 10 Hz   (c) 20 Hz   (d) 30 Hz

26. A beam of light from a source L is incident normally on a plane mirror fixed at a certain distance x from the source. The beam is reflected back as a spot on a scale placed just above the source L. When the mirror is rotated through a small angle q, the spot of the light is found to move through a distance y on the scale. The angle q is given by

(a) $\dfrac{x}{y}$ (b) $\dfrac{y}{2x}$ (c) $\dfrac{y}{x}$ (d) $\dfrac{x}{2y}$

27. The given electrical network is equivalent to

(a) NOT gate   (b) AND gate

(c) OR gate   (d) NOR gate

28. A particle executes linear simple harmonic motion with an amplitude of 3 cm. When the particle is at 2 cm from the mean position, the magnitude of its velocity is equal to that of its acceleration. Then its time period in seconds is

(a) $\dfrac{2\pi}{\sqrt{3}}$ (b) $\dfrac{\sqrt{5}}{\pi}$ (c) $\dfrac{\sqrt{5}}{2\pi}$ (d) $\dfrac{4\pi}{\sqrt{5}}$

29. Preeti reached the metro station and found that the escalator was not working. She walked up the stationary escalator in time t_1. On other days, if she remains stationary on the moving escalator, then the escalator takes her up in time t_2. The time taken by her to walk up on the moving escalator will be

(a) $t_1 - t_2$ (b) $\dfrac{t_1 + t_2}{2}$ (c) $\dfrac{t_1 t_2}{t_2 - t_1}$ (d) $\dfrac{t_1 t_2}{t_2 + t_1}$

30. Two discs of same moment of inertia rotating about their regular axis passing through centre and perpendicular to the plane of disc with angular velocities ω_1 and ω_2. They are brought into contact face to face coinciding the axis of rotation. The expression for loss of energy during this process is

(a) $\dfrac{1}{8}(\omega_1 - \omega_2)^2$ (b) $\dfrac{1}{8}I(\omega_1 + \omega_2)^2$

(c) $\dfrac{1}{4}I(\omega_1 - \omega_2)^2$ (d) $I(\omega_1 - \omega_2)^2$

31. A gas mixture consists of 2 moles of O_2 and 4 moles of Ar at temperature T. Neglecting all vibrational modes, the total internal energy of the system is

(a) 11 RT   (b) 4 RT   (c) 15 RT   (d) 9 RT

32. The bulk modulus of a spherical object is 'B'. If it is subjected to uniform pressure 'p', the fractional decrease in radius is

(a) $\dfrac{p}{3B}$ (b) $\dfrac{p}{B}$ (c) $\dfrac{B}{3p}$ (d) $\dfrac{3p}{B}$

33. One end of string of length l is connected to a particle of mass 'm' and the other end is connected to a small peg on a smooth horizontal table. If the particle moves in circle with speed 'v', the net force on the particle (directed towards center) will be (T represents the tension in the string)

(a) Zero   (b) T

(c) $T + \dfrac{mv^2}{I}$ (d) $T - \dfrac{mv^2}{I}$

34. A rope is wound around a hollow cylinder of mass 3 kg and radius 40 cm. What is the angular acceleration of the cylinder if the rope is pulled with a force of 30 N ?

(a) 5 m/s²   (b) 25 m/s²

(c) 0.25 rad/s   (d) 25 rad/s²

35. Young's double slit experiment is first performed in air and then in a medium other than air. It is found that 8th bright fringe in the medium lies where 5th dark fringe lies in air. The refractive index of the medium is nearly

(a) 1.78   (b) 1.25   (c) 1.59   (d) 1.69

36. Suppose the charge of a proton and an electron differ slightly. One of them is $-e$, the other is ($e + \Delta e$). If the net of electrostatic force and gravitational force between two hydrogen atoms placed at a distance d (much greater than atomic size) apart is zero, then Δe is of the order of [Given mass of hydrogen $m_H = 1.67 \times 10^{-27}$ kg]

(a) 10^{-47} C   (b) 10^{-20} C   (c) 10^{-23} C   (d) 10^{-37} C

37. Two rods A and B of different materials are welded together as shown in figure. Their thermal

conductivities are K_1 and K_2. The thermal conductivity of the composite rod will be
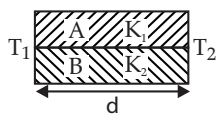
(a) $2(K_1 + K_2)$

(b) $\dfrac{K_1 + K_2}{2}$

(c) $\dfrac{3(K_1 + K_2)}{2}$

(d) $K_1 + K_2$

38. The photoelectric threshold wavelength of silver is 3250×10^{-10} m. The velocity of the electron ejected from a silver surface by ultra-violet light of wavelength 2536×10^{-10} m is
[Given $h = 4.14 \times 10^{-15}$ eV and $c = 3 \times 10^8$ ms^{-1}]

(a) $\approx 0.3 \times 10^6$ ms^{-1}

(b) $\approx 6 \times 10^5$ ms^{-1}

(c) $\approx 0.6 \times 10^6$ ms^{-1}

(d) $\approx 61 \times 10^3$ ms^{-1}

39. Two cars moving in opposite directions approach each other with speed of 22 m/s and 16.5 m/s respectively. The driver of the first car blows a horn having a frequency 400 Hz. The frequency heard by the driver of the second car is   Out of Syllabus
[Velocity of sound 340 m/s]

(a) 448 Hz

(b) 350 Hz

(c) 361 Hz

(d) 411 Hz

40. Consider a drop of rain water having mass 1 g falling from a height of 1 km. It hits the ground with a speed of 50 m/s. Take g constant with a value 10 m/s^2. The work done by the (i) gravitational force and the (ii) resistive force of air is

(a) (i) 10 J (ii) –8.75 J

(b) (i) –10 J (ii) –8.25 J

(c) (i) 1.25 J (ii) –8.25 J

(d) (i) 100 J (ii) 8.75 J

41. A spherical black body with a radius of 12 cm radiates 450 watt power at 500 K. If the radius were halved and the temperature doubled, the power radiated in watt would be

(a) 1800   (b) 225   (c) 450   (d) 1000

42. The diagrams below show regions of equipotentials.
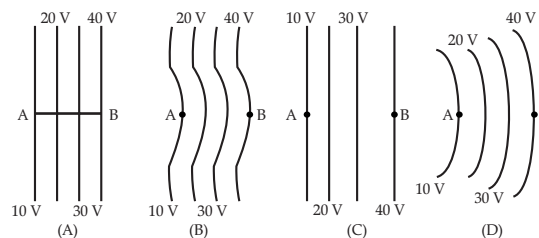
A positive charge is moved from A to B in each diagram.

(a) Maximum work is required to move q in figure (B).

(b) Maximum work is required to move q in figure (C).

(c) In all the four cases the work done is the same.

(d) Minimum work is required to move q in figure (A).

43. Which of the following statements are correct ?

(i) Centre of mass of a body always coincides with the centre of gravity of the body.

(ii) Centre of mass of a body is the point at which the total gravitational torque on the body is zero.

(iii) A couple on a body produce both translational and rotational motion in a body.

(iv) Mechanical advantage greater than one means that small effort can be used to lift a large load.

(a) (iii) and (iv)

(b) (ii) and (iv)

(c) (i) and (ii)

(d) (ii) and (iii)

44. If θ_1 and θ_2 be the apparent angles of dip observed in two vertical planes at right angles to each other, then the true angle of dip θ is given by   Out of Syllabus

(a) $\tan^2 \theta = \tan^2 \theta_1 - \tan^2 \theta_2$

(b) $\cot^2 \theta = \cot^2 \theta_1 + \cot^2 \theta_2$

(c) $\tan^2 \theta = \tan^2 \theta_1 + \tan^2 \theta_2$

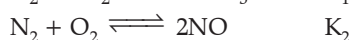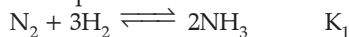(d) $\cot^2 \theta = \cot^2 \theta_1 - \cot^2 \theta_2$

45. Radioactive material 'A' has decay constant '8λ' and material 'B' has decay constant 'λ'. Initially they have same number of nuclei. After what time, the ratio of number of nuclei of material 'B' to that 'A' will be $\dfrac{1}{e}$?
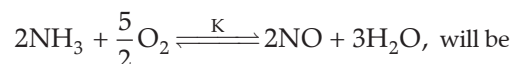
Out of Syllabus

(a) $\dfrac{1}{9\lambda}$

(b) $\dfrac{1}{\lambda}$

(c) $\dfrac{1}{7\lambda}$

(d) $\dfrac{1}{8\lambda}$

CHEMISTRY

46. The equilibrium constants of the following are :

$N_2 + 3H_2 \rightleftharpoons 2NH_3$ K_1

$N_2 + O_2 \rightleftharpoons 2NO$ K_2

$H_2 + \dfrac{1}{2}O_2 \longrightarrow H_2O$ K_3

The equilibrium constant (K) of the reaction :

$2NH_3 + \dfrac{5}{2}O_2 \xrightarrow{\ K\ } 2NO + 3H_2O,$ will be

(a) $K_2^3 K_3 / K_1$

(b) $K_1 K_3^3 / K_2$

(c) $K_2 K_3^3 / K_1$

(d) $K_2 K_3 / K_1$

47. The heating of phenyl-methyl ethers with HI produces

(a) benzene

(b) ethyl chlorides

(c) iodobenzene

(d) phenol

48. The most suitable method of separation of 1 : 1 mixture of ortho and para-nitrophenols is

(a) steam distillation

(b) sublimation

(c) chromatography

(d) crystallization

49. Predict the correct intermediate and product in the following reaction
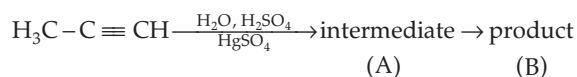
$$H_3C - C \equiv CH \xrightarrow[\text{HgSO}_4]{H_2O,\ H_2SO_4} \underset{(A)}{\text{intermediate}} \to \underset{(B)}{\text{product}}$$

(a) $A : H_3C-C=CH_2$ with OH ; $B : H_3C-C-CH_3$ with O (double bond)

(b) $A : H_3C-C=CH_2$ with SO_4 ; $B : H_3C-C-CH_3$ with O (double bond)

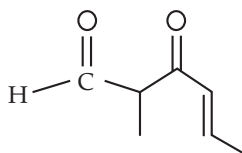**(c)** $A : H_3C-C=CH_2$ with OH ; $B : H_3C-C-CH_2$ with SO_4 (double bond)

(d) $A : H_3C-C=CH_3$ with O (double bond) ; $B : H_3C-C\equiv CH$

50. Which of the following reactions is appropriate for converting acetamide to methanamine ?
(a) Gabriels phthalimide synthesis
(b) Carbylamine reaction
(c) Hoffmann hypobromamide reaction
(d) Stephens reaction

**51.** The IUPAC name of the compound is _____.

(a) 3-keto-2-methylhex-5-enal
(b) 3-keto-2-methylhex-4-enal
(c) 5-formylhex-2-en-3-one
(d) 5-methyl-4-oxohex-2-en-5-al

52. Which of the following is a sink for CO ?

`Out of Syllabus`

(a) Plants
(b) Haemoglobin
(c) Micro-organisms present in the soil
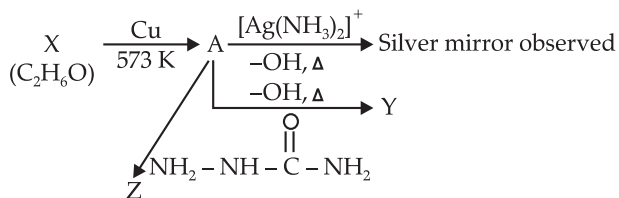(d) Oceans

53. Of the following, which is the product formed when cyclohexanone undergoes aldol condensation followed by heating ?
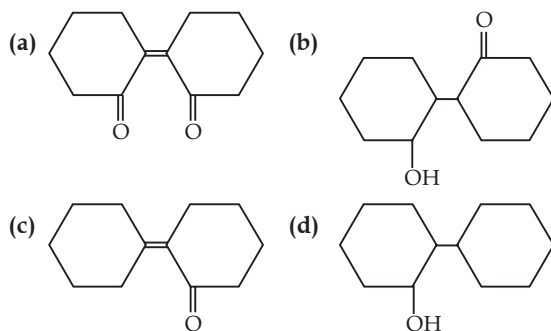
54. Which of the following pair of compounds is isoelectronic and isostructural ?
(a) IF_3, XeF_2
(b) $BeCl_2, XeF_2$
(c) TeI_2, XeF_2
(d) IBr_2^-, XeF_2

55. Consider the reactions :

Identify A, X, Y and Z
(a) A-Ethanol, X-Acetaldehyde, Y-Butanone, Z-Hydrazone
(b) A-Methoxymethane, X-Ethanoic acid, Y-Acetate ion, Z-hydrazine
(c) A-Methoxymethane, X-Ethanol, Y-Ethanoic acid, Z-Semicarbazide
(d) A-Ethanal, X-Ethanol, Y-But-2-enal, Z-Semicarbazone

56. Which one is the most acidic compound ?
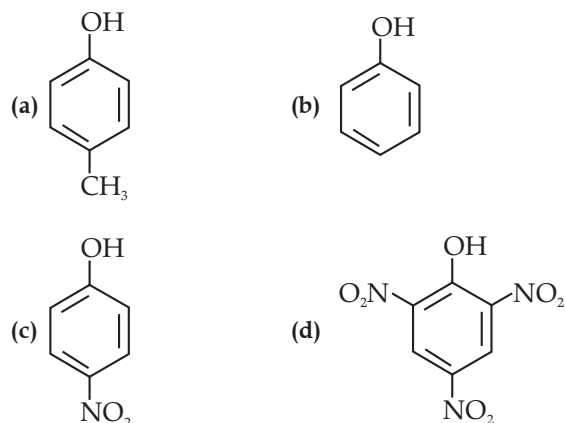
57. Name the gas that can readily decolourizes acidified $KMnO_4$ solution.
(a) P_2O_5
(b) CO_2
(c) SO_2
(d) NO_2

58. Which one is the correct order of acidity ?
(a) $CH_3 - CH_3 > CH_2 = CH_2 > CH_3 - C \equiv CH > CH \equiv CH$
(b) $CH_2 = CH_2 > CH_3 - CH = CH_2 > CH_3 - C \equiv CH > CH \equiv CH$
(c) $CH \equiv CH > CH_3 - C \equiv CH > CH_2 = CH_2 > CH_3 - CH_3$
(d) $CH \equiv CH > CH_2 = CH_2 > CH_3 - C \equiv CH > CH_3 - CH_3$

59. Concentration of the Ag^+ ions in a saturated solution of $Ag_2C_2O_4$ is 2.2×10^{-4} mol L^{-1}. Solubility product of $Ag_2C_2O_4$ is
(a) 5.3×10^{-12}
(b) 2.42×10^{-8}
(c) 2.66×10^{-12}
(d) 4.5×10^{-11}

60. With respect to the conformers of ethane, which of the following statements is true ?
(a) Both bond angles and bond length remains same.
(b) Bond angle remains same but bond length changes.

(c) Bond angle changes but bond length remains same.

(d) Both bond angle and bond length change.

61. The correct statement regarding electrophile is

(a) Electrophile can be either neutral or positively charged species and can form a bond by accepting a pair of electrons from a nucleophile.

(b) Electrophile is a negatively charged species and can form a bond by accepting a pair of electrons from a nucleophile

(c) Electrophile is a negatively charged species and can form a bond by accepting a pair of electrons from another electro-phile

(d) Electrophiles are generally neutral species and can form a bond by accepting a pair of electrons from a nucleophile

62. Which one is the wrong statement ?

(a) The energy of $2s$ orbital is less than the energy of $2p$ orbital in case of Hydrogen like atoms.

(b) de-Broglie's wavelength is given by $\lambda = \dfrac{h}{mv}$ where m = mass of the particle, v = group velocity of the particle.

(c) The uncertainty principle is $\Delta E \times \Delta t \geq \dfrac{h}{4\pi}$.

(d) Half-filled and fully filled orbitals have greater stability due to greater exchange energy, greater symmetry and more balanced arrangement.

63. Correct increasing order for the wavelengths of absorption in the visible region for the complexes of Co^{3+} is

(a) $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$, $[Co(H_2O)_6]^{3+}$

(b) $[Co(en)_3]^{3+}$, $[Co(NH_3)_6]^{3+}$, $[Co(H_2O)_6]^{3+}$

(c) $[Co(H_2O)_6]^{3+}$, $[Co(en)_3]^{3+}$, $[Co(NH_3)_6]^{3+}$

(d) $[Co(H_2O)_6]^{3+}$, $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$

64. Match the interhalogen compounds of column I with the geometry in column II and assign the correct code.

Column - I		Column - II	
(A)	XX'	(i)	T-shape
(B)	XX'$_3$	(ii)	Pentagonal bipyramidal
(C)	XX'$_5$	(iii)	Linear
(D)	XX'$_7$	(iv)	Square-pyramidal
		(v)	Tetrahedral

Codes :

	(A)	(B)	(C)	(D)
(a)	(iv)	(iii)	(ii)	(i)
(b)	(iii)	(iv)	(i)	(ii)
(c)	(iii)	(i)	(iv)	(ii)
(d)	(v)	(iv)	(iii)	(ii)

65. The species, having bond angles of 120° is

(a) BCl_3 (b) PH_3

(c) ClF_3 (d) NCl_3

66. The correct increasing order of basic strength for the following compounds is
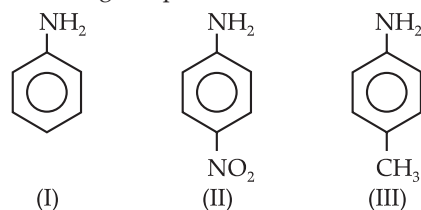
(a) II < I < III   (b) II < III < I

(c) III < I < II   (d) III < II < I

67. Which one of the following statements is not correct ?

Out of Syllabus

(a) Coenzymes increase the catalytic activity of enzyme.

(b) Catalyst does not initiate any reaction.

(c) The value of equilibrium constant is changed in the presence of a catalyst in the reaction at equilibrium.

(d) Enzymes catalyze mainly bio-chemical reactions.

68. A gas is allowed to expand in a well insulated container against a constant external pressure of 2.5 atm from an initial volume of 2.50 L to a final volume of 4.50 L. The change in internal energy ΔU of the gas in joules will be

(a) +505 J   (b) 1136.25 J   (c) –500 J   (d) –505 J

69. A 20 litre container at 400 K contains $CO_2(g)$ at pressure 0.4 atm and an excess of SrO (neglect the volume of solid SrO). The volume of the containers is now decreased by moving the movable piston fitted in the container. The maximum volume of the container, when pressure of CO_2 attains its maximum value, will be

[Given that : $SrCO_3(s) \rightleftharpoons SrO(s) + CO_2(g)$.

K_p = 1.6 atm]

(a) 2 litre   (b) 5 litre   (c) 10 litre   (d) 4 litre

70. Which of the following statements is not correct?

(a) Denaturation makes the proteins more active.

(b) Insulin maintains sugar level in the blood of a human body.

(c) Ovalbumin is a simple food reserve in egg-white.

(d) Blood proteins thrombin and fibrinogen are involved in blood clotting.
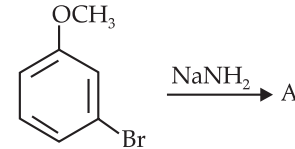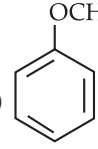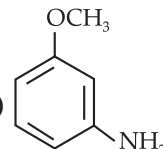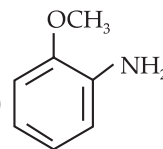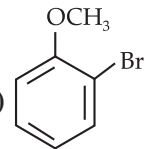
71. Mechanism of a hypothetical reaction $X_2 + Y_2 \rightarrow 2XY$ is given below :

(i) $X_2 \rightarrow X + X$ (fast)

(ii) $X + Y_2 \rightleftharpoons XY + Y$ (slow)

(iii) $X + Y \rightarrow XY$ (fast)
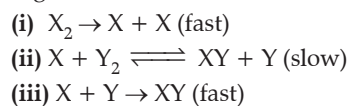
The overall order of the reaction will be

(a) 1.5   (b) 1   (c) 2   (d) 0

72. In which pair of ions both the species contain S – S bond ?

(a) $S_4O_6^{2-}$, $S_2O_7^{2-}$ (b) $S_2O_7^{2-}$, $S_2O_3^{2-}$

(c) $S_4O_6^{2-}$, $S_2O_3^{2-}$ (d) $S_2O_7^{2-}$, $S_2O_8^{2-}$

73. Which one of the following pairs of species have the same bond order ?

(a) N_2, O_2^- (b) CO, NO   (c) O_2, NO^+ (d) CN^-, CO

74. Mixture of chloroxylenol and terpineol acts as

Out of Syllabus

    (a) antibiotic.   (b) analgesic.

    (c) antiseptic.   (d) antipyretic.

75. It is because of inability of ns^2 electrons of the valence shell to participate in bonding that

    (a) Sn^{4+} is reducing while Pb^{4+} is oxidizing.

    (b) Sn^{2+} is reducing while Pb^{4+} is oxidizing.

    (c) Sn^{2+} is oxidizing while Pb^{4+} is reducing.

    (d) Sn^{2+} and Pb^{2+} are both oxidising and reducing.

76. For a given reaction, $\Delta H = 35.5$ kJ mol^{-1} and $\Delta S = 83.6$ JK^{-1} mol^{-1}. The reaction is sponta-neous at : [Assume that ΔH and ΔS do not vary with temperature]

    (a) T > 298 K   (b) T < 425 K

    (c) T > 425 K   (d) All temperatures

77. If molality of the dilute solution is doubled, the value of molal depression constant (K_f) will be

    (a) unchanged.   (b) doubled.

    (c) halved.   (d) tripled.

78. Which of the following is dependent on temperature ?

    (a) Weight percentage   (b) Molality

    (c) Molarity   (d) Mole fraction

79. Pick out the correct statement with respect to $[Mn(CN)_6]^{3-}$

    (a) It is dsp^2 hybridized and square planar.

    (b) It is sp^3d^2 hybridized and octahedral.

    (c) It is sp^3d^2 hybridized and tetrahedral.

    (d) It is d^2sp^3 hybridized and octahedral.

80. Which is the incorrect statement ?   Out of Syllabus

    (a) Frenkel defect is favoured in those ionic compounds in which sizes of cation and anions are almost equal.

    (b) $FeO_{0.98}$ has non stoichiometric metal deficiency defect.

    (c) Density decreases in case of crystals with Schottky's defect.

    (d) NaCl(s) is insulator, silicon is semi-conductor, silver is conductor, quartz is piezo electric crystal.

81. $HgCl_2$ and I_2 both when dissolved in water containing I^- ions, the pair of species formed is

    (a) Hg_2I_2, I^- (b) HgI_2, I_3^-

    (c) HgI_2, I^- (d) HgI_4^{2-}, I_3^-

82. Extraction of gold and silver involves leaching with CN^- ion. Silver is later recovered by   Out of Syllabus

    (a) Displacement with Zn (b) Liquation

    (c) Distillation   (d) Zone refining

83. The correct order of the stoichiometries of AgCl formed when $AgNO_3$ in excess is treated with the complexes : $CoCl_3 \cdot 6NH_3$, $CoCl_3 \cdot 5NH_3$, $CoCl_3 \cdot 4NH_3$ respectively is

    (a) 2 AgCl, 3 AgCl, 1 AgCl

    (b) 1 AgCl, 3 AgCl, 2 AgCl

    (c) 3 AgCl, 1 AgCl, 2 AgCl

    (d) 3 AgCl, 2 AgCl, 1 AgCl

84. Identify A and predict the type of reaction

    (a)   and cine substitution reaction

    (b)   and substitution reaction

    (c)   and elimination addition reaction

    (d)   and cine substitution reaction

85. An example of a sigma bonded organometallic compound is   Out of Syllabus

    (a) cobaltocene.   (b) ruthenocene.

    (c) grignard's reagent. (d) ferrocene.

86. The reason for greater range of oxidation states in actinoids is attributed to

    (a) $4f$ and $5d$ levels being close in energies.

    (b) the radioactive nature of actinoids.

    (c) actinoid contraction.

    (d) $5f$, $6d$ and $7s$ levels having comparable energies.

87. The element Z = 114 has been discovered recently. It will belong to which of the following family group and electronic configuration ?

    (a) Nitrogen family, $[Rn] 5f^{14} 6d^{10} 7s^2 7p^6$

    (b) Halogen family, $[Rn] 5f^{14} 6d^{10} 7s^2 7p^5$

    (c) Carbon family, $[Rn] 5f^{14} 6d^{10} 7s^2 7p^2$

    (d) Oxygen family, $[Rn] 5f^{14} 6d^{10} 7s^2 7p^4$

88. A first order reaction has a specific reaction rate of 10^{-2} s^{-1}. How much time will it take for 20 g of the reactant to reduce to 5 g ?

    (a) 693.0 second   (b) 238.6 second

    (c) 138.6 second   (d) 346.5 second

89. Ionic mobility of which of the following alkali metal ions is lowest when aqueous solution of their salts are put under an electric field ?   Out of Syllabus

    (a) Li   (b) Na   (c) K   (d) Rb

90. In the electrochemical cell $Zn|ZnSO_4$ (0.01M)$|$ $|CuSO_4$ (1.0 M)$|$ Cu, the emf of this Daniel cell is E_1. When the concentration

of $ZnSO_4$ is changed to 1.0 M and that of $CuSO_4$ changed to 0.01 M, the emf changes to E_2. From the following, which one is the relationship between E_1 and E_2 ?

(Given, $\dfrac{RT}{F} = 0.059$)

(a) $E_2 = 0 \neq E_1$ (b) $E_1 = E_2$
(c) $E_1 < E_2$ (d) $E_1 > E_2$

BIOLOGY

91. The final proof for DNA as the genetic material came from the experiments of
(a) Hargobind Khorana
(b) Griffith
(c) Hershey and Chase
(d) Avery, Mcleod and McCarty

92. Spliceosomes are not found in cells of
(a) bacteria. (b) plants.
(c) fungi. (d) animals.

93. The pivot joint between atlas and axis is a type of
(a) saddle joint.
(b) fibrous joint.
(c) cartilaginous joint.
(d) synovial joint.

94. The association of histone H1 with a nucleosome indicates
(a) the DNA double helix is exposed.
(b) transcription is occurring.
(c) DNA replication is occurring.
(d) the DNA is condensed into a chromatin fibre.

95. Which of the following is made up of dead cells ?
Out of Syllabus
(a) Phloem (b) Xylem parenchyma
(c) Collenchyma (d) Phellem

96. Select the correct route for the passage of sperms in male frogs
(a) Testes → Vasa efferentia → Kidney → Bidder's canal → Urinogenital duct → Cloaca
(b) Testes → Bidder's canal → Kidney → Vasa efferentia → Urinogenital duct → Cloaca
(c) Testes → Vasa efferentia → Kidney → Seminal Vesicle → Urinogenital duct → Cloaca
(d) Testes → Vasa efferentia → Bidder's canal → Ureter → Cloaca

97. Adult human RBC's are enucleate. Which of the following statement(s) is/are most appropriate explanation for this feature ?
(i) They do not need to reproduce
(ii) They are somatic cells
(iii) They do not metabolise
(iv) All their internal space is available for oxygen transport
Options
(a) (ii) and (iii) (b) Only (iv)
(c) Only (i) (d) (i), (iii) and (iv)

98. Homozygous pure lines in cattle can be obtained by
(a) mating of individuals of different species.
(b) mating of related individuals of same breed.
(c) mating of unrelated individuals of same breed.
(d) mating of individuals of different breed.

99. A temporary endocrine gland in the human body is
(a) corpus allatum. (b) pineal gland.
(c) corpus cardiacum. (d) corpus luteum.

100. Viroids differ from viruses in having
(a) RNA molecules without protein coat.
(b) DNA molecules with protein coat.
(c) DNA molecules without protein coat.
(d) RNA molecules with protein coat.

101. A decrease in blood pressure/volume will not cause the release of
(a) ADH.
(b) renin.
(c) atrial Natriuretic Factor.
(d) aldosterone.

102. An example of colonial alga is
(a) *Spirogyra.* (b) *Chlorella.* (c) *Volvox.* (d) *Ulothrix.*

103. The morphological nature of the edible part of coconut is
(a) pericarp. (b) perisperm.
(c) cotyledon. (d) endosperm.

104. Which of the following is correctly matched for the product produced by them ?
(a) *Saccharomyces cerevisiae* : Ethanol
(b) *Acetobacter aceti* : Antibiotics
(c) *Methanobacterium* : Lactic acid
(d) *Penicillium notatum* : Acetic acid

105. Match the following sexually transmitted diseases (Column - I) with their causative agent (Column - II) and select the correct option.

Column - I		Column - II	
(A)	Gonorrhea	(i)	HIV
(B)	Syphilis	(ii)	*Neisseria*
(C)	Genital Warts	(iii)	*Treponema*
(D)	AIDS	(iv)	Human Papilloma virus

Options

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

106. In case of poriferans, the spongocoel is lined with flagellated cells called
  (a) mesenchymal cells.
  (b) ostia.
  (c) oscula.
  (d) choanocytes.

107. Among the following characters, which one was not considered by Mendel in his experiments on pea ?
  (a) Pod – Inflated or Constricted
  (b) Stem – Tall or Dwarf
  (c) Trichomes – Glandular or Non-glandular
  (d) Seed – Green or Yellow

108. Identify the wrong statement in context of heartwood
  (a) It comprises dead elements with highly lignified walls.   Out of Syllabus
  (b) Organic compounds are deposited in it.
  (c) It is highly durable.
  (d) It conducts water and minerals efficiently.

109. During DNA replication, Okazaki fragments are used to elongate
  (a) the lagging strand away from the replication fork.
  (b) the leading strand towards the replication fork.
  (c) the lagging strand towards the replication fork.
  (d) the leading strand away from the replication fork.

110. Mycorrhizae are the example of
  (a) mutualism.
  (b) fungistasis.
  (c) amensalism.
  (d) antibiosis.

111. Which of the following RNA's is the most abundant in animal cell?
  (a) mi-RNA (b) r-RNA (c) t-RNA (d) m-RNA

112. The process of separation and purification of expressed protein before marketing is called
  (a) postproduction processing.
  (b) upstream processing.
  (c) downstream processing.
  (d) bioprocessing.

113. Which among the following are the smallest living cells, known without a definite cell wall, pathogenic to plants as well as animals and can survive without oxygen?
  (a) *Nostoc*
  (b) *Bacillus*
  (c) *Pseudomonas*
  (d) Mycoplasma

114. Which of the following components provides sticky character to the bacterial cell?
  (a) Glycocalyx
  (b) Cell wall
  (c) Nuclear membrane
  (d) Plasma membrane

115. With reference to factors affecting the rate of photosynthesis, which of the following statements is not correct ?
  (a) Tomato is a greenhouse crop which can be grown in CO_2-enriched atmosphere for higher yield.
  (b) Light saturation for CO_2 fixation occurs at 10% of full sunlight.
  (c) Increasing atmospheric CO_2 concen-tration upto 0.05% can enhance CO_2 fixation rate.
  (d) C_3 plants responds to higher tempera-tures with enhanced photosynthesis while C_4 plants have much lower temperature optimum.

116. Which of the following options best represents the enzyme composition of pancreatic juice ?
  (a) Lipase, amylase, trypsinogen, procarboxy-peptidase
  (b) Amylase, peptidase, trypsinogen, rennin
  (c) Amylase, pepsin, trypsinogen, maltase
  (d) Peptidase, amylase, pepsin, rennin

117. Which one of the following statements is correct, with reference to enzymes ?
  (a) Holoenzyme = Coenzyme + Co-factor
  (b) Apoenzyme = Holoenzyme + Coenzyme
  (c) Holoenzyme = Apoenzyme + Coenzyme
  (d) Coenzyme = Apoenzyme + Holoenzyme

118. If there are 999 bases in an RNA that codes for a protein with 333 amino acids, and the base at position 901 is deleted such that the length of the RNA becomes 998 bases, how many codons will be altered ?
  (a) 333   (b) 1   (c) 11   (d) 33

119. Asymptote in a logistic growth curve is obtained when
  (a) K < N
  (b) The value of 'r' approaches zero
  (c) K = N
  (d) K > N

120. Select the mismatch from the following
  (a) *Equisetum* – Homosporous
  (b) *Pinus* – Dioecious
  (c) *Cycas* – Dioecious
  (d) *Salvinia* – Heterosporous

121. Anaphase promoting complex (APC) is a protein degradation machinery necessary for proper mitosis of animal cells. If APC is defective in a human cell, which of the following is expected to occur ?
  (a) Recombination of chromosome arms will occur
  (b) Chromosomes will not condense
  (c) Chromosomes will be fragmented
  (d) Chromosomes will not segregate

122. Which ecosystem has the maximum biomass?
  (a) Lake ecosystem
  (b) Forest ecosystem
  (c) Grassland ecosystem
  (d) Pond ecosystem

123. Zygotic meiosis is characteristic of
  (a) *Chlamydomonas.*
  (b) *Marchantia.*
  (c) *Fucus.*
  (d) *Funaria.*

124. Hypersecretion of Growth Hormone in adults does not cause further increase in height, because
  (a) muscle fibres do not grow in size after birth.
  (b) growth hormone becomes inactive in adults.
  (c) epiphyseal plates close after adole scence.
  (d) bones loose their sensitivity to Growth Hormone in adults.

125. Frog's heart when taken out of the body continues to beat for sometime.
  Select the best option from the following statements :
  (i) Frog is a poikilotherm
  (ii) Frog does not have any coronary circulation
  (iii) Heart is "myogenic" in nature
  (iv) Heart is autoexcitable

Options

(a) (iii) & (iv)   (b) Only (iii)

(c) Only (iv)   (d) (i) & (ii)

126. Transplantation of tissues/organs fails often due to non-acceptance by the patient's body. Which type of immune-response is responsible for such rejections ?

(a) Physiological immune response

(b) Autoimmune response

(c) Cell-mediated immune response

(d) Hormonal immune response

127. Thalassemia and sickle cell anaemia are caused due to a problem in globin molecule synthesis. Select the correct statement.

(a) Sickle cell anemia is due to a quantitative problem of globin molecules.

(b) Both are due to a qualitative defect in globin chain synthesis.

(c) Both are due to a quantitative defect in globin chain synthesis.

(d) Thalassemia is due to less synthesis of globin molecules.

128. An important characteristic that Hemichordates share with Chordates is

(a) pharynx without gill slits.

(b) absence of notochord.

(c) ventral tubular nerve cord.

(d) pharynx with gill slits.

129. Double fertilization is exhibited by

(a) angiosperms.   (b) gymnosperms.

(c) algae.   (d) fungi.

130. Which of the following cell organelles is responsible for extracting energy from carbohydrates to form ATP ?

(a) Mitochondrion   (b) Lysosome

(c) Ribosome   (d) Chloroplast

131. Lungs are made up of air-filled sacs, the alveoli. They do not collapse even after forceful expiration, because of

(a) Expiratory Reserve Volume.

(b) Residual Volume.

(c) Inspiratory Reserve Volume.

(d) Tidal Volume.

132. Which of the following are not polymeric ?

(a) Lipids   (b) Nucleic acids

(c) Proteins   (d) Polysaccharides

133. Flowers which have single ovule in the ovary and are packed into inflorescence are usually pollinated by

(a) bat   (b) water   (c) bee   (d) wind

134. Life cycle of *Ectocarpus* and *Fucus* respectively are

(a) Haplodiplontic, Haplontic

(b) Haplontic, Diplontic

(c) Diplontic, Haplodiplontic

(d) Haplodiplontic, Diplontic

135. Presence of plants arranged into well defined vertical layers depending on their height can be seen best in

(a) Temperate Forest.   (b) Tropical Savannah.

(c) Tropical Rain Forest. (d) Grassland.

136. Phosphoenol pyruvate (PEP) is the primary CO_2 acceptor in

(a) C_3 and C_4 plants   (b) C_3 plants

(c) C_4 plants   (d) C_2 plants

137. Good vision depends on adequate intake of carotene rich food   `Out of Syllabus`

Select the best option from the following statements:

(i) Vitamin A derivatives are formed from carotene

(ii) The photopigments are embedded in the membrane discs of the inner segment

(iii) Retinal is a derivative of vitamin A

(iv) Retinal is a light absorbing part of all the visual photopigments

Options

(a) (ii), (iii) & (iv)   (b) (i) & (ii)

(c) (i), (iii) & (iv)   (d) (i) & (iii)

138. Which one from the given below is the period for Mendel's hybridization experiments ?

(a) 1870 - 1877   (b) 1856 - 1863

(c) 1840 - 1850   (d) 1857 - 1869

139. Select the mismatch

(a) *Rhizobium*   –   Alfalfa

(b) *Frankia*   –   Alnus

(c) *Rhodospirillum*   –   Mycorrhiza

(d) *Anabaena*   –   Nitrogen fixer

140. Attractants and rewards are required for

(a) cleistogamy.   (b) anemophily.

(c) entomophily.   (d) hydrophily.

141. In case of a couple, where the male is having a very low sperm count, which technique will be suitable for fertilisation ?

(a) Intracytoplasmic sperm injection

(b) Intrauterine transfer

(c) Gamete intracytoplasmic fallopian transfer

(d) Artificial Insemination

142. Which among these is the correct combination of aquatic mammals ?

(a) *Trygon*, Whales, Seals

(b) Seals, Dolphins, Sharks

(c) Dolphins, Seals, *Trygon*

(d) Whales, Dolphins, Seals

143. Functional megaspore in an angiosperm develops into

(a) embryo.   (b) ovule.

(c) endosperm.   (d) embryo sac.

144. Root hairs develop from the region of

(a) Meristematic activity   (b) Maturation

(c) Elongation   (d) Root cap

145. A dioecious flowering plant prevents both

(a) cleistogamy and xenogamy.

(b) autogamy and xenogamy.

(c) autogamy and geitonogamy.

(d) geitonogamy and xenogamy.

146. The hepatic portal vein drains blood to liver from

(a) intestine.   (b) heart.   (c) stomach.   (d) kidneys.

147. What is the criterion for DNA fragments movement on agarose gel during gel electrophoresis ?
(a) Negatively charged fragments do not move
(b) The larger the fragment size, the farther it moves
(c) The smaller the fragment size, the farther it moves
(d) Positively charged fragments move to farther end

148. Which of the following represents order of 'Horse' ?
Out of Syllabus
(a) Ferus
(b) Equidae
(c) Perissodactyla
(d) Caballus

149. Which statement is wrong for Kreb's cycle ?
(a) The cycle starts with the condensation of acetyl group (acetyl CoA) with pyruvic acid to yield citric acid.
(b) There are three points in the cycle where NAD^+ is reduced to $NADH + H^+$.
(c) There is one point in the cycle where FAD^+ is reduced to $FADH_2$.
(d) During conversion of succinyl CoA to succinic acid, a molecule of GTP is synthesized.

150. Artificial selection to obtain cows yielding higher milk output represents
(a) Stabilizing; followed by disruptive as it stabilizes the population to produce higher yielding cows.
(b) Stabilizing; selection as it stabilizes this character in the population.
(c) Directional; as it pushes the mean of the character in one direction.
(d) Disruptive; as it splits the population into two, one yielding higher output and the other lower output.

151. The region of Biosphere Reserve which is legally protected and where no human activity is allowed is known as
(a) Restoration zone.
(b) Core zone.
(c) Buffer zone.
(d) Transition zone.

152. Receptor sites for neurotransmitters are present on
(a) post-synaptic membrane.
(b) membranes of synaptic vesicles.
(c) pre-synaptic membrane.
(d) tips of axons.

153. The vascular cambium normally gives rise to
Out of Syllabus
(a) periderm
(b) phelloderm
(c) primary phloem
(d) secondary xylem

154. A baby boy aged two years is admitted to play school and passes through a dental check-up. The dentist observed that the boy had twenty teeth.
Out of Syllabus
Which teeth were absent ?
(a) Molars
(b) Incisors
(c) Canines
(d) Premolars

155. The water potential of pure water is   Out of Syllabus
(a) more than one.
(b) zero.
(c) less than zero.
(d) more than zero but less than one.

156. DNA fragments are
(a) either positively or negatively charged depending on their size.
(b) positively charged.
(c) negatively charged.
(d) neutral.

157. Capacitation occurs in
(a) female Reproductive tract.
(b) rete testis.
(c) epididymis.
(d) vas deferens.

158. The function of copper ions in copper releasing IUD's is
(a) they inhibit ovulation.
(b) they suppress sperm motility and fertilizing capacity of sperms.
(c) they inhibit gametogenesis.
(d) they make uterus unsuitable for implantation.

159. A gene whose expression helps to identify transformed cell is known as
(a) structural gene.
(b) selectable marker.
(c) vector.
(d) plasmid.

160. Which one of the following statements is not valid for aerosols ?
(a) They have negative impact on agricultural land.
(b) They are harmful to human health.
(c) They alter rainfall and monsoon patterns.
(d) They cause increased agricultural productivity.

161. Which of the following statements is correct ?
(a) The descending limb of loop of Henle is permeable to electrolytes.
(b) The ascending limb of loop of Henle is impermeable to water.
(c) The descending limb of loop of Henle is impermeable to water.
(d) The ascending limb of loop of Henle is permeable to water.

162. Which of the following in sewage treatment removes suspended solids ?
(a) Sludge treatment
(b) Tertiary treatment
(c) Secondary treatment
(d) Primary treatment

163. GnRH, a hypothalamic hormone, needed in reproduction, acts on
(a) posterior pituitary gland and stimulates secretion of LH and relaxin.
(b) anterior pituitary gland and stimulates secretion of LH and oxytocin.
(c) anterior pituitary gland and stimulates secretion of LH and FSH.
(d) posterior pituitary gland and stimulates secretion of oxytocin and FSH.

164. Which of the following facilitates opening of stomatal aperture ?
(a) Longitudinal orientation of cellulose microfibrils in the cell wall of guard cells
(b) Contraction of outer wall of guard cells

(c) Decrease in turgidity of guard cells

(d) Radial orientation of cellulose microfibrils in the cell wall of guard cells

165. The genotypes of a Husband and Wife are I^AI^B and I^Ai. Among the blood types of their children, how many different genotypes and phenotypes are possible ?

(a) 4 genotypes ; 4 phenotypes

(b) 3 genotypes ; 3 phenotypes

(c) 3 genotypes ; 4 phenotypes

(d) 4 genotypes ; 3 phenotypes

166. Plants which produce characteristic pneu-matophores and show vivipary belongs to

(a) hydrophytes.   **(b)** mesophytes.

(c) halophytes.   **(d)** psammophytes.

167. Alexander Von Humboldt described for the first time

(a) population Growth equation.

(b) ecological Biodiversity.

(c) laws of limiting factor.

(d) species area relationships.

168. DNA replication in bacteria occurs

(a) just before transcription.

(b) during S-phase.

(c) within nucleolus.

(d) prior to fission.

169. MALT constitutes about _____ percent of the lymphoid tissue in human body.

(a) 10%   **(b)** 50%   **(c)** 20%   **(d)** 70%

170. In *Bougainvillea* thorns are the modifications of

(a) leaf.   **(b**) stipules.

(c) adventitious root.   **(d**) stem.

171. Fruit and leaf drop at early stages can be prevented by the application of

(a) gibberellic acid.   **(b)** cytokinins.

(c) ethylene.   **(d)** auxins.

172. Which of the following are found in extreme saline conditions ?

(a) Mycobacteria   **(b)** Archaebacteria

(c) Eubacteria   **(d)** Cyanobacteria

173. Coconut fruit is a

(a) capsule.   **(b)** drupe.

(c) berry.   **(d)** nut.

174. The DNA fragments separated on an agarose gel can be visualised after staining with

(a) ethidium bromide.   **(b**) bromophenol blue.

(c) acetocarmine.   **(d**) aniline blue.

175. Out of 'X' pairs of ribs in humans only 'Y' pairs are true ribs. Select the option that correctly represents values of X and Y and provides their explanation

(a)	X = 24, Y = 12	True ribs are dorsally attached to vertebral column but are free on ventral side
(b)	X = 12, Y = 7	True ribs are attached dorsally to vertebral column and ventrally to the sternum
(c)	X = 12, Y = 5	True ribs are attached dorsally to vertebral column and sternum on the two ends
(d)	X = 24, Y = 7	True ribs are dorsally attached to vertebral column but are free on ventral side

176. Myelin sheath is produced by

(a) Osteoclasts and Astrocytes.

(b) Schwann Cells and Oligodendrocytes.

(c) Astrocytes and Schwann Cells.

(d) Oligodendrocytes and Osteoclasts.

177. Which of the following options gives the correct sequence of events during mitosis ?

(a) Condensation → arrangement at equator → centromere division → segregation → telophase

(b) Condensation → nuclear membrane disassembly → crossing over → segregation → telophase

(c) Condensation → nuclear membrane disassembly → arrangement at equator → centromere division → segregation → telophase

(d) Condensation → crossing over → nuclear membrane disassembly → segregation → telophase

178. A disease caused by an autosomal primary non-disjunction is

(a) sickle cell anemia.

(b) down's syndrome.

(c) klinefelter's syndrome.

(d) turner's syndrome.

179. Which cells of 'Crypts of Lieberkuhn' secrete antibacterial lysozyme ?   Out of Syllabus

(a) Kupffer cells   **(b)** Argentaffin cells

(c) Paneth cells   **(d)** Zymogen cells

180. Which one of the following is related to Ex-situ conservation of threatened animals and plants ?

(a) Himalayan region

(b) Wildlife Safari parks

(c) Biodiversity hot spots

(d) Amazon rainforest

□□□

This is an OMR (Optical Mark Recognition) answer sheet.

Booklet [ ]

Batch [ ]

RollNumber [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]

Booklet options: (A) (B) (C) (D) (E) (F) (G) (H) (I) (J)

Batch options:
- 10+1 (S)
- 10-2 (V)
- 10-3 (A)
- Crash (C)

Paper [ ]
- Paper 1 (1)
- Paper 2 (2)

RollNumber columns each with digits 0–9.

Name [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]
[ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]

Test Date [ ][ ][ ][ ][ ][ ][ ]

Invigilator's Signature

Student's Signature

Certified that all the entries In this section have been properly filled by the student

The OMR Sheet will be computer checked Fill the clrcles completely and dark enough for proper detection, Use ballpen (black or blue) for marking.

Avoid Improper Marking

Partially Filled

Lightly Filled

Test Center Code [ ][ ]
Digits 0–9 in two columns.

1 (a)(b)(c)(d)	6 (a)(b)(c)(d)	11 (a)(b)(c)(d)	16 (a)(b)(c)(d)	21 (a)(b)(c)(d)	26 (a)(b)(c)(d)
2 (a)(b)(c)(d)	7 (a)(b)(c)(d)	12 (a)(b)(c)(d)	17 (a)(b)(c)(d)	22 (a)(b)(c)(d)	27 (a)(b)(c)(d)
3 (a)(b)(c)(d)	8 (a)(b)(c)(d)	13 (a)(b)(c)(d)	18 (a)(b)(c)(d)	23 (a)(b)(c)(d)	28 (a)(b)(c)(d)
4 (a)(b)(c)(d)	9 (a)(b)(c)(d)	14 (a)(b)(c)(d)	19 (a)(b)(c)(d)	24 (a)(b)(c)(d)	29 (a)(b)(c)(d)
5 (a)(b)(c)(d)	10 (a)(b)(c)(d)	15 (a)(b)(c)(d)	20 (a)(b)(c)(d)	25 (a)(b)(c)(d)	30 (a)(b)(c)(d)
31 (a)(b)(c)(d)	36 (a)(b)(c)(d)	41 (a)(b)(c)(d)	46 (a)(b)(c)(d)	51 (a)(b)(c)(d)	56 (a)(b)(c)(d)
32 (a)(b)(c)(d)	37 (a)(b)(c)(d)	42 (a)(b)(c)(d)	47 (a)(b)(c)(d)	52 (a)(b)(c)(d)	57 (a)(b)(c)(d)
33 (a)(b)(c)(d)	38 (a)(b)(c)(d)	43 (a)(b)(c)(d)	48 (a)(b)(c)(d)	53 (a)(b)(c)(d)	58 (a)(b)(c)(d)
34 (a)(b)(c)(d)	39 (a)(b)(c)(d)	44 (a)(b)(c)(d)	49 (a)(b)(c)(d)	54 (a)(b)(c)(d)	59 (a)(b)(c)(d)
35 (a)(b)(c)(d)	40 (a)(b)(c)(d)	45 (a)(b)(c)(d)	50 (a)(b)(c)(d)	55 (a)(b)(c)(d)	60 (a)(b)(c)(d)
61 (a)(b)(c)(d)	66 (a)(b)(c)(d)	71 (a)(b)(c)(d)	76 (a)(b)(c)(d)	81 (a)(b)(c)(d)	86 (a)(b)(c)(d)
62 (a)(b)(c)(d)	67 (a)(b)(c)(d)	72 (a)(b)(c)(d)	77 (a)(b)(c)(d)	82 (a)(b)(c)(d)	87 (a)(b)(c)(d)
63 (a)(b)(c)(d)	68 (a)(b)(c)(d)	73 (a)(b)(c)(d)	78 (a)(b)(c)(d)	83 (a)(b)(c)(d)	88 (a)(b)(c)(d)
64 (a)(b)(c)(d)	69 (a)(b)(c)(d)	74 (a)(b)(c)(d)	79 (a)(b)(c)(d)	84 (a)(b)(c)(d)	89 (a)(b)(c)(d)
65 (a)(b)(c)(d)	70 (a)(b)(c)(d)	75 (a)(b)(c)(d)	80 (a)(b)(c)(d)	85 (a)(b)(c)(d)	90 (a)(b)(c)(d)
91 (a)(b)(c)(d)	96 (a)(b)(c)(d)	101 (a)(b)(c)(d)	106 (a)(b)(c)(d)	111 (a)(b)(c)(d)	116 (a)(b)(c)(d)
92 (a)(b)(c)(d)	97 (a)(b)(c)(d)	102 (a)(b)(c)(d)	107 (a)(b)(c)(d)	112 (a)(b)(c)(d)	117 (a)(b)(c)(d)
93 (a)(b)(c)(d)	98 (a)(b)(c)(d)	103 (a)(b)(c)(d)	108 (a)(b)(c)(d)	113 (a)(b)(c)(d)	118 (a)(b)(c)(d)
94 (a)(b)(c)(d)	99 (a)(b)(c)(d)	104 (a)(b)(c)(d)	109 (a)(b)(c)(d)	114 (a)(b)(c)(d)	119 (a)(b)(c)(d)
95 (a)(b)(c)(d)	100 (a)(b)(c)(d)	105 (a)(b)(c)(d)	110 (a)(b)(c)(d)	115 (a)(b)(c)(d)	120 (a)(b)(c)(d)
121 (a)(b)(c)(d)	126 (a)(b)(c)(d)	131 (a)(b)(c)(d)	136 (a)(b)(c)(d)	141 (a)(b)(c)(d)	146 (a)(b)(c)(d)
122 (a)(b)(c)(d)	127 (a)(b)(c)(d)	132 (a)(b)(c)(d)	137 (a)(b)(c)(d)	142 (a)(b)(c)(d)	147 (a)(b)(c)(d)
123 (a)(b)(c)(d)	128 (a)(b)(c)(d)	133 (a)(b)(c)(d)	138 (a)(b)(c)(d)	143 (a)(b)(c)(d)	148 (a)(b)(c)(d)
124 (a)(b)(c)(d)	129 (a)(b)(c)(d)	134 (a)(b)(c)(d)	139 (a)(b)(c)(d)	144 (a)(b)(c)(d)	149 (a)(b)(c)(d)
125 (a)(b)(c)(d)	130 (a)(b)(c)(d)	135 (a)(b)(c)(d)	140 (a)(b)(c)(d)	145 (a)(b)(c)(d)	150 (a)(b)(c)(d)
151 (a)(b)(c)(d)	156 (a)(b)(c)(d)	161 (a)(b)(c)(d)	166 (a)(b)(c)(d)	171 (a)(b)(c)(d)	176 (a)(b)(c)(d)
152 (a)(b)(c)(d)	157 (a)(b)(c)(d)	162 (a)(b)(c)(d)	167 (a)(b)(c)(d)	172 (a)(b)(c)(d)	177 (a)(b)(c)(d)
153 (a)(b)(c)(d)	158 (a)(b)(c)(d)	163 (a)(b)(c)(d)	168 (a)(b)(c)(d)	173 (a)(b)(c)(d)	178 (a)(b)(c)(d)
154 (a)(b)(c)(d)	159 (a)(b)(c)(d)	164 (a)(b)(c)(d)	169 (a)(b)(c)(d)	174 (a)(b)(c)(d)	179 (a)(b)(c)(d)
155 (a)(b)(c)(d)	160 (a)(b)(c)(d)	165 (a)(b)(c)(d)	170 (a)(b)(c)(d)	175 (a)(b)(c)(d)	180 (a)(b)(c)(d)

ANSWER KEY

|											
1	(d)	31	(a)	61	(a)	91	(c)	121	(d)	151	(b)
2	(c)	32	(a)	62	(a)	92	(a)	122	(b)	152	(a)
3	(c)	33	(b)	63	(b)	93	(d)	123	(a)	153	(d)
4	(a)	34	(d)	64	(c)	94	(d)	124	(c)	154	(d)
5	(c)	35	(a)	65	(a)	95	(d)	125	(a)	155	(b)
6	(a)	36	(d)	66	(a)	96	(a)	126	(c)	156	(c)
7	(d)	37	(b)	67	(c)	97	(b)	127	(d)	157	(a)
8	(d)	38	(c)	68	(d)	98	(b)	128	(d)	158	(b)
9	(a)	39	(a)	69	(b)	99	(d)	129	(a)	159	(b)
10	(c)	40	(a)	70	(a)	100	(a)	130	(a)	160	(d)
11	(c)	41	(a)	71	(a)	101	(c)	131	(b)	161	(b)
12	(b)	42	(c)	72	(c)	102	(c)	132	(a)	162	(d)
13	(b)	43	(b)	73	(d)	103	(d)	133	(d)	163	(c)
14	(d)	44	(b)	74	(c)	104	(a)	134	(d)	164	(d)
15	(d)	45	(c)	75	(b)	105	(b)	135	(c)	165	(d)
16	(c)	46	(c)	76	(c)	106	(d)	136	(c)	166	(c)
17	(d)	47	(d)	77	(a)	107	(c)	137	(c)	167	(d)
18	(b)	48	(a)	78	(c)	108	(d)	138	(b)	168	(d)
19	(c)	49	(a)	79	(d)	109	(a)	139	(c)	169	(b)
20	(d)	50	(c)	80	(a)	110	(a)	140	(c)	170	(d)
21	(d)	51	(b)	81	(d)	111	(b)	141	(d)	171	(d)
22	(c)	52	(c)	82	(a)	112	(c)	142	(d)	172	(b)
23	(d)	53	(c)	83	(d)	113	(d)	143	(d)	173	(b)
24	(d)	54	(d)	84	(b)	114	(a)	144	(b)	174	(a)
25	(c)	55	(d)	85	(c)	115	(d)	145	(c)	175	(b)
26	(b)	56	(d)	86	(d)	116	(a)	146	(a)	176	(b)
27	(d)	57	(c)	87	(c)	117	(c)	147	(c)	177	(c)
28	(d)	58	(c)	88	(c)	118	(d)	148	(c)	178	(b)
29	(d)	59	(a)	89	(a)	119	(c)	149	(a)	179	(c)
30	(c)	60	(a)	90	(d)	120	(b)	150	(c)	180	(b)

ANSWERS WITH EXPLANATIONS

PHYSICS

1. Option (d) is correct.

Given,

Ratio of the spring lengths 1 : 2 : 3

Force constant in series is k'

Force constant in parallel is k''
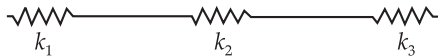
k_1 k_2 k_3

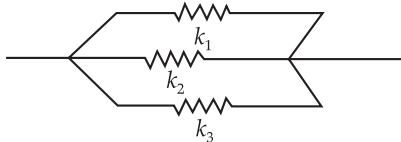We know that spring constant (k) is inversely proportional to the length.

i.e., $k \propto \dfrac{1}{l}$ ...(i)

Case 1 : Series combination :

$\dfrac{1}{k'} = \dfrac{1}{k_1} + \dfrac{1}{k_2} + \dfrac{1}{k_3}$ ...(ii)

Where k_1, k_2 and k_3 are spring constants.

Case 2 : Parallel combination :

So, $k_{eq} = k_1 + k_2 + k_3$ ...(iii)

Let us assume that lengths of strings be $\dfrac{l}{6}, \dfrac{2l}{6}, \dfrac{3l}{6}$

Substituting the value of l in equation (i), we get

$k_1 = \dfrac{kl}{\dfrac{l}{6}} = 6k$

$k_2 = \dfrac{kl}{\dfrac{2l}{6}} = 3k$

$k_3 = \dfrac{kl}{\dfrac{3l}{6}} = 2k$

Now, putting the values of k_1, k_2, k_3 in equation (ii),

$\dfrac{1}{k'} = \dfrac{1}{6k} + \dfrac{1}{3k} + \dfrac{1}{2k}$

$= \dfrac{1 + 2 + 3}{6k} = \dfrac{1}{k}$

$k' = k$

Again Putting the values of k_1, k_2 & k_3 in equation (iii),

$k'' = 6k + 3k + 2k = 11k$

Therefore, $\dfrac{k'}{k''} = \dfrac{k}{11k} = \dfrac{1}{11}$

So, $k' : k'' = 1 : 11$

2. Option (c) is correct.

Thermodynamic processes are of four types :

1. **Isochoric process :** It is a change in the physical system, where the volume remains constant. Since there is no change in volume, the amount of work done during the isochoric process is zero.

2. **Adiabatic process :** Adiabatic process occurs when we perfectly isolate the system from the surrounding and the change must be rapid. The temperature increases when work is done on the system, and the temperature decreases when work is done by the system.

3. **Isothermal process :** If a system undergoes change at a constant temperature throughout the process, it is called an isothermal process.

4. **Isobaric process :** It is a change of a system where the system pressure remains constant.
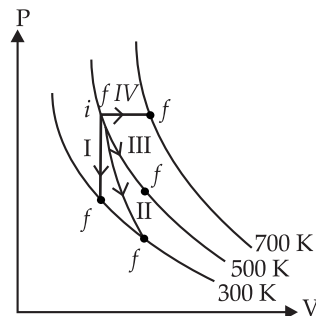
In the given graph.

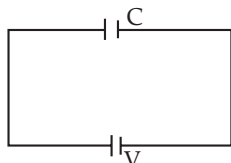Process I = Isochoric (Volume is constant).

Process II = Adiabatic (temperature falls).

Process III = Isothermal (Temperature is constant).

Process IV = Isobaric (Pressure is constant).
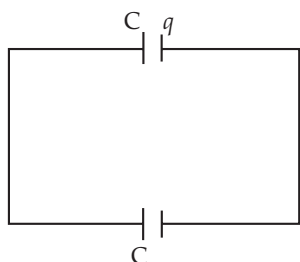
3. **Option (c) is correct.**

Based on the question, we shall draw a circuit where the battery is connected to the capacitor.

We know the formula for capacitance,

$$q = CV$$

When replacing a battery with another uncharged capacitor,

As the uncharged capacitor is connected in parallel, So,

$$V_c = \frac{q_1 + q_2}{C + C}$$

$$V_c = \frac{q + 0}{C + C}$$

$$V_c = \frac{V}{2}$$

In order to find the total electrostatic energy of the resulting system, we need to calculate the initial and final energy of the circuit.

Initial energy :

$$U_i = \frac{1}{2}CV^2$$

Final energy :

$$U_f = \frac{1}{2}C\left(\frac{V}{2}\right)^2 + \frac{1}{2}C\left(\frac{V}{2}\right)^2$$

$$U_f = \frac{CV^2}{8} + \frac{CV^2}{8}$$

$$= \frac{2CV^2}{8}$$

$$U_f = \frac{CV^2}{4}$$

Loss of energy = $U_i - U_f$

$$= \frac{CV^2}{2} - \frac{CV^2}{4}$$

$$= \frac{2CV^2 - CV^2}{4}$$

$$= \frac{CV^2}{4}$$

$\Rightarrow$ Loss of energy = $\frac{1}{2}U_i$

Therefore, the total electrostatic energy of the resulting system decreases by a factor of 2.

4. **Option (a) is correct.**

The two ends of the tube are open, so the pressure on both surfaces must be equal.

As a result, the pressure exerted by the fluid at a certain point within the fluid due to the force of gravity,

$$P = \rho gh$$

$$P_{1(oil)} = P_{2(water)}$$

$$h_{oil}\,\rho_{oil}g = h_{water}\,\rho_{water}\,g$$

From the diagram, substitute the values of h_{oil}, h_{water}, ρ_{water}

$$140 \times \rho_{oil} = 130 \times \rho_{water}$$

$$\rho_{water} = 997 \oplus 1000 \text{ kg/m}^3$$

$$140 \times \rho_{oil} = 130 \times 1000$$

$$14 \times \rho_{oil} = 13 \times 1000$$

$$\rho_{oil} = \frac{13}{14} \times 1000$$

$$\rho_{oil} = 928 \text{ kg-m}^{-3}.$$

Therefore, the density of the oil is 928 kg-m^{-3}.

5. **Option (c) is correct.**

de-Broglie equation describes the wave properties of matter, especially the wave nature of the electron.

$$\lambda = \frac{h}{mv}$$

λ is wavelength; h is the Planck constant; m is the mass of the particle moving at velocity v.

Thermal neutron refers to any free neutron whose average energy of motion corresponds to the average energy of the ambient material particles.

Thus, we can calculate the kinetic energy of the thermal neutron using the formula,

$$K.E. = \frac{3}{2}kT$$

$\Rightarrow$ $$\lambda = \frac{h}{\sqrt{2m(KE)}}$$

$\Rightarrow$ $$\lambda = \frac{h}{\sqrt{2m\left(\frac{3}{z}kE\right)}}$$

$$\Rightarrow \qquad \lambda = \frac{h}{\sqrt{3mkT}}$$

6. Option (a) is correct.

The acceleration gained by an object due to gravitational force is called acceleration due to gravity and it is represented by the letter g. This acceleration due to gravity can be calculated by the following formulae :

Acceleration due to gravity above the earth surface :

$$g' = g\left(1 - \frac{2h}{R_e}\right)$$

$$\Delta g' = g\frac{2h}{R_e} \qquad\qquad ...(i)$$

Acceleration due to gravity below the earth surface :

$$g' = g\left(1 - \frac{d}{R_e}\right)$$

$$\Delta g = g\frac{d}{R_e} \qquad\qquad ...(ii)$$

From (i) and (ii) we can say that

$$d = 2h$$

So, acceleration due to gravity below the earth at 2 km will be equal to acceleration due to gravity above the earth at 1 km.

7. Option (d) is correct.

Given : $\qquad\qquad x = 5t - 2t^2$

$$y = 10t$$

To find : acceleration of the particle at $t = 2$

$$x = 5t - 2t^2$$
$$y = 10t$$

Differentiating x with respect to t

$$\frac{dx}{dt} = 5 - 4t$$

$$v_x = 5 - 4t$$

$$\frac{dv}{dt}x = -4$$

$$a_x = -4$$

$$\frac{dy}{dt} = 10$$

$$v_y = 10$$

$$\frac{dv}{dt}y = 0$$

$$a_y = \frac{d^2y}{dt^2} = 0$$
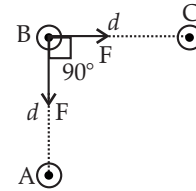
$$a = a_x + a_y$$
$$= -4 + 0$$
$$a = -4 \text{ ms}^{-2}$$

So, acceleration of particle at $t = 2$ is -4 m/s^2

8. Out of Syllabus

9. Option (a) is correct.

To find: Magnitude of force per unit length (B)

Magnetic field due to current carrying long

$$\text{wire} = \frac{\mu_0 I^2}{2\pi d}$$

The Force between BC and AB will be same in magnitude

So, $\qquad F_{BC} = F_{BA} = \dfrac{\mu_0 I^2}{2\pi d}$

$$F = \sqrt{2}F_{BC}$$

$$= \sqrt{2}\frac{\mu_0 I^2}{2\pi d}$$

$$F = \frac{\mu_0 I^2}{\sqrt{2}\pi d}$$

The magnitude of force per unit length on the middle wire is given by

$$F = \frac{\mu_0 I^2}{\sqrt{2}\pi d}$$

10. Option (c) is correct.

Newton's law of gravity states that "Every object in the universe attracts every other object with a force which is directly proportional to the product of their masses and inversely proportional to the squares of the distance between their centers". So there will be an attraction between two objects if they have mass. Thus the astronauts having masses will attract each other as a result they move towards each other.

11. Out of Syllabus

12. Option (b) is correct.

Given :

Length, $l = 2.1$ cm

Number of turns, N = 250

Width, W = 1.25 cm

Current, I = 85 μA

Magnetic field, B = 0.85 T

Work done in rotating the coil is given by :

$$W = MB(\cos\theta_1 - \cos\theta_2)$$
$$W = MB(\cos 0° - \cos 180°)$$
$$= MB(1+1)$$
$$\qquad\qquad [\because \cos 0° = 1, \cos 180° = 1]$$
$$W = 2MB \qquad\qquad ...(i)$$

Here Magnetic Field,

$$M = NIA$$

Therefore putting the value of M in equation (i),

W = 2 NIAB   ...(ii)

Now substituting the values in equation (ii) we get,

$W = 2 \times 250 \times 85 \times 10^{-6} \times (1.25 \times 2.1 \times 10^{-4})$

$\times 85 \times 10^{-2}$

W = 9.1 μJ

The work done to rotate the coil by 180° against the torque is 9.1 μJ.

13. Option (b) is correct.

The diode is said to be forward-biased when voltage is applied across a diode in such a way that the diode allows the current.

In the PN junction device, the device allows the flow in one direction of the larger current. If the anode is connected to the positive end, the device is said to be forward biased, and a cathode is connected to the negative end of the battery.

$$\overset{0\,V}{\rule{2cm}{0.4pt}}\!\!\triangleright\!\!\!-\!\!\!\text{www}\!-\!\!\overset{-2\,V}{\rule{2cm}{0.4pt}}$$
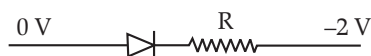
A diode is said to be forward biased when the potential at A is higher than at B

i.e., $V_A > V_B$

[∵ V is more positive than – 2V]

14. Option (d) is correct.

Using the Relation

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \qquad ...(i)$$

For last line of Balmer series,

$n_1 = 2, n_2 = \infty,$

Substituting the values of n_1, n_2 in equation (i),

$$\frac{1}{\lambda_b} = R\left(\frac{1}{2^2} - \frac{1}{\infty}\right) = \frac{R}{4} \qquad ...(ii)$$

For last line of Lyman series, $n_1 = 1, n_2 = \infty,$

Substituting the values of n_1, n_2 in equation (i),

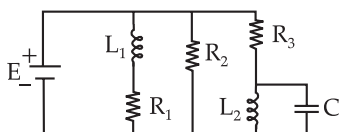$$\frac{1}{\lambda_l} = R\left(\frac{1}{1^2} - \frac{1}{\infty}\right) = R \qquad ...(iii)$$

Now dividing equation (iii) by (ii) we get,

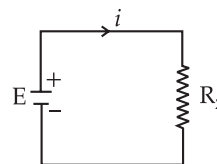$$\frac{\lambda_b}{\lambda_l} = \frac{\dfrac{4}{R}}{\dfrac{1}{R}}$$

$$\frac{\lambda_b}{\lambda_l} = 4$$

Therefore, the ratio of wavelengths of the last line of Balmer series to that of last line of Lyman series is 4.

15. Option (d) is correct.

At *t* = 0, no current flows through R_1 and R_3, Hence, the circuit becomes as

Therefore, the current flow when the switch is closed.

Here, substituting the values emf, $i = \dfrac{\varepsilon}{R_2}$ = 18 V,

$$R_2 = 9\,\Omega$$

$$i = \frac{18}{9} = 2\,A$$

⇒   i = 2 A

Hence, the current flow when the switch is closed is 2 A.

16. Option (c) is correct.

Given :

Two blocks A and B of masses 3*m* and *m* are connected by a massless inextensible string. Now we need to find the magnitude of acceleration before the string is cut and after the string is cut.
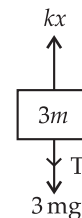
Thus before the string is cut

     kx = 3mg + T

Here,   T = mg

Hence,   kx = mg + 3mg

     kx = 4mg

Now after string is cut T = 0

$$a = \frac{kx - 3mg}{3m} \qquad ...(i)$$

where,   kx = 4mg

Then equation (i) becomes as,

⇒ $a = \dfrac{4mg - 3mg}{3m}$

⇒ $a = \dfrac{mg}{3m}$

Therefore, $a = \dfrac{g}{3}$

Now we have,

$$\Rightarrow \qquad a_2 = \frac{mg}{m}$$
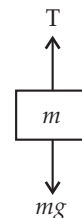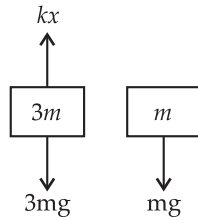
$$\Rightarrow \qquad a_2 = g$$

So, the magnitudes are $\left(\dfrac{g}{3}, g\right)$.

17. Option (d) is correct.

Given :

Number of turns, $n = 100$

Radius, $r = 0.01$ m

Resistance, $R = 10\pi^2 \ \Omega$

As we know, $E = -N\dfrac{d\phi}{dt}$

$$\Rightarrow \qquad \frac{E}{R} = -\frac{N}{R}\frac{d\phi}{dt}$$

$$\Rightarrow \qquad \frac{\Delta Q}{\Delta t} = -\frac{N}{R}\frac{d\phi}{dt}$$

$$\Rightarrow \qquad \Delta Q = -\left[\frac{N}{R}\left(\frac{\Delta\phi}{\Delta t}\right)\right]\Delta t$$

In the above equation, negative sign shows that the induced emf opposes the change in the Flux,

Hence,

$$\Delta Q = \frac{\mu_0 n i \pi r^2}{R}$$

Substituting $\mu_0 = 4\pi \times 10^{-7}$ and the other values of n, r, i we get,

$$\Delta Q = \frac{4\pi \times 10^{-7} \times 100 \times 4 \times \pi \times (0.01)^2}{10\pi^2} = 32 \ \mu C$$

$\Delta Q = 32 \ \mu C$

Thus, the total charge flowing through the coil is $32 \ \mu C$.

18. Option (b) is correct.

Dimension of length is related as,

$$[l] = [c]^x [G]^y \left[\frac{e^2}{4\pi\varepsilon_0}\right]^z \qquad \left[\because \frac{e^2}{4\pi\varepsilon_0} = [ML^3 T^{-2}]\right]$$

$$l = [LT^{-1}]^x \ [M^{-1}L^3 T^{-2}]^y \ [ML^3 \ T^{-2}]^z$$

$$[L] = [L^{x+3y+3z} \ M^{-y+z} \ T^{-x-2y-2z}]$$

Comparing powers on both the sides,

$$-y + z = 0$$

$$\Rightarrow \qquad y = z \qquad \qquad \dots(i)$$

$$x + 3y + 3z = 1 \qquad \qquad \dots(ii)$$

$$-x - 4z = 0 \qquad \qquad \dots(iii)$$

Substituting $y = z$ in equation (ii)

$$x + 3z + 3z = 1$$

$$x + 6z = 1$$

$$x = 1 - 6z$$

Now, from equation (iii) $x = -4z$

Substituting the value, we get

$$-4z = 1 - 6z$$

$$-4z + 6z = 1$$

$$2z = 1$$

$$z = \frac{1}{2} = y$$

$$x = -4\left(\frac{1}{2}\right)$$

$$x = -2$$

From (i), (ii) & (iii), we get

$$z = y = \frac{1}{2}, x = -2$$

Hence, $\qquad L = c^{-2}\left[G.\dfrac{e^2}{4\pi\varepsilon_0}\right]^{\frac{1}{2}}$

19. Option (c) is correct.

Given, $\qquad E_{rms} = 6$ V/m

The electric field vector and the magnetic field vector is related with the following :

$$\frac{E_{rms}}{B_{rms}} = c$$

$$\Rightarrow \qquad B_{rms} = \frac{E_{rms}}{c} \qquad \qquad \dots(i)$$

$$B_{rms} = \frac{B_0}{\sqrt{2}}$$

$$\Rightarrow \qquad B_0 = \sqrt{2} \ B_{rms}$$

$$B_0 = \sqrt{2} \times \frac{E_{rms}}{c} \quad \text{(From equation (i))}$$

$$= \frac{\sqrt{2} \times 6}{3 \times 10^8}$$

$$= \frac{\sqrt{2} \times 2}{10^8}$$

$$= 2.83 \times 10^{-8} \ T$$

Hence, the peak value of the magnetic field is 2.83×10^{-8} T.

20. Option (d) is correct.

The resistance of a wire of length l and area A and resistivity ρ is given by

$$R = \frac{\rho l}{A}$$

Given : $l' = nl$

As the volume of the wire remains constant,

$$A'l' = Al$$

$$A' = \frac{Al}{l'} = \frac{Al}{nl}$$

Therefore, $A' = \dfrac{A}{n}$

Now, $R' = \dfrac{\rho l'}{A'}$

$$R' = \frac{\rho nl}{\dfrac{A}{n}} = \frac{n^2 \rho l}{A} = n^2 R$$

Therefore, the new resistance will be $n^2 R$.

21. Option (d) is correct.

Given :

Optical microscope of wavelengths :

$$\lambda_1 = 4000 \text{ Å}$$
$$\lambda_2 = 6000 \text{ Å}$$

Resolving power is the ability of the imaging device to separate the points of the object that are located at a small angular distance.

Resolving power is inversely proportional to wavelength.

i.e., $R \propto \dfrac{1}{\lambda}$
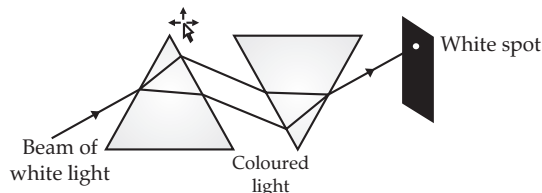
$$\frac{R_1}{R_2} = \frac{\lambda_2}{\lambda_1}$$

$$= \frac{6000 \text{ Å}}{4000 \text{ Å}} = \frac{3}{2}$$

Therefore, the ratio of resolving powers of the optical microscope is $3 : 2$

22. Option (c) is correct.

Condition for Dispersion less Deviation is

$$(\mu_v - \mu_r)A + (\mu_v' - \mu_r')A' = 0$$

Beam of white light
Coloured light
White spot

μ_v = Violet refractive index (prism 1),
μ_r = Red refractive index (prism 1),
U_v = Violet refractive index (prism 2),
μ_r' = Red refractive index (prism 2),

For spread without deviation

$$|S_1| = |S_2|$$
$$(\mu - 1)A + (\mu' - 1)A' = 0$$
$$|(\mu - 1)A| = |(\mu' - 1)A'|$$
$$(1.42 - 1) \times 10° = (1.7 - 1)A'$$

$$A' = \frac{0.42 \times 10}{0.7}$$

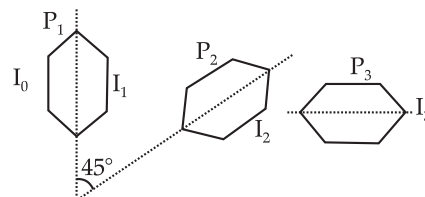$$4.2 = 0.7A'$$

$$A' = 6°$$

23. Option (d) is correct.

Law on Malus :

$$I = I_0 \cdot \cos^2 \theta$$

θ = E angle made by the transmission axis vector E.
I = Transmitted light intensity after polarization.
I_0 = Incident light Intensity.

Light intensity after traverse $P_1 = \dfrac{I_0}{2}$

Intensity of light after crossing $P_2 = \dfrac{I_0}{2} \cdot \cos^2 45°$

$$P_2 = \frac{I_0}{2} \times \frac{1}{2} = \frac{I_0}{4}$$

Intensity of light after crossing $P_3 = \dfrac{I_0}{4} \cdot \cos^2 45°$

$$P_3 = \frac{I_0}{8}$$

The intensity of transmitted light through P_3 is $\dfrac{I_0}{8}$.

24. Out of Syllabus

25. Option (c) is correct.

For a tube closed at one end and open at other end, the fundamental node is $v/(4L)$ Hz, where v is velocity of sound and L is length of tube.

Two successive frequencies of closed pipe.,

$$\frac{nv}{4l} = 220 \qquad \qquad \text{...(i)}$$

$$\frac{(n + 2)v}{4l} = 260 \qquad \qquad \text{...(ii)}$$

Dividing (ii) by (i), we get

$$\frac{n + 2}{n} = \frac{260}{220} = \frac{13}{11}$$

$$11n + 22 = 13n$$
$$13n - 11n = 22$$
$$2n = 22$$
$$n = \frac{22}{2}$$
$$n = 11$$
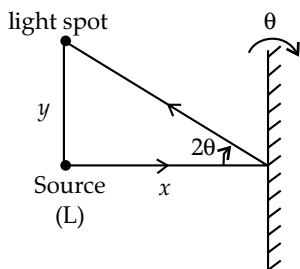
So, $\dfrac{11v}{4l} = 220$

$$\frac{v}{4l} = \frac{220}{11}$$

$$\frac{v}{4l} = 20$$

Therefore, fundamental frequency is 20 Hz.

26. Option (b) is correct.

The beam is reflected as a spot on a scale situated just above the 'L' source. When we rotate the mirror at a small angle θ, the spot of light will move on the scale through a distance y.

$$2\theta = \frac{y}{x}; \ \theta = \frac{y}{2x}$$

When the mirror is rotated at an angle θ then the reflected ray rotates at an angle 2θ
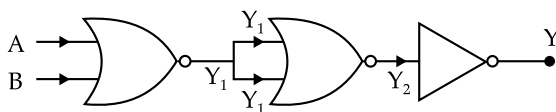
Therefore, $\qquad 2\theta = \dfrac{y}{x}$

So, $\qquad\qquad \theta = \dfrac{y}{2x}$

27. Option (d) is correct.

Given :

The electrical network :

The 1st NOR Gate output is

$$y_1 = \overline{A+B}$$

The 2nd NOR gate output is

$$y_2 = \overline{y_1 + y_1} = \overline{\overline{y_1}} = A + B$$

The NOR gate is a digital logic gate, which implements logical NOR. It acts to the right according to the truth table. We get a HIGH output (1) when both inputs to the gate are LOW (0). If one or both input is HIGH (1), it results in LOW output (0). NOR is the result of OR Operator's denial.

The third NOT gate output is

$$y = \overline{y_2} = \overline{A + B}$$

A NOT gate is often called an inverter, because it has only one input with simple behaviour. A NOT gate on its input performs logical negation. To put it another way, if the input is true, then the output is false. A false input likewise results in a true output.

Hence, the equivalent output to the electrical network is NOR.

28. Option (d) is correct.

Since, S.H.M. equation,

$$a = -\frac{d^2x}{dt^2} = -\omega^2 x$$

$$\omega = \sqrt{\frac{k}{m}}$$

Where, $\qquad x = A\sin(\omega t + \delta)$

Velocity and displacement relationships :

Displacement is the difference in vector between an object's ending and starting positions. Velocity is the rate at which the time for displacement changes. It is also a vector. The average velocity over some interval during that interval is the total displacement, divided by the time.

$$v = \omega\sqrt{A^2 - x^2}$$

Where, x is offset from the mean position

According to the questions,

$$\omega\sqrt{A^2 - x^2} = \omega^2 x$$

$$\sqrt{(3)^2 - (2)^2} = 2\left(\frac{2\pi}{T}\right)$$

$$\sqrt{5} = \frac{4\pi}{T}$$

$$T = \frac{4\pi}{\sqrt{5}}$$

29. Option (d) is correct.

Concept : When A & B are moving in the opposite direction along with straight line.

$$\vec{V}_A = \text{Object velocity A.}$$

$$\vec{V}_B = \text{Object velocity B.}$$

The relative velocity of A regarding B is

$$\vec{V}_{AB} = \vec{V}_A - \left(-\vec{V}_B\right)$$

$$\vec{V}_{AB} = \vec{V}_A + \vec{V}_B$$

Let V and t be the usual speed and time by Preeti.

Further, d be the length of escalator

Now, according to the question, Preeti speed will remains same,

Thus, $\qquad \dfrac{d}{t} = \dfrac{d}{t_1} + \dfrac{d}{t_2}$

$$\frac{1}{t} = \frac{1}{t_1} + \frac{1}{t_2}$$

$$t = \frac{t_1 t_2}{(t_1 + t_2)}$$

30. Option (c) is correct.

Initial Angular Impulse = $I\omega_1 + I\omega_2$

Let ω the combined system be at angular velocity.
Dynamic angular finale = $2I\omega$
According to angular momentum

$$I\omega_1 + I\omega_2 = 2I\omega$$

or, $$\omega = \frac{\omega_1 + \omega_2}{2}$$

Initial kinetic rotational energy

$$E_i = \frac{1}{2}I(\omega_1^2 + \omega_2^2)$$

$$E_f = \frac{1}{2}(2I)\omega^2 = \frac{1}{2}(2I)\left(\frac{\omega_1 + \omega_2}{2}\right)^2$$

$$= \frac{1}{4}I(\omega_1 + \omega_2)^2$$

Therefore, The Energy Loss,
$$\Delta E = E_i - E_f$$

$$= \frac{I}{2}(\omega_1^2 + \omega_2^2) - \frac{I}{4}(\omega_1^2 + \omega_2^2 + 2\omega_1\omega_2)$$

$$= \frac{I}{4}[\omega_1^2 + \omega_2^2 - 2\omega_1\omega_2]$$

$$= \frac{I}{4}[\omega_1 - \omega_2]^2$$

Hence, $\frac{I}{4}(\omega_1 - \omega_2)^2$ is the expression for loss of energy during this process.

31. Option (a) is correct.
Internal energy of a system is given by :

$$U = n\frac{f}{2}RT$$

Internal energy for 2 moles of oxygen is

$$U_{O_2} = n_1\frac{f_1}{2}RT$$

$$= 2 \times \frac{5}{2}RT$$

$$= 5\,RT$$

Internal energy for 4 moles of argon is

$$U_{Ar} = n_2\frac{f_2}{2}RT$$

$$= 4 \times \frac{3}{2}RT = 6\,RT$$

So, Total internal energy

$$U = U_{O_2} + U_{Ar}T$$

$$= 5\,RT + 6\,RT$$

$$= 11\,RT$$

The total internal energy of the system is 11 RT.

32. Option (a) is correct.
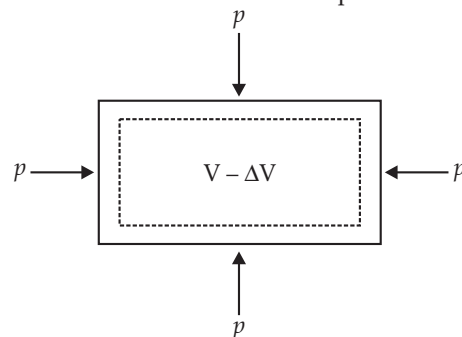**Bulk Modulus :** Ratio of normal stress to volumetric strain.

$$K = \frac{\dfrac{f}{A}}{-\dfrac{\Delta V}{V}} - \frac{-FV}{A\Delta V}$$

$$B = \frac{p}{\left(\dfrac{\Delta V}{V}\right)} \qquad \text{....(i)}$$

V = Original volume
ΔV = Change in volume
P = Increase in pressure

–ve (sign) shows a decrease in volume (ΔV)
In equation (i) we get this value

$$\frac{p}{B} = \frac{\Delta V}{V}$$

or, $$\frac{p}{B} = 3\frac{\Delta r}{r}$$

or, $$\frac{\Delta r}{r} = \frac{p}{3B}$$

The radius of fractional decreases is

$$-\frac{\Delta r}{r} = \frac{p}{3B}$$

33. Option (b) is correct.
Circular motion is the object movement along the circumference of a circle or a circular path rotation. It can be uniform, with constant angular rotation rate and constant velocity, or non-uniform with varying rotational rate.

$$F_c = \frac{mv^2}{r}$$

The tension in the string balances the centripetal force. So, the net force acting, then, is :

$$F = T = \frac{mv^2}{r}$$

34. Option (d) is correct.
Given :
Force at which the rope is pulled = 30 N
Mass of the cylinder = 3 kg

Radius of the cylinder = 40 cm

Angular acceleration = ?

We know torque, $\vec{\tau} = \vec{r_1} \times \vec{F_1}$

$r_1 = $ Perpendicular distance to line of force from the origin.

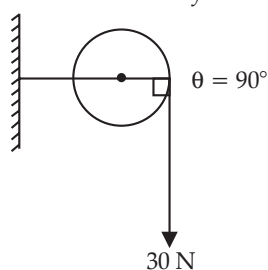$F_1 = $ Strength component perpendicular to line joining force.

Analogue of second law of motion for pure rotation is :

$$\tau = I a$$

Torque equation can be applied only about two points 1

(i) Centre of motion.

(ii) Point which has zero velocity or acceleration.

30 N

$$F \times R = MR^2\alpha$$
$$30 \times 0.4 = 3 \times (0.4)^2\alpha$$
$$12 = 3 \times 0.16\alpha$$
$$400 = 16\alpha$$
$$\alpha = 25 \text{ rad/s}^2$$

Thus, the angular acceleration of the cylinder is 25 rad/s^2

35. Option (a) is correct.

Refractive index, also called refraction index, measure the bending of a ray of light as it passes from one medium to another. Also, the refractive index is equal to the speed of light c of a given wavelength in empty space divided into a substance by its velocity v, or $n = \dfrac{c}{v}$

As we know that

Fringe in a medium width is

$$\beta' = \frac{\beta}{\mu}$$

Since wavelength in the medium is given as, $\lambda = \dfrac{\lambda_0}{\mu}$

Indoor fringe width = $\dfrac{\lambda_0 D}{d}$

In any other medium the fringe width = $\left(\dfrac{\lambda_0}{\mu}\right) \cdot \dfrac{D}{d}$

$$X_1 = X_{\text{5th dark}} = (2 \times 5 - 1)\frac{\lambda D}{2d}$$

$$X_2 = X_{\text{8th bright}} = 8\frac{\lambda D}{\mu d}$$

$$X_1 = X_2$$

$$\frac{9}{2}\frac{\lambda D}{d} = 8\frac{\lambda D}{\mu d}$$

$$\mu = \frac{16}{9} = 1.78$$

The refractive index of the medium is 1.78.

36. Option (d) is correct.

Given :

Mass of hydrogen

$$m_H = 1.67 \times 10^{-27} \text{ kg}$$

Water consists of two atoms of hydrogen (H), and one atom of oxygen (O).

Net hydrogen charge $q = (e + \Delta e) - e = \Delta e$

Let them distance each other d.

Now, equating gravity and electrostatic force, we get

$$F_e = F_g$$

$$\frac{1}{4\pi\varepsilon_0}\frac{(\Delta e)^2}{d^2} = \frac{Gm^2}{d^2}$$

Substituting the values,

$$9 \times 10^9 (\Delta e^2) = 6.67 \times 10^{-11} \times 1.67 \times 10^{-27}$$
$$\times 1.67 \times 10^{-27}$$

$$\Delta e^2 = \frac{6.67 \times 1.67 \times 1.67}{9} \times 10^{-74}$$

$$\Delta e \approx 10^{-37}$$

37. Option (b) is correct.

Thermal current,

$$H = H_1 + H_2$$

$$K_{EC} = \frac{K_1 A(T_1 - T_2)}{d} + \frac{K_2 A(T_1 - T_2)}{d}$$

$$= \frac{K_{EQ} 2A(T_1 - T_2)}{d}$$

$$= \frac{A(T_1 - T_2)}{d}[K_1 + K_2]$$

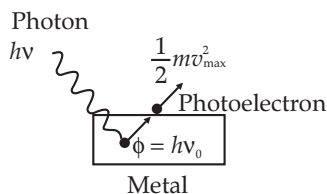$$K = \left[\frac{K_1 + K_2}{2}\right]$$

38. Option (c) is correct.

Given :

$h = 4.14 \times 10^{-15}$ eV and $c = 3 \times 10^8$ ms^{-1}

Energy conservation :

The minimum energy needed to eject an electron from the surface is called work function of photoelectric effect work. The threshold equals a wavelength of 683 nm for this element.

$$h(\nu - \nu_0) = \frac{1}{2}mv^2_{\text{max}}$$

Photon $h\nu$
$\frac{1}{2}mv_{max}^2$
Photoelectron
$\phi = h\nu_0$
Metal

Highest kinetic energy $= \dfrac{hc}{\lambda} = \phi$

$$\lambda_0 = 3250 \times 10^{-10} \text{ m}$$
$$\lambda = 2536 \times 10^{-10} \text{ m}$$

$$\phi = \frac{1242\,eVvm}{325\,vm} = 3.82\,eV$$

$$h\nu = \frac{1242\,eV - vm}{253.6\,vm} = 4.89\,eV$$

$$KE_{max} = (4.89 - 3.82)eV = 1.077\,eV$$

$$\frac{1}{2}mv^2 = 1.077 \times 1.6 \times 10^{-19}$$

$$v = \sqrt{\frac{2 \times 1.077 \times 1.6 \times 10^{-19}}{9.1 \times 10^{-31}}}$$

$$v = 0.6 \times 10^6 \text{ ms}^{-1}$$

39. Out of Syllabus

40. Option (a) is correct.

$$m = 1g = \frac{1}{1000}\,kg$$

$$h = 1 \text{ km} = 1000 \text{ m}$$

Work done through gravitational force $W = mgh$

$$W = mgh$$

$$W = \frac{1}{1000} \times 10 \times 1000$$

Since, in kinetic energy, $\Delta K.E = \dfrac{1}{2}mv^2 - 0$

Apply, $w_g + w_a = K_f - K_i$
Hence, w_a is the work done by air.

$$mgh + w_a = \frac{1}{2}mv^2 - 0$$

$$10^{-3} \times 10 \times 10^3 + w_a = \frac{1}{2} \times 10^{-3} \times (50)^2$$

$$w_a = -8.75\,J$$

Therefore, work done due to air resistance and work done due to gravity = 10 J.

41. Option (a) is correct.
Given :
Radius of the spherical black body = 12 cm
Power radiated by the black body at 500 K = 450 W
According to Stefan-Boltzmann law statement, the total

power emitted from a black body is directly proportional to the fourth power of its absolute temperature.

$$P = \sigma AT^4$$
$$r \propto R^2T^4$$

So, radiated power,
Hence, R in the radius and other alphabets are in their usual meaning.

So, $$\frac{r_1}{r_2} = \frac{R_1^2 T_1^4}{R_2^2 T_2^4}$$
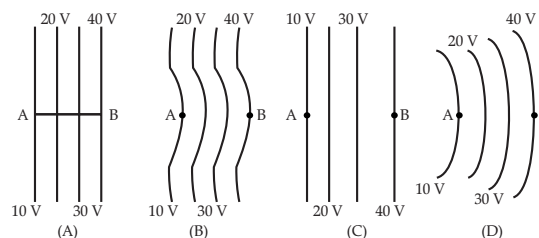
Substituting the values, we get

$$= 4 \times \frac{1}{16}$$

$$\frac{450}{r_2} = \frac{1}{4}$$

$$r_2 = 1800\,W$$

42. Option (c) is correct.
Given :

Any surface on which the potential is constant is called an equipotential surface. In other words, the potential difference on an equipotential surface between any two points is nil.

Hence, the potential difference between A and B in all the four cases is the same.

Therefore, the work done in all four cases is the same.

43. Option (b) is correct.
The centre of mass may or may not coincide with centre of gravity.

At the point of centre of mass the net gravitational torque acting on the body is zero.

Couple refers to two equally parallel forces that act in opposite direction. Hence, they produce only rotational motion.

We know that,

$$\text{Mechanical advantage} = \frac{\text{Output force}}{\text{Input force}}$$

In order for mechanical advantage to be greater than 1, the output force should be greater than the input force. This implies a less input effort is sufficient to lift a large load.

Hence, only statements (ii) and (iv) are correct.

44. Out of Syllabus

45. Out of Syllabus

CHEMISTRY

46. Option (c) is correct.

K_1 is the equilibrium constant of first reaction given. But to achieve the final reaction this reaction has to be reversed. Thus forming the reaction

$$2NH_3 \rightleftharpoons N_2 + 3H_2 \qquad \ldots(i)$$

Therefore, the equilibrium constant of the above reaction is $\dfrac{1}{K_1}$

For second reaction $N_2 + O_2 \rightleftharpoons 2NO$ the equilibrium constant is K_2. $\qquad \ldots(ii)$

For third reaction, the equilibrium constant is K_3. On multiplying this reaction by 3 we get

$$3H_2 + \dfrac{3}{2}O_2 \rightarrow 3H_2O \qquad \ldots(iii)$$
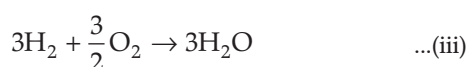
The equilibrium constant for the reaction is K_3^3.

On adding these three reactions we get the final

reaction $2NH_3 + \dfrac{5}{2}O_2 \rightleftharpoons 2NO + 3H_2O$
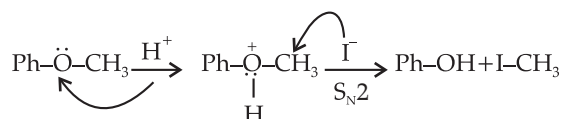
$\qquad \ldots(iv)$
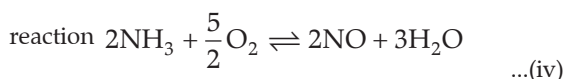
Equation (iv) = Equation (i) + Equation (ii) + 3 × Equation (iii)

Equilibrium constant for this reaction is

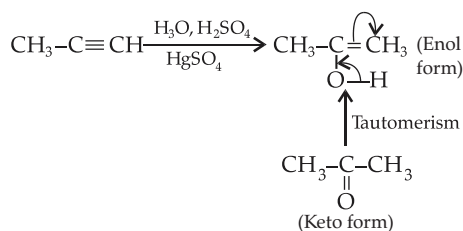$$K = \dfrac{K_3^3 K_2}{K_1}$$

47. Option (d) is correct.

$$Ph{-}\overset{\cdot\cdot}{\underset{\cdot\cdot}{O}}{-}CH_3 \xrightarrow{H^+} Ph{-}\overset{+}{\underset{\underset{H}{|}}{O}}{-}CH_3 \xrightarrow[S_N2]{I^-} Ph{-}OH + I{-}CH_3$$

O–CH$_3$ bond is weaker bond than O–C$_6$H$_5$ bond due delocalisation of electron pair the ring there is a partial double character. Moreover –C$_6$H$_5$ group is more sterically hindered than –CH$_3$ group for S$_N$2 substitution reaction.
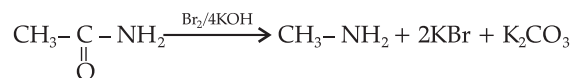
48. Option (a) is correct.

The ortho and para isomers can be separated by steam distillation as *o*-nitrophenol is steam volatile due to intramolecular hydrogen bonding while *p*-nitrophenol is less volatile due to intermolecular hydrogen bonding which causes association of molecules.
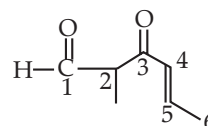
49. Option (a) is correct.

$$CH_3{-}C{\equiv}CH \xrightarrow[HgSO_4]{H_3O,\,H_2SO_4} \underset{\substack{|\\O{-}H}}{CH_3{-}C{=}CH_3} \text{ (Enol form)}$$

$$\Big\uparrow \text{Tautomerism}$$

$$\underset{\substack{\|\\O}}{CH_3{-}C{-}CH_3}$$
$$\text{(Keto form)}$$

50. Option (c) is correct.

$$\underset{\substack{\|\\O}}{CH_3{-}C{-}NH_2} \xrightarrow{Br_2/4KOH} CH_3{-}NH_2 + 2KBr + K_2CO_3$$

This reaction is known as Hoffmann hypobromamide reaction.

51. Option (b) is correct.

$$H{-}\overset{O}{\underset{1}{C}}{-}\overset{}{\underset{2}{C}}{-}\overset{O}{\underset{3}{C}}{-}\underset{\underset{6}{CH_3}}{\overset{4}{CH}}{=}^{5}$$
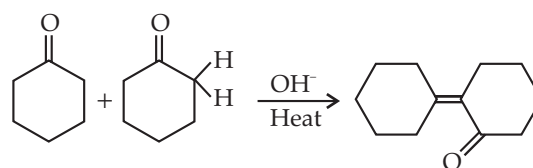
3-keto-2-methylhex-4-enal

52. Out of Syllabus

53. Option (c) is correct.

Mechanism :

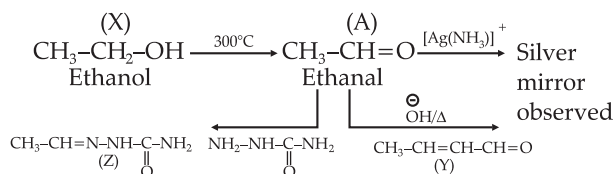**54. Option (d) is correct.**

IBr_2^- and XeF_2 are isostructural (Linear) and isoelectronic as both compounds have 22 electrons.

$BeCl_2$ and XeF_2 are also isostructural pairs but not isoelectronic.

55. Option (d) is correct.

$$\underset{\text{Ethanol}}{\overset{(X)}{CH_3{-}CH_2{-}OH}} \xrightarrow{300°C} \underset{\text{Ethanal}}{\overset{(A)}{CH_3{-}CH{=}O}} \xrightarrow{[Ag(NH_3)]^+} \text{Silver mirror observed}$$

$$\underset{\substack{\|\\(Z)\ \ O}}{CH_3{-}CH{=}N{-}NH{-}C{-}NH_2} \quad \underset{\substack{\|\\O}}{NH_2{-}NH{-}C{-}NH_2} \quad \underset{(Y)}{CH_3{-}CH{=}CH{-}CH{=}O} \xrightarrow{\overset{\ominus}{OH}/\Delta} \text{observed}$$
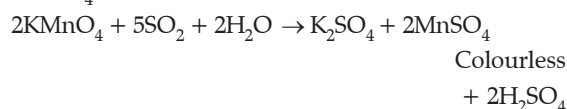
A - Ethanal   X - Ethanol

Y - But-2-enal   Z - Semicarbazone

56. Option (d) is correct.

Electron withdrawing group at o and p-position w.r.t. OH group of phenol, increase the acidic strength.

Picric acid (2, 4, 6-trinitrophenol) is extremely more acidic among the given compounds due to the presence of three strong electron withdrawing groups (NO$_2$ group) at *ortho*- and *para*-positions.

57. Option (c) is correct.

SO$_2$ decolourises pink, violet colour of acidified KMnO$_4$ solution

$$2KMnO_4 + 5SO_2 + 2H_2O \rightarrow K_2SO_4 + 2MnSO_4$$
$$\text{Colourless}$$
$$+\ 2H_2SO_4$$

58. Option (c) is correct.

$$CH{\equiv}CH > CH_3{-}C{\equiv}CH > CH_2{=}CH_2 >$$
$$CH_3{-}CH_3$$
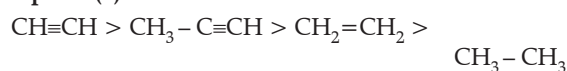
Acidic nature depends on Electronegativity and Inductive effect.

$\equiv C$ has sp hybridization, so 50% s character More electronegative. More acidic.

$=C$ has sp^2 hybridization, so 33.3% s character.

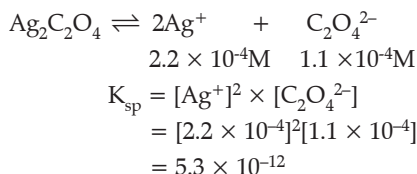$-C$ has sp^3 hybridization, so 25% s character.

59. Option (a) is correct.

$$Ag_2C_2O_4 \rightleftharpoons 2Ag^+ \quad + \quad C_2O_4^{2-}$$
$$2.2 \times 10^{-4}M \quad 1.1 \times 10^{-4}M$$
$$K_{sp} = [Ag^+]^2 \times [C_2O_4^{2-}]$$
$$= [2.2 \times 10^{-4}]^2[1.1 \times 10^{-4}]$$
$$= 5.3 \times 10^{-12}$$

60. Option (a) is correct.

Both bond angles and bond length remain same.

In conformations, bond angles and bond lengths remain unaffected.

61. Option (a) is correct.

Electrophiles can be either neutral or positively charged species and can form a bond by accepting a pair of electron from a nucleophile.

62. Option (a) is correct.

For H-like atoms,

energy of $2s$ = energy of $2p$

All other statements are correct.

63. Option (b) is correct.

$$E \propto \frac{1}{\lambda}$$

where,   E = absorbed energy (splitting energy)

λ = absorbed wavelength

Presence of Strong Field Ligand $\Rightarrow$ E high, so λ low.

Strength : $H_2O < NH_3 < en$

So, E : $H_2O < NH_3 < en$

So, λ : $H_2O > NH_3 > en$

64. Option (c) is correct.
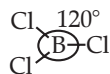
$XX' \Rightarrow$ Linear

$XX'_3 \Rightarrow$ T shape, sp^3d

$XX'_5 \Rightarrow$ Square pyramidal, sp^3d^2
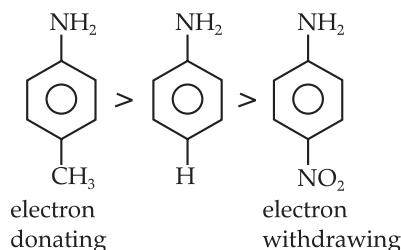
$XX'_7 \Rightarrow$ Pentagonal bipyramidal, sp^3d^3

65. Option (a) is correct.

It is sp^2 hybridised having triangular planar geometry.

66. Option (a) is correct.

Basicity $\propto$ + I effect.

67. Out of Syllabus

68. Option (d) is correct.

Work done in irreversible process

$$W = -P_{ext}\Delta V$$
$$= -2.5[4.50 - 2.50]$$
$$= -5 \text{ L.atm}$$
$$= -5 \times 101.3 \text{ J}$$
$$= -505 \text{ J}$$

Since system is well insulated, so $q = 0$

By First law of thermodynamics,

$$\Delta E = q + W$$
$$\Delta E = 0 - 505 \text{ J}$$
$$\Delta E = -505 \text{ J}$$

69. Option (b) is correct.

Given :

$$SrCO_3(s) \rightleftharpoons SrO(s) + CO_2(g)$$

So, $K_p = P_{CO_2}$

maximum pressure of CO_2 = 1.6 atm

$$P_1V_1 = P_2V_2$$
$$0.4 \times 20 = 1.6 \times V_2$$

So, $V_2 = 5$ L

70. Option (a) is correct.

This statement is incorrect.

Denaturation makes the protein more in-active because globules become unfold, helix get uncoiled as hydrogen bonds are disturbed consequently protein losses it's biological activity.

71. Option (a) is correct.

According to law of mass action

$$r = K[X][Y_2] \quad\quad ...(i)$$

From fast step (i)

$$K_{eq} = \frac{[X]^2}{[X_2]}$$

$$[X]^2 = K_{eq}. [X_2]$$

$$[X] = \sqrt{K_{eq}}. [X_2]^{1/2} \quad\quad ...(ii)$$

From equation (i) & (ii)

$$r = K\sqrt{K_{eq}}. [X_2]^{1/2}[Y_2]$$

$$r = K[X_2]^{1/2}[Y_2]$$

Overall order of reaction = 1 + 0.5 = 1.5

72. Option (c) is correct.
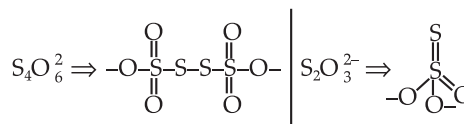
73. Option (d) is correct.

Isoelectronic species will have same bond order.

Total no. of electrons in CN^- = 14

Total no. of electrons in CO = 14

Bond order = 3

74. Out of Syllabus

75. Option (b) is correct.

$Sn^{2+} \rightarrow Sn^{4+}$

Sn^{2+} has a tendency to oxidize to Sn^{4+}, so, it behaves as Reducing Agent.

While, in case of Pb,

$Pb^{4+} \rightarrow Pb^{2+}$

Pb^{4+} has a tendency to reduce to Pb^{2+}, so, it behaves as Oxidizing Agent. Due to Inert Pair Effect.

76. Option (c) is correct.

Apply, $\Delta G = \Delta H - T\Delta S$

For equilibrium condition, $\Delta G = 0$

So,

$$\Delta H = T\Delta S$$

$$T_{eq.} = \frac{\Delta H}{\Delta S}$$

$$T_{eq.} = \frac{35.5 \times 1000}{83.6} = 425 \text{ K}$$

Since the reaction is endothermic, it will be spontaneous at T > 425 K.

77. Option (a) is correct.

K_f does not depend on concentration of solution. It only depends on nature of solvent.

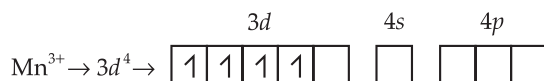So, it will remain unchanged.

78. Option (c) is correct.

Because out of all the given options, only Molarity has volume in its expression. All the other options have mass only, which is independent of the temperature changes.
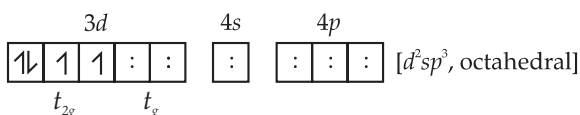
79. Option (d) is correct.

It is d^2sp^3 hybridized and octahedral.

$[Mn(CN)_6]^{3-} \rightarrow$ Oxidation State of Mn is (+3)
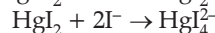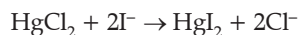
Coordination Number = 6

$$Mn^{3+} \rightarrow 3d^4 \rightarrow \boxed{1\ 1\ 1\ 1\ \ } \quad \boxed{\ } \quad \boxed{\ \ \ }$$

3d   4s   4p

Presence of strong field ligand will result in pairing.

3d   4s   4p

$$\boxed{1\!\!\uparrow\ 1\ 1\ :\ :} \quad \boxed{:} \quad \boxed{:\ :\ :} \ [d^2sp^3, \text{octahedral}]$$

t_{2g} t_g

80. Out of Syllabus

81. Option (d) is correct.
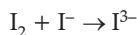
$$HgCl_2 + 2I^- \rightarrow HgI_2 + 2Cl^-$$
$$HgI_2 + 2I^- \rightarrow HgI_4^{2-}$$
$$\text{Soluble complex}$$
$$I_2 + I^- \rightarrow I_3^-$$
$$\text{Water soluble}$$

82. Out of Syllabus

83. Option (d) is correct.

$[Co(NH_3)_6]Cl_3 + AgNO_3 \rightarrow 3$ moles of AgCl
$[Co(NH_3)_5Cl]Cl_2 + AgNO_3 \rightarrow 2$ moles of AgCl
$[Co(NH_3)_4Cl_2]Cl + AgNO_3 \rightarrow 1$ mole of AgCl
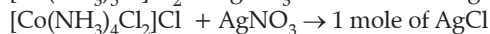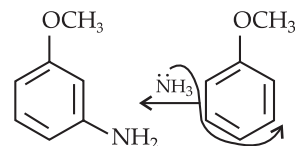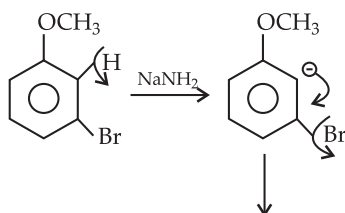
84. Option (b) is correct.

85. Out of Syllabus

86. Option (d) is correct.

Minimum energy gap between $5f$, $6d$ and $7s$ subshells. That's why electron excitation will be easier.

87. Option (c) is correct.

$Z = 114 = [Rn]^{86}\ 7s^2\ 5f^{14}\ 6d^{10}\ 7p^2$

p^2 configuration is similar to that of Carbon.

So, 14th group. Carbon family.

88. Option (c) is correct.

Half life of first order reaction, $t_{1/2} = \dfrac{0.693}{k}$

Given, $k = 10^{-2}\text{ s}^{-1}$

$$t_{1/2} = \frac{0.693}{0.01}$$

$$t_{1/2} = 69.3 \text{ s}$$

$20g \rightarrow 10g \rightarrow 5g$

2 half-lives

So, total time $= 2.t_{1/2} = 2 \times 69.3$ s

$= 138.6$ s

89. Out of Syllabus

90. Option (d) is correct.

For cell

$$Zn|ZnSO_4(0.01M)||CuSO_4(1M)|Cu$$

Cell reaction $\rightarrow Zn + Cu^{2+} \longrightarrow Zn^{2+} + Cu$
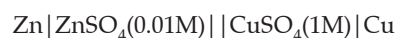
$$E_1 = E° - \frac{0.059}{2}\log\frac{Zn^{2+}}{Cu^{2+}}$$

$$E_1 = E° - \frac{0.059}{2}\log\frac{0.01}{1}$$

$$= E° - \frac{0.059}{2}\log\frac{1}{100} \qquad ...(i)$$

For cell

$$Zn|ZnSO_4(1M)||CuSO_4(0.01M)|Cu$$

$$E_2 = E° - \frac{0.059}{2}\log\frac{1}{0.01}$$

$$= E° - \frac{0.059}{2}\log 100 \qquad ...(ii)$$

$\therefore \qquad E_1 > E_2$

BIOLOGY

91. Option (c) is correct.

Hershey and Chase gave the unequivocal proof that the DNA is the genetic material.

92. Option (a) is correct.

Spliceosomes are found in cells of eukaryotes only as split genes are absent in prokaryotes. They are used in removal of introns during post-transcriptional processing of hnRNA.

93. Option (d) is correct.

Synovial joints are freely movable joints and allow considerable movement.

94. Option (d) is correct.

The association of H1 protein indicates the complete formation of nucleosome because of which the DNA is condensed form.

95. Out of Syllabus

96. Option (a) is correct.

In male frog, the Vasa efferentia are 10-12 in number that arises from testes and opens into Bidder's canal. It communicates with the urinogenital duct that open into cloaca.

97. Option (b) is correct.

In human RBC's, nucleus degenerates during maturation which provide more space for oxygen carrying pigment-haemoglobin. They do not reproduce.

98. Option (b) is correct.

Mating of related individuals of same breed increases homozygosity.

99. Option (d) is correct.

Corpus luteum is a temporary endocrine structure formed in the ovary after ovulation. It is responsible for the release of hormones such as progesterone.

100. Option (a) is correct.

Viroids are infectious RNA particles devoid of protein coat. They are obligate parasites.

101. Option (c) is correct.

A decrease in blood pressure/volume stimulates the release of renin, aldosterone, and ADH while increase in blood flow to the atria of the heart can cause the release of Atrial Natriuretic factor (ANF). ANF causes dilation of blood vessel and also inhibits RAAS (Renin Angiotensin Aldosterone System) mechanism that decreases the blood volume.

102. Option (c) is correct.

Volvox is motile colonial fresh water green algae. *Chlorella* is a unicellular non-flagellate green alga. *Ulothrix* and *Spirogyra* are filamentous.

103. Option (d) is correct.

Endosperm is the nutritive tissue for the development of the embryo in angiosperms which develops post-fertilisation. In mature coconut, the liquid endosperm becomes milky and is enclosed by the kernel.

104. Option (a) is correct.

Saccharomyces cerevisiae is commonly known as Brewer's yeast. By fermentation of carbohydrates, it produces ethanol.

105. Option (b) is correct.

The correct matches are as follows-

Gonorrhea is a sexually transmitted disease caused by bacterium Neisseria gonorrhoeae. This bacterium infects genital region of males and females.

Syphilis is a bacterial disease caused by Treponema pallidum. It is transmitted through sexual contact and also from the mother to foetus.

Genital warts is a viral disease which is caused by Human Papilloma Virus. In this disease, benign and hard warts appear over the skin.

AIDS is caused by Human Immunodeficiency Virus. It is a disease which is transferred via body fluid contact. HIV attacks helper T-lymphocytes, due to which patient becomes immunodeficient.

106. Option (d) is correct.

Choanocytes or collar cells line the spongocoel and the canals. The flagella in the collar cells provide circulation to water in water canal system.

107. Option (c) is correct.

Mendel studied seven characters during his experiments. The nature of trichomes were not studied by him.

108. Out of Syllabus

109. Option (a) is correct.

Each Okazaki fragment is synthesised by DNA Polymerase at lagging strand in $5' \to 3'$ direction. New Okazaki fragments appear in the replication fork opens further. As the first Okazaki fragment appears away from the replication fork, the direction of elongation would be away from the replication fork.

110. Option (a) is correct.

Mycorrhizae is a symbiotic association of fungi with roots of higher plants.

111. Option (b) is correct.

*r*RNA is the most abundant in animal cell and constitutes 80% of the total RNA.

112. Option (c) is correct.

After completion of the biosynthetic stage, the product is subjected through downstream processing before it is ready for marketing.

113. Option (d) is correct.

Mycoplasma are the smallest organisms that completely lack a cell wall and can survive without oxygen. They are pathogenic to plants and animals.

114. Option (a) is correct.

Cell envelop is the outer covering of protoplasm of bacterial cell. It consist of three components: glycocalyx, cell wall, and cell membrane. Glycocalyx may occur in form of loose sheath or thick, tough mucilage covering called as capsule. The capsule is responsible for giving gummy and sticky character to the cell.

115. Option (d) is correct.

C_4 plants have higher temperature because of the presence of pyruvate phosphate dikinase enzyme which is sensitive to low temperature. C_3 plants show decreased photosynthesis at higher temperature due to increased photorespiration.

116. Option (a) is correct.

Rennin and pepsin enzymes are present in the gastric juice. Maltase is present in the intestinal juice.

117. Option (c) is correct.

Holoenzyme is a conjugate enzyme in which protein part is apoenzyme while non-protein is coenzyme.

118. Option (d) is correct.

If deletion takes place at 901st position the remaining 98 bases specifying for 33 codons of amino acids will be altered.

119. Option (c) is correct.

A population growing in a habitat with limited resources shows logistic growth curve.

For logistic growth

$dN/dt = rN(K-N/K)$

If $K = N$ then $K-NK = 0$

∵ the $dN/dt = 0$,

the population reaches asymptote.

120. Option (b) is correct.

Pinus is monoecious plant having both male and female cones on the same plant. Conifers are usually monoecious.

121. Option (d) is correct.

APC is a protein necessary for the separation of daughter chromosomes during anaphase. The chromosome will fail to segregate during anaphase if APC is defective.

122. Option (b) is correct.

Highly productive ecosystems are as follows :

Tropical rain forest, Coral reef, Estuaries, and Sugarcane fields.

123. Option (a) is correct.

Majority of the algae exhibit haplontic life cycle. *Chlamydomonas* has haplontic life cycle and hence shows zygotic meiosis.

124. Option (c) is correct.

Epiphyseal plate is responsible for the growth of bone which closes after adolescence therefore, *hypersecretion* of growth hormone in adult does not cause further increase in height.

125. Option (a) is correct.

Frogs heart is myogenic in nature which means it originates in muscle tissue and not from nerve impulse and it is auto excitable (does not need external stimuli). When frog's heart is taken out of the body, it continues to beat for some time *i.e.*, till the time ATP is available, because it is not dependent on nervous system and does not require external stimuli as SA node can generate action potential on its own.

126. Option (c) is correct.

Rejection or non-acceptance of the graft or transplanted tissues/organs is due to cell mediated immune response.

127. Option (d) is correct.

Thalassemia differs from sickle-cell anaemia in that, the former is a quantitative problem of synthesising too few globin molecules while the latter is a qualitative problem of synthesising an incorrectly functioning globin.

128. Option (d) is correct.

Pharyngeal gill slits are common to both hemichordates as well as in chordates. Notochord is present in chordates whereas ventral tubular nerve cord is a feature of nonchordates.

129. Option (a) is correct.

Out of two sperms, one sperm fertilises with the egg to form a diploid zygote. While the other sperm fuses with the two polar nuclei to develop triploid endosperm, the process is known as double fertilisation. Double fertilisation is the characteristic feature of angiosperm.

130. Option (a) is correct.

Mitochondria are the site of aerobic oxidation of carbohydrates to generate ATP.

131. Option (b) is correct.

The volume of air remaining in the lungs even after a forcible expiration is known as residual volume. It prevents the alveoli from collapsing even after forcible expiration.

132. Option (a) is correct.

Lipids are the esters of fatty acids and alcohol. Nucleic acids are the polymers of nucleotides, proteins are the polymers of amino acids and polysaccharides are polymers of monosaccharides.

133. Option (d) is correct.

Wind pollinated flowers often have a single ovule in each ovary and numerous flowers packed into inflorescence.

134. Option (d) is correct.

Ectocarpus has haplodiplontic life cycle while Fucus has diplontic life cycle. Most of the algal genera are haplontic.

135. Option (c) is correct.

The tropical rain forests have vertical layers on the basis of height of plants.

136. Option (c) is correct.

PEP is the primary CO_2 acceptor in C_4 plants.

137. Out of Syllabus

138. Option (b) is correct.

Mendel conducted hybridisation experiments on pea plant for 7 years between 1856 to 1863 and his research data was published in 1865.

139. Option (c) is correct.

Mycorrhiza is the association of the fungus with the root of the vascular host plant. It increases the water and nutrition absorption capacity of the plant. Rhodospirillum is a facultative anaerobe. It is a nitrogen fixer which helps in the conversion of atmospheric nitrogen to ammonia. It is not associated with roots of the vascular plant as mycorrhiza.

140. Option (c) is correct.

Insect pollinated plants provide rewards such as nectar and pollen grains to sustain insect visits. In some species, floral rewards are in providing safe places to lay eggs.

141. Option (d) is correct.

Infertility cases are either due to the inability of the male partner to inseminate the female or due to low sperm count in the ejaculates, it could be corrected by artificial insemination.

142. Option (d) is correct.

Whales, Dolphins and Seals are the aquatic mammals belonging to class Mammalia whereas, Sharks and Trygon are the members of Chondrichthyes (cartilaginous fish).

143. Option (d) is correct.

The functional megaspore develops into the female gametophyte (embryo sac).

144. Option (b) is correct.

In roots, the root hairs arise from the zone of maturation, which undergoes differentiation. Root hairs are unicellular elongations of the epidermal cells.

145. Option (c) is correct.

In several species such as papaya, male and female flowers are present on different plants. This condition prevents both autogamy and geitonogamy.

146. Option (a) is correct.

The hepatic portal vein carries blood from the intestine to the liver before it is delivered to the systemic circulation. It carries maximum amount of nutrients from intestine to liver.

147. Option (c) is correct.

During electrophoresis, DNA fragments separate according to their size through sieving effect provided by the agarose gel.

148. Out of Syllabus

149. Option (a) is correct.

The TCA cycle starts with the condensation of acetyl group with OAA and water to yield citric acid.

150. Option (c) is correct.

Artificial selection to obtain cow yielding higher milk output represents directional selection as it shift the peak to mean direction.

151. Option (b) is correct.

Biosphere Reserves are ecologically unique and biodiversity rich regions. It has three zones: core zone: without any human interference; buffer zone: with limited human activity and transition zone: where human settlement, grazing, cultivation are allowed.

152. Option (a) is correct.

Pre-synaptic membrane is involved in the release of neurotransmitter. The receptor sites for neurotransmitters are present on postsynaptic membrane.

153. Out of Syllabus

154. Out of Syllabus

155. Out of Syllabus

156. Option (c) is correct.

DNA is made up of deoxyribose sugar, phosphate group, and nitrogenous bases. Phosphate groups are negatively charged which imparts negative charge to the DNA. The charge of DNA and DNA fragments is the same.

157. Option (a) is correct.

Capacitation is increase in fertilizing capacity of sperms which occurs in female reproductive tract.

158. Option (b) is correct.

IUDs increase phagocytosis of sperm within the uterus and the Cu ions released suppress the sperm motility and the fertilizing capacity of sperms.

159. Option (b) is correct.

In recombinant DNA technology, selectable markers helps in identifying and eliminating non-transformants and selectively permitting the growth of transformants.

160. Option (d) is correct.

Continually increasing air pollution by aerosol is a threat to agriculture.

161. Option (b) is correct.

The descending limb of loop of Henle is permeable to water but impermeable to electrolytes while, the ascending limb is impermeable to water but permeable to electrolytes.

162. Option (d) is correct.

Primary treatment involves sequential filtration and sedimentation. It removes suspended solids.

163. Option (c) is correct.

GnRH secreted by hypothalamus stimulates anterior pituitary gland for the gonadotropins-FSH and LH.

164. Option (d) is correct.

Cellulose microfibrils are oriented radially which makes easy for the stomata to open.

165. Option (d) is correct.

Number of Genotypes = 4

Number of Phenotypes = 3

$I^A I^A$ and $I^A i$ = A.

$I^A I^B$ = AB

$I^B i$ = B

♀ \ ♂	I^A	I^B
I^A	$I^A I^A$	$I^A I^B$
i	$I^A i$	$I^B i$

166. Option (c) is correct.

Halophytes grow in saline swampy soil and show vivipary which is in-situ seed germination. Pneumatophores are for gaseous exchange.

167. Option (d) is correct.

Alexander Von Humbolt discovered the species area relationship, which clearly states that, the

area increases with increasing the species in the particular area, and it is due to immigrants etc.

168. Option (d) is correct.

DNA replication in bacteria occurs prior to fission.

169. Option (b) is correct.

Mucosa associated lymphoid tissue (MALT) constitutes about 50% of the lymphoid tissue in human body.

170. Option (d) is correct.

Thorns are the modification of stem. These are pointed, hard structures for protection.

171. Option (d) is correct.

Auxins prevent fruit and leaf drop at early stages.

172. Option (b) is correct.

Archaebacteria are able to survive in extremely harsh conditions as they have a different cell wall structure. Halophiles live in extreme salty areas.

173. Option (b) is correct.

A drupe develops from monocarpellary superior ovary and are one seeded.

174. Option (a) is correct.

Ethidium bromide is used to stain the DNA fragments as orange coloured bands appear when exposed to UV light.

175. Option (b) is correct.

In human, 12 pairs of ribs are present in which 7 pairs of ribs *i.e.*, from 1st to 7th pairs are true ribs. These are attached dorsally to vertebral column and ventrally to the sternum.

176. Option (b) is correct.

Schwann cells produce myelin sheath in peripheral nervous system whereas oligodendrocytes produce myelin sheath in central nervous system.

177. Option (c) is correct.

(i) Condensation of DNA so that chromosomes become visible to take place during early prophase.

(ii) Nuclear membrane disassembly starts at late prophase

(iii) Arrangement of chromosomes at equator occurs during metaphase

(iv) Centromere division occurs during anaphase.

(v) Each sister chromatid separate and more towards the opposite poles during Anaphase.

(vi) Nuclear membrane develops around each set of chromosomes and the nuclear DNA is separated from cytoplasm in Telophase.

178. Option (b) is correct.

Down's syndrome is caused by nondisjunction of 21st chromosome.

179. Out of Syllabus

180. Option (b) is correct.

Ex-situ conservation is in which threatened animals and plants are placed in special settings, out of their natural habitat.

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