



SOLVED PAPER 2016 (Phase II)

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

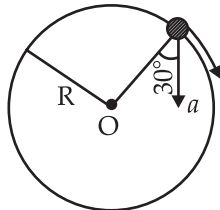
1. Planck's constant (h), speed of light in vacuum (c) and Newton's gravitational constant (G) are three fundamental constants. Which of the following combinations of these has the dimension of length?

(a) $\sqrt{\frac{hG}{3c^2}}$ (b) $\sqrt{\frac{hG}{5c^2}}$ (c) $\sqrt{\frac{hc}{G}}$ (d) $\sqrt{\frac{Gc}{3h^2}}$

2. Two cars P and Q start from a point at the same time in a straight line and their positions are represented by $x_P(t) = at + bt^2$ and $x_Q(t) = ft - t^2$. At what time do the cars have the same velocity?

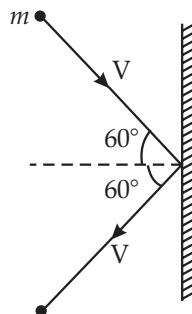
(a) $\frac{a-f}{1+b}$ (b) $\frac{a+f}{2(b-1)}$ (c) $\frac{a+f}{2(1+b)}$ (d) $\frac{f-a}{2(1+b)}$

3. In the given figure, $a = 15 \text{ m/s}^2$ represents the total acceleration of a particle moving in the clockwise direction in the circle of radius $R = 2.5 \text{ m}$ at a given instant of time. The speed of the particle is



(a) 4.5 m/s (b) 5.0 m/s (c) 5.7 m/s (d) 6.2 m/s

4. A rigid ball of mass m strikes a rigid wall at 60° and gets reflected without loss of speed as shown in the figure. The value of impulse imparted by the wall on the ball will be



(a) $\frac{mV}{2}$ (b) $\frac{mV}{3}$ (c) mV (d) $2mV$

5. A bullet of mass 10 g moving horizontal with a velocity of 400 m/s strikes a wood block of mass 2 kg which is suspended by light inextensible string of length 5 m. As a result, the centre of gravity of the block found to rise a vertical distance of 10 cm. The speed of the bullet after it emerges of horizontally from the block will be

(a) 100 m/s (b) 80 m/s (c) 120 m/s (d) 160 m/s

6. Two identical balls A and B having velocities of 0.5 m/s and -0.3 m/s respectively collide elastically in one dimension. The velocities of B and A after the collision respectively will be

(a) -0.5 m/s and 0.3 m/s (b) 0.5 m/s and -0.3 m/s

(c) -0.3 m/s and 0.5 m/s (d) 0.3 m/s and 0.5 m/s

7. A particle moves from a point $(-2\hat{i} + 5\hat{j})$ to $(4\hat{i} + 3\hat{k})$ when a force of $(4\hat{i} + 3\hat{j}) \text{ N}$ is applied. How much work has been done by the force?

(a) 8 J (b) 11 J (c) 5 J (d) 2 J

8. Two rotating bodies A and B of masses m and $2m$ with moments of inertia I_A and I_B ($I_B > I_A$) have equal kinetic energy of rotation. If L_A and L_B be their angular momenta respectively, then

(a) $L_A = \frac{L_B}{2}$ (b) $L_A = 2L_B$

(c) $L_B > L_A$ (d) $L_A > L_B$

9. A solid sphere of mass m and radius R is rotating about its diameter. A solid cylinder of the same mass and same radius is also rotating about its geometrical axis with an angular speed twice that of the sphere. The ratio of

their kinetic energies of rotation $\left(\frac{E_{\text{sphere}}}{E_{\text{cylinder}}}\right)$ will be

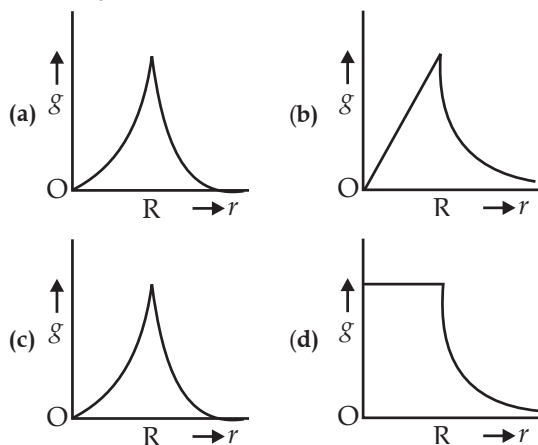
(a) 2 : 3 (b) 1 : 5 (c) 1 : 4 (d) 3 : 1

10. A light rod of length l has two masses m_1 and m_2 attached to its two ends. The moment of inertia of the system about an axis perpendicular to the rod and passing through the centre of mass is

(a) $m_1 m_2 / (m_1 + m_2) \times l^2$ (b) $(m_1 + m_2) / m_1 m_2 \times l^2$

(c) $(m_1 + m_2) \times l^2$ (d) $\sqrt{m_1 m_2} l^2$

11. Starting from the centre of the earth having radius R , the variation of g (acceleration due to gravity) is shown by



12. A satellite of mass m is orbiting the earth (of radius R) at a height h from its surface. The total energy of the satellite in terms of g_0 , the value of acceleration due to gravity at the earth's surface is

(a) $\frac{mg_0R^2}{2(R+h)}$ (b) $-\frac{mg_0R^2}{2(R+h)}$
 (c) $\frac{2mg_0R^2}{R+h}$ (d) $-\frac{2mg_0R^2}{R+h}$

13. A rectangular film of liquid is extended from $(4 \text{ cm} \times 2 \text{ cm})$ to $(5 \text{ cm} \times 4 \text{ cm})$. If the work done is $3 \times 10^{-4} \text{ J}$, the value of the surface tension of the liquid is
 (a) 0.250 Nm^{-1} (b) 0.125 Nm^{-1}
 (c) 0.2 Nm^{-1} (d) 8.0 Nm^{-1}

14. Three liquids of densities ρ_1, ρ_2 and ρ_3 (with $\rho_1 > \rho_2 > \rho_3$), having the same value of surface tension T , rise to the same height in three identical capillaries. The angles of contact θ_1, θ_2 and θ_3 obey

(a) $\frac{\pi}{2} > \theta_1 > \theta_2 > \theta_3 \geq 0$
 (b) $0 \leq \theta_1 < \theta_2 < \theta_3 < \frac{\pi}{2}$
 (c) $\frac{\pi}{2} < \theta_1 < \theta_2 < \theta_3 < \pi$
 (d) $\pi > \theta_1 > \theta_2 > \theta_3 > \frac{\pi}{2}$

15. Two identical bodies are made of a material for which the heat capacity increases with temperature. One of these is at 100°C , while the other one is at 0°C . If the two bodies are brought into contact, then assuming no heat loss, the final common temperature is

(a) 50°C
 (b) more than 50°C
 (c) less than 50°C but greater than 0°C
 (d) 0°C

16. A body cools from a temperature $3T$ to $2T$ in 10 minutes. The room temperature is T . Assume that Newton's law of cooling is applicable. The temperature of the body at the end of next 10 minutes will be

Out of Syllabus

(a) $\frac{7}{4}T$ (b) $\frac{3}{2}T$ (c) $\frac{4}{3}T$ (d) T

17. One mole of an ideal monatomic gas undergoes a process described by the equation $pV^3 = \text{constant}$. The heat capacity of the gas during this process is

(a) $\frac{3}{2}R$ (b) $\frac{5}{2}R$ (c) $2R$ (d) R

18. The temperature inside a refrigerator is $t_2^\circ\text{C}$ and the room temperature is $t_1^\circ\text{C}$. The amount of heat delivered to the room for each joule of electrical energy consumed ideally will be

Out of Syllabus

(a) $\frac{t_1}{t_1 - t_2}$ (b) $\frac{t_1 + 273}{t_1 - t_2}$
 (c) $\frac{t_2 + 273}{t_1 - t_2}$ (d) $\frac{t_1 + t_2}{t_1 + 273}$

19. A given sample of an ideal gas occupies a volume V at a pressure p and absolute temperature T . The mass of each molecule of the gas is m . Which of the following gives the density of the gas?

(a) $\frac{p}{(kT)}$ (b) $\frac{pm}{(kT)}$ (c) $\frac{p}{(kTV)}$ (d) mkT

20. A body of mass m is attached to the lower end of a spring whose upper end is fixed. The spring has negligible mass. When the mass m is slightly pulled down and released, it oscillates with a time period of 3 s. When the mass m is increased by 1 kg, the time period of oscillations becomes 5 s. The value of m in kg is

(a) $\frac{3}{4}$ (b) $\frac{4}{3}$ (c) $\frac{16}{9}$ (d) $\frac{9}{16}$

21. The second overtone of an open organ pipe has the same frequency as the first overtone of a closed pipe L meter long. The length of the open pipe will be

(a) L (b) $2L$ (c) $\frac{L}{2}$ (d) $4L$

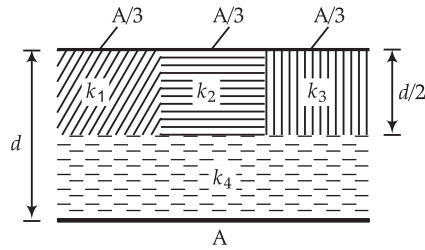
22. Three sound waves of equal amplitudes have frequencies $(n-1), n, (n+1)$. They superimpose to give beats. The number of beats produced per second will be

(a) 1 (b) 4 (c) 3 (d) 2

23. An electric dipole is placed at an angle of 30° with an electric field intensity $2 \times 10^5 \text{ N/C}$. It experiences a torque equal to 4 Nm . The charge on the dipole, if the dipole length is 2 cm , is

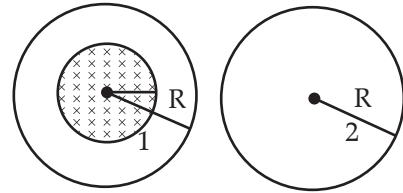
(a) 8 mC (b) 2 mC (c) 5 mC (d) 7 mC

24. A parallel-plate capacitor of area A , plate separation d and capacitance C is filled with four dielectric materials having dielectric constants k_1, k_2, k_3 and k_4 as shown in the figure below. If a single dielectric material is to be used to have the same capacitance C in this capacitor, then its dielectric constant k is given by

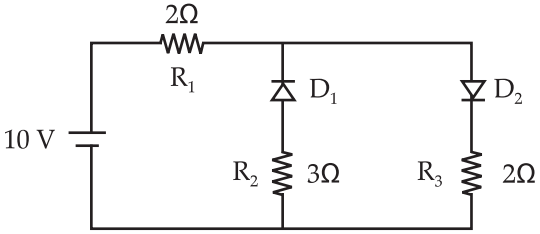
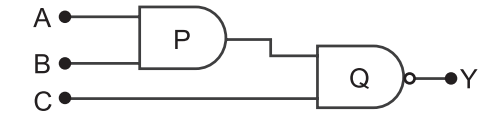


- (a) $k = k_1 + k_2 + k_3 + 3k_4$
 (b) $k = \frac{2}{3}(k_1 + k_2 + k_3) + 2k_4$
 (c) $\frac{2}{k} = \frac{3}{k_1 + k_2 + k_3} + \frac{1}{k_4}$
 (d) $\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2} + \frac{1}{k_3} + \frac{3}{2k_4}$
25. The potential difference ($V_A - V_B$) between the points A and B in the given figure is
-
- (a) -3 V (b) $+3\text{ V}$ (c) $+6\text{ V}$ (d) $+9\text{ V}$
26. A filament bulb (500 W, 100 V) is to be used in a 230 V main supply. When a resistance R is connected in series, it works perfectly and the bulb consumes 500 W. The value of R is
- (a) $230\ \Omega$ (b) $46\ \Omega$ (c) $26\ \Omega$ (d) $13\ \Omega$
27. A long wire carrying a steady current is bent into a circular loop of one turn. The magnetic field at the centre of the loop is B. It is then bent into a circular coil of n turns. The magnetic field at the centre of this coil of n turns will be
- (a) nB (b) n^2B (c) $2nB$ (d) $2n^2B$
28. A bar magnet is hung by a thin cotton thread in a uniform horizontal magnetic field and is in equilibrium state. The energy required to rotate it by 60° is W . Now the torque required to keep the magnet in this new position is
- (a) $\frac{W}{\sqrt{3}}$ (b) $\sqrt{3}W$ (c) $\frac{\sqrt{3}W}{2}$ (d) $\frac{2W}{\sqrt{3}}$
29. An electron is moving in a circular path under the influence of a transverse magnetic field of 3.57×10^{-2} T. If the value of e/m is 1.76×10^{11} C/kg, the frequency of revolution of the electron is
- (a) 1 GHz (b) 100 MHz
 (c) 62.8 MHz (d) 6.28 MHz
30. Which of the following combinations should be selected for better tuning of an L-C-R circuit used for communication?
- (a) $R = 20\ \Omega$, $L = 1.5\text{ H}$, $C = 35\ \mu\text{F}$
 (b) $R = 25\ \Omega$, $L = 2.5\text{ H}$, $C = 45\ \mu\text{F}$
 (c) $R = 15\ \Omega$, $L = 3.5\text{ H}$, $C = 30\ \mu\text{F}$
 (d) $R = 25\ \Omega$, $L = 1.5\text{ H}$, $C = 45\ \mu\text{F}$
31. A uniform magnetic field is restricted within a region of radius r . The magnetic field changes with time at a rate $\frac{dB}{dt}$. Loop 1 of radius $R > r$ encloses the region r

and loop 2 of radius R is outside the region of magnetic field as shown in the figure. Then, the emf generated is



- (a) zero in loop 1 and zero in loop 2
 (b) $-\frac{dB}{dt}\pi r^2$ in loop 1 and $-\frac{dB}{dt}\pi R^2$ in loop 2
 (c) $-\frac{dB}{dt}\pi R^2$ in loop 1 and zero in loop 2
 (d) $-\frac{dB}{dt}\pi r^2$ in loop 1 and zero in loop 2
32. The potential differences across the resistance, capacitance and inductance are 80 V, 40 V and 100 V respectively in an L-C-R circuit. The power factor of this circuit is
- (a) 0.4 (b) 0.5 (c) 0.8 (d) 1.0
33. A $100\ \Omega$ resistance and a capacitor of $100\ \Omega$ reactance are connected in series across a 220 V source. When the capacitor is 50% charged, the peak value of the displacement current is
- (a) 2.2 A (b) 11 A (c) 4.4 A (d) $11\sqrt{2}A$
34. Two identical glass ($\mu_g = \frac{3}{2}$) equi-convex lenses of focal length f each are kept in contact. The space between the two lenses is filled with water ($\mu_w = \frac{4}{3}$). The focal length of the combination is
- (a) $\frac{f}{3}$ (b) f (c) $\frac{4f}{3}$ (d) $\frac{3f}{4}$
35. An air bubble in a glass slab with refractive index 1.5 (near normal incidence) is 5 cm deep when viewed from one surface and 3 cm deep when viewed from the opposite face. The thickness (in cm) of the slab is
- (a) 8 (b) 10 (c) 12 (d) 16
36. The interference pattern is obtained with two coherent light sources of intensity ratio n . In the interference pattern, the ratio $\frac{I_{\max} - I_{\min}}{I_{\max} + I_{\min}}$ will be
- (a) $\frac{\sqrt{n}}{n+1}$ (b) $\frac{2\sqrt{n}}{n+1}$
 (c) $\frac{\sqrt{n}}{(n+1)^2}$ (d) $\frac{2\sqrt{n}}{(n+1)^2}$
37. A person can see clearly objects only when they lie between 50 cm and 400 cm from his eyes. In order to increase the maximum distance of distinct vision to infinity, the type and power of the correcting lens, the person has to use, will be
- (a) convex, + 2.25 diopter (b) concave, -0.25 diopter
 (c) concave, -0.2 diopter (d) convex, + 0.15 diopter

38. A linear aperture whose width is 0.02 cm is placed immediately in front of a lens of focal length 60 cm. The aperture is illuminated normally by a parallel beam of wavelength 5×10^{-5} cm. The distance of the first dark band of the diffraction pattern from the centre of the screen is
(a) 0.10 cm (b) 0.25 cm (c) 0.20 cm (d) 0.15 cm
39. Electrons of mass m with de-Broglie wavelength λ fall on the target in an X-ray tube. The cut-off wavelength (λ_0) of the emitted X-ray is
(a) $\lambda_0 = \frac{2mc\lambda^2}{h}$ (b) $\lambda_0 = \frac{2h}{mc}$
(c) $\lambda_0 = \frac{2m^2c^2\lambda^3}{h^2}$ (d) $\lambda_0 = \lambda$
40. Photons with energy 5 eV are incident on a cathode C in a photoelectric cell. The maximum energy of emitted photoelectrons is 2 eV. When photons of energy 6 eV are incident on C, no photoelectrons will reach the anode A, if the stopping potential of A relative of C is
(a) +3 V (b) +4 V (c) -1 V (d) -3 V
41. If an electron in a hydrogen atom jumps from the third orbit to the second orbit, it emits a photon of wavelength λ . When it jumps from the fourth orbit to the third orbit, the corresponding wavelength of the photon will be
(a) $\frac{16}{25}\lambda$ (b) $\frac{9}{16}\lambda$ (c) $\frac{20}{7}\lambda$ (d) $\frac{20}{13}\lambda$
42. The half-life of a radioactive substance is 30 minutes. The time (in minutes) taken between 40% decay and 85% decay of the same radioactive substance is
Out of Syllabus
(a) 15 (b) 30 (c) 45 (d) 60
43. For CE transistor amplifier, the audio signal voltage across the collector resistance of $2 \text{ k}\Omega$ is 4 V. If the current amplification factor of the transistor is 100 and the base resistance is $1 \text{ k}\Omega$, then the input signal voltage is
Out of Syllabus
(a) 10 mV (b) 20 mV (c) 30 mV (d) 15 mV
44. The given circuit has two ideal diodes connected as shown in the figure below. The current flowing through the resistance R_1 will be

(a) 2.5 A (b) 10.0 A (c) 1.43 A (d) 3.13 A
45. What is the output Y in the following circuit, when all the three inputs A, B, C are first 0 and then 1?

(a) 0, 1 (b) 0, 0 (c) 1, 0 (d) 1, 1

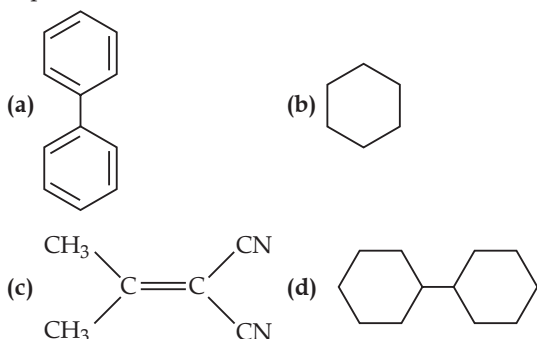
CHEMISTRY

46. Which one of the following compounds shows the presence of intramolecular hydrogen bond?
(a) H_2O_2 (b) HCN
(c) Cellulose (d) Concentrated acetic acid
47. The molar conductivity of a 0.5 mol/dm^3 solution of AgNO_3 with electrolytic conductivity of $5.76 \times 10^{-3} \text{ S cm}^{-1}$ at 398 K is
(a) $2.88 \text{ S cm}^2/\text{mol}$ (b) $11.52 \text{ S cm}^2/\text{mol}$
(c) $0.086 \text{ S cm}^2/\text{mol}$ (d) $28.8 \text{ S cm}^2/\text{mol}$
48. The decomposition of phosphine (PH_3) on tungsten at low pressure is a first-order reaction. It is because the
(a) rate is proportional to the surface coverage.
(b) rate is inversely proportional to the surface coverage.
(c) rate is independent of the surface coverage.
(d) rate of decomposition is very slow.
49. The coagulation values in millimoles per litre of the electrolytes used for the coagulation of As_2S_3 are given below
I. (NaCl) = 52,
II. (BaCl_2) = 0.69
III. (MgSO_4) = 0.22
The correct order of their coagulating power is
(a) I > II > III (b) II > I > III
(c) III > II > I (d) III > I > II
50. During the electrolysis of molten sodium chloride, the time required to produce 0.10 mol of chlorine gas using a current of 3A is
(a) 55 minutes. (b) 110 minutes.
(c) 220 minutes. (d) 330 minutes.
51. How many electrons can fit in the orbital for which $n = 3$ and $l = 1$?
(a) 2 (b) 6 (c) 10 (d) 14
52. For sample of perfect gas when its pressure is changed isothermally from P_i to P_f , the entropy change is given by
(a) $\Delta S = nR \ln \left(\frac{P_f}{P_i} \right)$ (b) $\Delta S = nR \ln \left(\frac{P_i}{P_f} \right)$
(c) $\Delta S = nRT \ln \left(\frac{P_f}{P_i} \right)$ (d) $\Delta S = RT \ln \left(\frac{P_i}{P_f} \right)$
53. The van't Hoff factor (i) for a dilute aqueous solution of the strong electrolyte barium hydroxide is
(a) 0 (b) 1 (c) 2 (d) 3
54. The percentage of pyridine ($\text{C}_5\text{H}_5\text{N}$) that forms pyridinium ion ($\text{C}_5\text{H}_5\text{N}^+\text{H}$) in a 0.10 M aqueous pyridine solution (K_b for $\text{C}_5\text{H}_5\text{N} = 1.7 \times 10^{-9}$) is
(a) 0.0060% (b) 0.013% (c) 0.77% (d) 1.6%

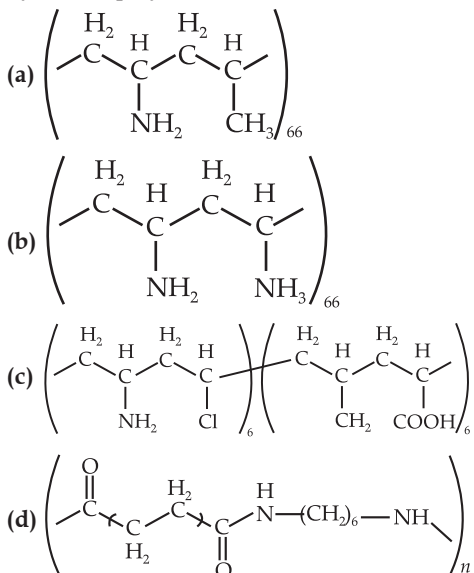
55. In calcium fluoride, having the fluorite structure, the coordination numbers for calcium ion (Ca^{2+}) and fluoride ion (F^-) are Out of Syllabus
 (a) 4 and 2 (b) 6 and 6 (c) 8 and 4 (d) 4 and 8
56. If the E_{cell}° for a given reaction has a negative value, which of the following gives correct relationships for the values of ΔG° and K_{eq} ?
 (a) $\Delta G^\circ > 0$; $K_{\text{eq}} < 1$ (b) $\Delta G^\circ > 0$; $K_{\text{eq}} > 1$
 (c) $\Delta G^\circ < 0$; $K_{\text{eq}} > 1$ (d) $\Delta G^\circ < 0$; $K_{\text{eq}} < 1$
57. Which one of the following is incorrect for ideal solution?
 (a) $\Delta H_{\text{mix}} = 0$
 (b) $\Delta U_{\text{mix}} = 0$
 (c) $\Delta P = P_{\text{obs}} - P_{\text{calculated by Raoult's law}} = 0$
 (d) $\Delta G_{\text{mix}} = 0$
58. The solubility of $\text{AgCl}(s)$ with solubility product 1.6×10^{-10} in 0.1 M NaCl solution would be
 (a) 1.26×10^{-5} M (b) 1.6×10^{-9} M
 (c) 1.6×10^{-11} M (d) zero
59. Suppose the elements X and Y combine to form two compounds XY_2 and X_3Y_2 . When 0.1 mole of XY_2 weighs 10 g and 0.05 mol of X_3Y_2 weighs 9 g, the atomic weights of X and Y are
 (a) 40, 30 (b) 60, 40 (c) 20, 30 (d) 30, 20
60. The number of electrons delivered at the cathode during electrolysis by a current of 1 A in 60 s is (charge on electron = 1.60×10^{-19} C)
 (a) 6×10^{23} (b) 6×10^{20}
 (c) 3.75×10^{20} (d) 7.48×10^{23}
61. Boric acid is an acid because its molecule
 (a) contains replaceable H^+ ion.
 (b) gives up a proton.
 (c) accepts OH^- from water releasing proton.
 (d) combines with proton from water molecule.
62. AlF_3 is soluble in HF only in presence of KF . It is due to the formation of
 (a) $\text{K}_3[\text{AlF}_3\text{H}_3]$ (b) $\text{K}_3[\text{AlF}_6]$
 (c) AlH_3 (d) $\text{K}[\text{AlF}_3\text{H}]$
63. Zinc can be coated on iron to produce galvanised iron but the reverse is not possible. It is because Out of Syllabus
 (a) zinc is lighter than iron.
 (b) zinc has lower melting point than iron.
 (c) zinc has lower negative electrode potential than iron.
 (d) zinc has higher negative electrode potential than iron.
64. The suspension of slaked lime in water is known as Out of Syllabus
 (a) lime water.
 (b) quick lime.
 (c) milk of lime.
 (d) aqueous solution of slaked lime.
65. The hybridisations of the atomic orbitals of nitrogen in NO_2^+ , NO_3^- and NH_4^+ respectively are
 (a) sp , sp^3 and sp^2 (b) sp^2 , sp^3 and sp
 (c) sp , sp^2 and sp^3 (d) sp^2 , sp and sp^3
66. Which of the following fluoro-compounds is most likely to behave as a Lewis base?
 (a) BF_3 (b) PF_3 (c) CF_4 (d) SiF_4
67. Which of the following pairs of ions is isoelectronic and isostructural?
 (a) CO_3^{2-} , NO_3^- (b) ClO_3^- , CO_3^{2-}
 (c) SO_3^{2-} , NO_3^- (d) ClO_3^- , SO_3^{2-}
68. In context with beryllium, which one of the following statements is incorrect? Out of Syllabus
 (a) It is rendered passive by nitric acid.
 (b) It forms Be_2C .
 (c) Its salts rarely hydrolyse.
 (d) Its hydride is electron-deficient and polymeric.
69. Hot concentrated sulphuric acid is a moderately strong oxidising agent. Which of the following reaction does not show oxidising behaviour?
 (a) $\text{Cu} + 2\text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + \text{SO}_2 + 2\text{H}_2\text{O}$
 (b) $3\text{S} + 2\text{H}_2\text{SO}_4 \rightarrow 3\text{SO}_2 + 2\text{H}_2\text{O}$
 (c) $\text{C} + 2\text{H}_2\text{SO}_4 \rightarrow \text{CO}_2 + 2\text{SO}_2 + 2\text{H}_2\text{O}$
 (d) $\text{CaF}_2 + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 + 2\text{HF}$
70. Which of the following pairs of d -orbitals will have electron density along the axes?
 (a) d_{z^2} , d_{xz} (b) d_{xz} , d_{yz}
 (c) d_{z^2} , $d_{x^2-y^2}$ (d) d_{xy} , $d_{x^2-y^2}$
71. The correct geometry and hybridisation for XeF_4 are
 (a) octahedral, sp^3d^2
 (b) trigonal bipyramidal, sp^3d
 (c) planar triangle, sp^3d^3
 (d) square planar, sp^3d^2
72. Among the following, which one is a wrong statement?
 (a) PH_5 and BiCl_5 do not exist.
 (b) $p\pi-d\pi$ bonds are present in SO_2 .
 (c) SeF_4 and CH_4 have same shape.
 (d) I_3^+ has bent geometry.
73. The correct increasing order of trans-effect of the following species is
 (a) $\text{NH}_3 > \text{CN}^- > \text{Br}^- > \text{C}_6\text{H}_5^-$
 (b) $\text{CN}^- > \text{C}_6\text{H}_5^- > \text{Br}^- > \text{NH}_3$
 (c) $\text{Br}^- > \text{CN}^- > \text{NH}_3 > \text{C}_6\text{H}_5^-$
 (d) $\text{CN}^- > \text{Br}^- > \text{C}_6\text{H}_5^- > \text{NH}_3$
74. Which one of the following statements related to lanthanoids is incorrect?
 (a) Europium shows + 2 oxidation state.
 (b) The basicity decreases as the ionic radius decreases from Pr to Lu.
 (c) All the lanthanoids are much more reactive than aluminium.
 (d) $\text{Ce} (+4)$ solution are widely used as oxidising agent in volumetric analysis.
75. Jahn-Teller effect is not observed in high spin complexes of
 (a) d^7 (b) d^8 (c) d^4 (d) d^9
76. Which of the following can be used as the halide component for Friedel-Crafts reaction?

- (a) Chlorobenzene (b) Bromobenzene
(c) Chloroethene (d) Isopropyl chloride

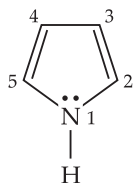
77. In which of the following molecules, all atoms are coplanar ?



78. Which one of the following structures represents nylon 6, 6 polymer ?



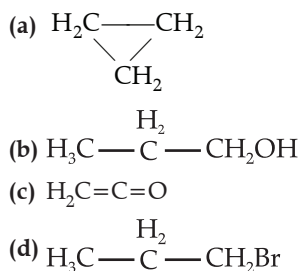
79. In pyrrole



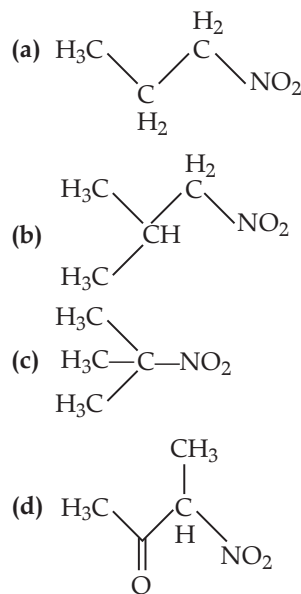
the electron density is maximum on

- (a) 2 and 3 (b) 3 and 4 (c) 2 and 4 (d) 2 and 5

80. Which of the following compounds shall not produce propene by reaction with HBr followed by elimination or direct only elimination reaction ?



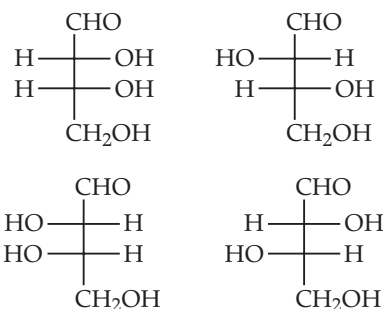
81. Which one of the following nitro-compounds does not react with nitrous acid ?



82. The central dogma of molecular genetics states that the genetic information flows from

- (a) amino acids \rightarrow proteins \rightarrow DNA
(b) DNA \rightarrow carbohydrates \rightarrow proteins
(c) DNA \rightarrow RNA \rightarrow proteins
(d) DNA \rightarrow RNA \rightarrow carbohydrates

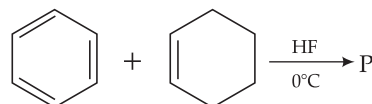
83. The correct corresponding order of names of four aldoses with configuration given below



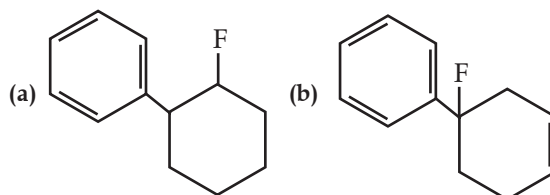
respectively, is

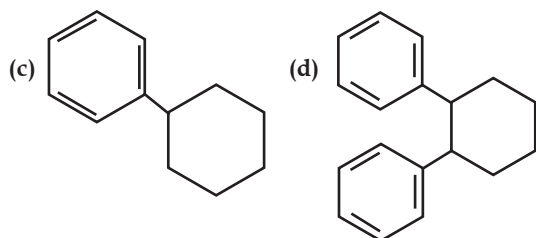
- (a) L-erythrose, L-threose, L-erythrose, D-threose
(b) D-threose, D-erythrose, L-threose, L-erythrose
(c) L-erythrose, L-threose, D-erythrose, D-threose
(d) D-erythrose, D-threose, L-erythrose, L-threose

84. In the given reaction

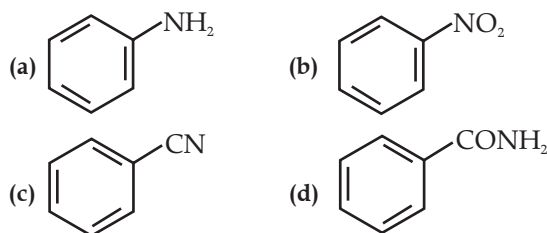


the product P is





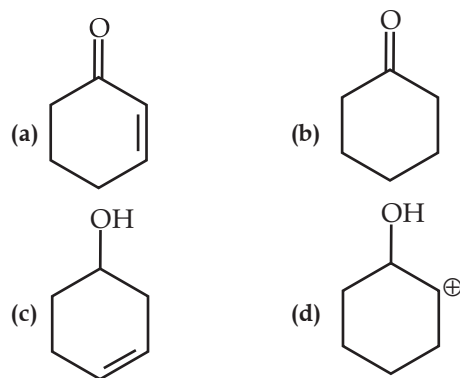
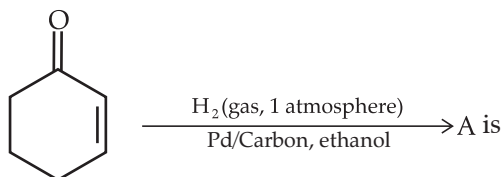
85. A given nitrogen-containing aromatic compound A reacts with Sn/HCl, followed by HNO₂ to give an unstable compound B. B, on treatment with phenol, forms a beautiful coloured compound C with the molecular formula C₁₂H₁₀N₂O. The structure of compound A is



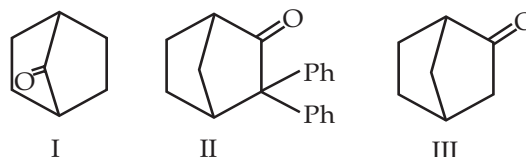
86. Consider the reaction
 $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br} + \text{NaCN} \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CN} + \text{NaBr}$

This reaction will be the faster in

- (a) ethanol
 (b) methanol
 (c) N, N'-dimethylformamide (DMF)
 (d) water
87. The correct structure of the product A formed in the reaction

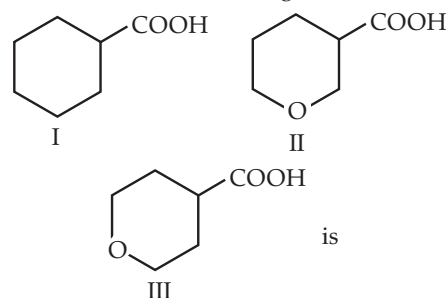


88. Which among the given molecules can exhibit tautomerism ?



- (a) III only
 (b) Both I and II
 (c) Both I and II
 (d) Both II and III

89. The correct order of strength of the carboxylic acids



- (a) I > II > III
 (b) II > III > I
 (c) III > II > I
 (d) II > I > III
90. The compound that will react most readily with gaseous bromine has the formula
 (a) C₃H₆ (b) C₂H₂ (c) C₄H₁₀ (d) C₂H₄

BIOLOGY

91. Which one of the following is wrong for fungi ?
 (a) They are eukaryotic.
 (b) All fungi possess a purely cellulosic cell wall.
 (c) They are heterotrophic.
 (d) They are both unicellular and multicellular.
92. Methanogens belongs to
 (a) eubacteria. (b) archaebacteria.
 (c) dinoflagellates. (d) slime moulds.
93. Select the wrong statement.
 (a) The walls of diatoms are easily destructible.
 (b) 'Diatomaceous earth' is formed by the cell walls of diatoms.
 (c) Diatoms are chief producers in the oceans.
 (d) Diatoms are microscopic and float passively in water.
94. The label of a herbarium sheet does not carry information on
 (a) date of collection. (b) name of collector.
 (c) local names. (d) height of the plant.
95. Conifers are adapted to tolerate extreme environmental conditions because of
 (a) broad hardy leaves. (d) superficial stomata.
 (c) thick cuticle. (d) the presence of vessels.
96. Which one of the following statements is wrong ?
 (a) Algae increase the level of dissolved oxygen in the immediate environment.
 (b) Algin is obtained from red algae and carrageenan from brown algae.
 (c) Agar-agar is obtained from *Gelidium* and *Gracilaria*.
 (d) *Laminaria* and *Sargassum* are used as food.

97. The term 'polyadelphous' is related to
 (a) gynoeceium. (b) androeceium.
 (c) corolla. (d) calyx.
98. How many plants among *Indigofera*, *Sesbania*, *Salvia*, *Allium*, *Aloe*, mustard, groundnut, radish, gram and turnip have stamens with different lengths in their flowers ?
 (a) Three (b) Four (c) Five (d) Six
99. Radial symmetry is found in the flowers of
 (a) *Brassica*. (b) *Trifolium*. (c) *Pisum*. (d) *Cassia*.
100. Free-central placentation is found in
 (a) *Dianthus*. (b) *Argemone*. (c) *Brassica*. (d) *Citrus*.
101. Cortex is the region found between
 (a) epidermis and stele.
 (b) pericycle and endodermis.
 (c) endodermis and pith.
 (d) endodermis and vascular bundle.
102. The balloon-shaped structures called tyloses
 (a) originate in the lumen of vessels.
 (b) characterise the sapwood.
 (c) are extensions of xylem parenchyma cells into vessels.
 (d) are linked to the ascent of sap through xylem vessels.
103. A non-proteinaceous enzyme is
 (a) lysozyme. (b) ribozyme.
 (c) ligase. (d) deoxyribonuclease.
104. Select the mismatch.
 (a) Gas vacuoles — Green bacteria Cells
 (b) Large central — Animals cells vacuoles
 (c) Protists — Eukaryotes
 (d) *Methanogens* — Prokaryotes
105. Select the wrong statement.
 (a) Bacterial cell wall is made up of peptidoglycan.
 (b) Pili and fimbriae are mainly involved in motility of bacterial cells.
 (c) Cyanobacteria lack flagellated cells.
 (d) *Mycoplasma* is a wall-less microorganism.
106. A cell organelle containing hydrolytic enzyme is
 (a) lysosome. (b) microsome.
 (c) ribosome. (d) mesosome.
107. During cell growth, DNA synthesis takes places in
 (a) S-phase. (b) G₁-phase.
 (c) G₂-phase. (d) M-phase.
108. Which of the following biomolecules is common to respiration-mediated break down of fats, carbohydrates and proteins ?
 (a) Glucose-6-phosphate.
 (b) Fructose 1, 6-bisphosphate.
 (c) Pyruvic acid.
 (d) Acetyl Co-A.
109. A few drops of sap were collected by cutting across a plant stem by a suitable method. The sap was tested chemically. Which one of the following test results indicates that it is phloem sap ?
 (a) Acidic
 (b) Alkaline
 (c) Low refractive index
 (d) The absence of sugar
110. You are given a tissue with its potential for differentiation in an artificial culture. Which of the following pairs of hormones would you add to the medium to secure shoots as well as roots ?
 (a) IAA and gibberellin.
 (b) Auxin and cytokinin.
 (c) Auxin and abscisic acid.
 (d) Gibberellin and abscisic acid.
111. Phytochrome is a
 (a) flavoprotein. (b) glycoprotein.
 (c) lipoprotein. (d) chromoprotein.
112. Which is essential for the growth of root tip ?
 (a) Zn (b) Fe
 (c) Ca (d) Mn
113. The process which makes major difference between C₃ and C₄ plants is
 (a) glycolysis. (b) Calvin cycle.
 (c) photorespiration. (d) respiration.
114. Which one of the following statements is not correct?
 (a) Offspring produced by the asexual reproduction are called clone.
 (b) Microscopic, motile asexual reproductive structures are called zoospores.
 (c) In potato, banana and ginger, the plantlets arise from the internodes present in the modified stem.
 (d) Water hyacinth, growing in the standing water, drains oxygen from water that leads to the death of fishes.
115. Which one of the following generates new genetic combinations leading to variation ?
 (a) Vegetative reproduction
 (b) Parthenogenesis
 (c) Sexual reproduction
 (d) Nucellar polyembryony
116. Match column I with column II and select the correct option using the codes given below
- | Column I | | Column II | |
|----------|------------------------------|-----------|---------------|
| A. | Pistils fused together | 1. | Gametogenesis |
| B. | Formation of gametes | 2. | Pistillate |
| C. | Hyphae of higher ascomycetes | 3. | Syncarpous |
| D. | Unisexual female flower | 4. | Dikaryotic |
- Codes
- | | | | | |
|-----|---|---|---|---|
| | A | B | C | D |
| (a) | 4 | 3 | 2 | 1 |
| (b) | 2 | 1 | 4 | 3 |
| (c) | 1 | 2 | 4 | 3 |
| (d) | 3 | 1 | 4 | 2 |
117. In majority of angiosperms
 (a) egg has a filiform apparatus.
 (b) there are numerous antipodal cells.

- (c) reduction division occurs in the megaspore mother cells.
(d) a small central cell is present in the embryo sac.
118. Pollination in water hyacinth and water lily is brought about by the agency of
(a) water. (b) insects or wind.
(c) birds. (d) bats.
119. The ovule of an angiosperm is technically equivalent to
(a) megasporangium.
(b) megasporophyll.
(c) megaspore mother cell.
(d) megaspore.
120. Taylor conducted the experiments to prove semi-conservative mode of chromosome replication on
(a) *Vinca rosea*.
(b) *Vicia faba*.
(c) *Drosophila melanogaster*.
(d) *E. coil*.
121. The mechanism that causes a gene to move from one linkage group to another is called
(a) inversion. (b) duplication.
(c) translocation. (d) crossing-over.
122. The equivalent of a structural gene is
(a) muton. (b) cistron. (c) operon. (d) recon.
123. A true breeding plant is
(a) one that is able to breed on its own.
(b) produced due to cross-pollination among unrelated plants.
(c) near homozygous and produces offspring of its own kind.
(d) always homozygous recessive in its genetic constitution.
124. Which of the following *rRNAs* act as structural RNA as well as ribozyme in bacteria ?
(a) 5 *srRNA* (b) 18 *srRNA*
(c) 23 *srRNA* (d) 5-8 *srRNA*
125. Stirred-tank bioreactors have been designed for
(a) purification of product.
(b) addition of preservatives to the product.
(c) availability of oxygen throughout the process.
(d) ensuring anaerobic conditions in the culture vessel.
126. A foreign DNA and plasmid cut by the same restriction endonuclease can be joined to form a recombinant plasmid using
(a) *Eco* RI. (b) *taq* polymerase.
(c) polymerase III. (d) ligase.
127. Which of the following is not a component of downstream processing ?
(a) Separation (b) Purification
(c) Preservation (d) Expression
128. Which of the following restriction enzymes produces blunt ends ?
(a) *Sal* I (b) *Eco* RV (c) *Xho* (d) *Hind* III
129. Which kind of therapy was given in 1990 to a four-year-old girl with Adenosine Deaminase (ADA) deficiency ?
(a) Gene therapy (b) Chemotherapy
(c) Immunotherapy (d) Radiation therapy
130. How many hotspots of biodiversity in the world have been identified till date by Norman Myers ?
(a) 17 (b) 25 (c) 34 (d) 43
131. The primary producers of the deep-sea hydrothermal vent ecosystem are
(a) green algae.
(b) chemosynthetic bacteria.
(c) blue-green algae.
(d) coral reefs.
132. Which of the following is correct for *r*-selected species?
(a) Large number of progeny with small size.
(b) Large number of progeny with large size.
(c) Small number of progeny with small size.
(d) Small number of progeny with large size.
133. If '+' sign is assigned to beneficial interaction, '-' sign to detrimental and '0' sign to neutral interaction, then the population interaction represented by '+''-' refers to
(a) mutualism. (b) amensalism.
(c) commensalism. (d) parasitism.
134. Which of the following is correctly matched ?
(a) Aerenchyma — *Opuntia*
(b) Age pyramid — Biome
(c) *Parthenium hysterophorus* — Threat to biodiversity
(d) Stratification — Population
135. Red List contains data or information on
(a) all economically important plants.
(b) plants whose products are in international trade.
(c) threatened species.
(d) marine vertebrates only.
136. Which of the following sets of diseases is caused by bacteria ?
(a) Cholera and tetanus (b) Typhoid and smallpox
(c) Tetanus and mumps (d) Herpes and influenza
137. Match column I with column II for housefly classification and select the correct option using the codes given below
- | Column I | | Column II | |
|----------|--------|-----------|------------|
| A. | Family | 1. | Diptera |
| B. | Order | 2. | Arthropoda |
| C. | Class | 3. | Muscidae |
| D. | Phylum | 4. | Insecta |
- Codes**
- | | | | | |
|-----|---|---|---|---|
| | A | B | C | D |
| (a) | 3 | 1 | 4 | 2 |
| (b) | 3 | 2 | 4 | 1 |
| (c) | 4 | 3 | 2 | 1 |
| (d) | 4 | 2 | 1 | 3 |
138. Choose the correct statement.
(a) All mammals are viviparous.
(b) All cyclostomes do not possess jaws and paired fins.
(c) All reptiles have a three-chambered heart.
(d) All Pisces have gills covered by an operculum.
139. Study the four statements (I-IV) given below and select the two correct ones out of them.
I. Definition of biological species was given by Ernst Mayr.

II. Photoperiod does not affect reproduction in plants.
 III. Binomial nomenclature system was given by RH Whittaker.

IV. In unicellular organisms, reproduction is synonymous with growth.

The two correct statements are

- (a) II and III (b) III and IV
 (c) I and IV (d) I and II

140. In male cockroaches, sperms are stored in which part of the reproductive system ? **Out of Syllabus**

- (a) Seminal vesicles (b) Mushroom glands
 (c) Testes (d) Vas deferens

141. Smooth muscles are

- (a) involuntary, fusiform, non-striated
 (b) voluntary, multinucleate, cylindrical
 (c) involuntary, cylindrical, striated
 (d) voluntary, spindle-shaped, uninucleate

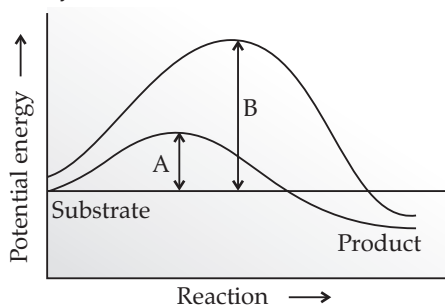
142. Oxidative phosphorylation is

- (a) formation of ATP by transfer of phosphate group from a substrate to ADP.
 (b) oxidation of phosphate group in ATP.
 (c) addition of phosphate group to ATP.
 (d) formation of ATP by energy released from electron removed during substrate oxidation.

143. Which of the following is the least likely to be involved in stabilising the three-dimensional folding of most proteins ?

- (a) Hydrogen bonds
 (b) Electrostatic interaction
 (c) Hydrophobic interaction
 (d) Ester bonds

144. Which of the following describes the given graph correctly ?



- (a) Endothermic reaction with energy A in the presence of enzyme and B in the absence of enzyme.
 (b) Exothermic reaction with energy A in the presence of enzyme and B in the absence of enzyme.
 (c) Endothermic reaction with energy A in the absence of enzyme and B in the presence enzyme.
 (d) Exothermic reaction with energy A in the absence of enzyme and B in the presence of enzyme.

145. When cell has stalled DNA replication fork, which checkpoint should be predominantly activated ?

- (a) $\frac{G_1}{S}$ (b) $\frac{G_2}{M}$
 (c) M (d) Both $\frac{G_2}{M}$ and M

146. Match the stages of meiosis in column I to their characteristic features in column II and select the correct option using the codes given below

Column I		Column II	
A.	Pachytene	1.	Pairing of homologous chromosomes
B.	Metaphase-I	2.	Terminalisation of chiasmata
C.	Diakinesis	3.	Crossing-over takes place
D.	Zygotene	4.	Chromosomes align at equatorial plate

Codes

- | | A | B | C | D |
|-----|---|---|---|---|
| (a) | 3 | 4 | 2 | 1 |
| (b) | 1 | 4 | 2 | 3 |
| (c) | 2 | 4 | 3 | 1 |
| (d) | 4 | 3 | 2 | 1 |

147. Which hormones do stimulate the production of pancreatic juice and bicarbonate ?

- (a) Angiotensin and epinephrine
 (b) Gastrin and insulin
 (c) Cholecystokinin and secretin
 (d) Insulin and glucagon

148. The partial pressure of oxygen in the alveoli of the lungs is

- (a) equal to that in the blood.
 (b) more than that in the blood.
 (c) less than that in the blood.
 (d) less than that of carbon dioxide.

149. Choose the correct statement. **Out of Syllabus**

- (a) Nociceptors respond to changes in pressure.
 (b) Meissner's corpuscles are thermo-receptors.
 (c) Photoreceptors in the human eye are depolarised during darkness and become hyperpolarised in response to the light stimulus.
 (d) Receptors do not produce graded potentials.

150. Grave's disease is caused due to **Out of Syllabus**

- (a) hyposecretion of thyroid gland.
 (b) hypersecretion of thyroid gland.
 (c) hyposecretion of adrenal gland.
 (d) hypersecretion of adrenal gland.

151. Name the ion responsible for unmasking of active sites for myosin for cross-bridge activity during muscle contraction.

- (a) Calcium (b) Magnesium
 (c) Sodium (d) Potassium

152. Name the blood cells, whose reduction in number can cause clotting disorder, leading to excessive loss of blood from the body.

- (a) Erythrocytes (b) Leucocytes
 (c) Neutrophils (d) Thrombocytes

153. Name a peptide hormone which acts mainly on hepatocytes, adipocytes and enhances cellular glucose uptake and utilisation.

- (a) Insulin (b) Glucagon
 (c) Secretin (d) Gastrin

154. Osteoporosis, an age-related disease of skeletal system, may occur due to
 (a) immune disorder affecting neuromuscular junction leading to fatigue.
 (b) high concentration of Ca^{++} and Na^+ .
 (c) decreased level of oestrogen.
 (d) accumulation of uric acid leading to inflammation of joints.
155. Serum differs from blood in
 (a) lacking globulins.
 (b) lacking albumins.
 (c) lacking clotting factors.
 (d) lacking antibodies.
156. Lungs do not collapse between breaths and some air always remains in the lungs which can never be expelled because
 (a) there is a negative pressure in the lungs.
 (b) there is a negative intrapleural pressure pulling at the lung walls.
 (c) there is a positive intrapleural pressure.
 (d) pressure in the lungs is higher than the atmospheric pressure.
157. The posterior pituitary gland is not a 'true' endocrine gland because
 (a) it is provided with a duct.
 (b) it only stores and releases hormones.
 (c) it is under the regulation of hypothal-amus.
 (d) it secretes enzymes.
158. The part of nephron involved in active reabsorption of sodium is
 (a) distal convoluted tubule.
 (b) proximal convoluted tubule.
 (c) Bowman's capsule.
 (d) descending limb of Henle's loop.
159. Which of the following is hormone-releasing IUD ?
 (a) LNG-20 (b) Multiload-375
 (c) Lippes loop (d) Cu-7
160. Which of the following is incorrect regarding vasectomy ?
 (a) No sperm occurs in seminal fluid.
 (b) No sperm occurs in epididymis.
 (c) Vasa deferentia is cut and tied.
 (d) Irreversible sterility.
161. Embryo with more than 16 blastomeres formed due to *in vitro* fertilisation is transferred into
 (a) uterus. (b) fallopian tube.
 (c) fimbriae. (d) cervix.
162. Which of the following depicts the correct pathway of transport of sperms ?
 (a) Rete testis → Efferent ductules → Epididymis → Vas deferens
 (b) Rete testis → Epididymis → Efferent ductules → Vas deferens
 (c) Rete testis → Vas deferens → Efferent ductules → Epididymis
 (d) Efferent ductules → Rete testis → Vas deferens → Epididymis
163. Match column I with column II and select the correct option using the codes given below
- | Column I | | Column II | |
|----------|---------------|-----------|---------------------------|
| A. | Mons pubis | 1. | Embryo formation |
| B. | Antrum | 2. | Sperm |
| C. | Trophectoderm | 3. | Female external genitalia |
| D. | Nebenkern | 4. | Graafian follicle |
- Codes**
- | | | | | |
|-----|---|---|---|---|
| | A | B | C | D |
| (a) | 3 | 4 | 2 | 1 |
| (b) | 3 | 4 | 1 | 2 |
| (c) | 3 | 1 | 4 | 2 |
| (d) | 1 | 4 | 3 | 2 |
164. Several hormones like hGG, hPL, oestrogen, progesterone are produced by
 (a) ovary. (b) placenta.
 (c) fallopian tube. (d) pituitary.
165. If a colourblind man marries a woman who is homozygous for normal colour vision, the probability of their son being colourblind is
 (a) 0 (b) 0.5 (c) 0.75 (d) 1
166. Genetic drift operates in
 (a) small isolated population.
 (b) large isolated population.
 (c) non-reproductive population.
 (d) slow reproductive population.
167. In Hardy-Weinberg equation, the frequency of heterozygous individual is represented by
 (a) p^2 (b) $2pq$ (c) pq (d) q^2
168. The chronological order of human evolution from early to the recent is
 (a) *Australopithecus* → *Ramapithecus* → *Homo habilis* → *Homo erectus*
 (b) *Ramapithecus* → *Australopithecus* → *Homo habilis* → *Homo erectus*
 (c) *Ramapithecus* → *Homo habilis* → *Australopithecus* → *Homo erectus*
 (d) *Australopithecus* → *Homo habilis* → *Ramapithecus* → *Homo erectus*
169. Which of the following is the correct sequence of events in the origin of life ?
 I. Formation of protobionts.
 II. Synthesis of organic monomers.
 III. Synthesis of organic polymers.
 IV. Formation of DNA-based genetic systems.
 (a) I, II, III, IV (b) I, III, II, IV
 (c) II, III, I, IV (d) II, III, IV, I
170. A molecule that can act as a genetic material must fulfil the traits given below, except
 (a) it should be able to express itself in the form of 'Mendelian characters'.
 (b) it should be able to generate its replica.
 (c) it should be unstable structurally and chemically.
 (d) it should provide the scope for slow changes that are required for evolution.

171. DNA-dependent RNA polymerase catalyses transcription on one strand of the DNA which is called the
 (a) template strand. (b) coding strand.
 (c) alpha strand. (d) anti strand.
172. Interspecific hybridisation is the mating of
 (a) animals within same breed without having common ancestors.
 (b) two different related species.
 (c) superior males and females of different breeds.
 (d) more closely related individuals within same breed for 4-6 generations.
173. Which of the following is correct regarding AIDS causative agent HIV ?
 (a) HIV is enveloped virus containing one molecule of single-stranded RNA and one molecule of reverse transcriptase.
 (b) HIV is enveloped virus that contains two identical molecules of single-stranded RNA and two molecules of reverse transcriptase.
 (c) HIV is unenveloped retrovirus.
 (d) HIV does not escape but attacks the acquired immune response.
174. Among the following edible fishes, which one is marine fish having rich source of omega-3 fatty acids?

(a) *Mystus* (b) *Mangur* (c) *Mrigala* (d) *Mackerel*

175. Match column I with column II and select the correct option using the codes given below

Column I		Column II	
A.	Citric acid	1.	<i>Trichoderma</i>
B.	Cyclosporin	2.	<i>Clostridium</i>
C.	Statins	3.	<i>Aspergillus</i>
D.	Butyric acid	4.	<i>Monascus</i>

Codes

	A	B	C	D
(a)	3	1	2	4
(b)	3	1	4	2
(c)	1	4	2	3
(d)	3	4	1	2

176. Biochemical Oxygen Demand (BOD) may not be a good index for pollution in water bodies receiving effluents from
 (a) domestic sewage. (b) dairy industry.
 (c) petroleum industry. (d) sugar industry.
177. The principle of competitive exclusion was stated by
 (a) C Darwin. (b) GF Gause.
 (c) Mac Arthur. (d) Verhulst and Pearl.
178. Which of the following National Parks is home to the famous musk deer or hangul ?
 (a) Keibul Lamjao National Park, Manipur.
 (b) Bandhavgarh National Park, Madhya Pradesh.
 (c) Eaglenest Wildlife Sancturay, Arunachal Pradesh.
 (d) Dachigam National Park, Jammu and Kashmir.
179. A lake which is rich in organic waste may result in
 (a) increased population of aquatic organisms due to minerals.
 (b) drying of the lake due to algal bloom.
 (c) increased population of fish due to lots of nutrients.
 (d) mortality of fish due to lack of oxygen.
180. The highest DDT concentration in aquatic food chain shall occur in
 (a) phytoplankton. (b) seagull.
 (c) crab. (d) eel.

Booklet	Batch	RollNumber
<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
(A) 10+1 (S)		0 0 0 0 0 0 0 0 0 0
(B) 10-2 (V)		1 1 1 1 1 1 1 1 1 1
(C) 10-3 (A)		2 2 2 2 2 2 2 2 2 2
(D) Crash (C)		3 3 3 3 3 3 3 3 3 3
(E)		4 4 4 4 4 4 4 4 4 4
(F) Paper		5 5 5 5 5 5 5 5 5 5
(G)	<input type="checkbox"/>	6 6 6 6 6 6 6 6 6 6
(H) Paper 1 (1)		7 7 7 7 7 7 7 7 7 7
(I) Paper 2 (2)		8 8 8 8 8 8 8 8 8 8
(J)		9 9 9 9 9 9 9 9 9 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 circles completely and dark enough for proper detection. Use ballpen (black or blue) for marking.

Avoid Improper Marking

Partially Filled

Lightly Filled

Test Center Code

0 0

1 1

2 2

3 3

4 4

5 5

6 6

7 7

8 8

9 9

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



SOLVED PAPER 2016 (Phase II)

ANSWERS WITH EXPLANATIONS

PHYSICS

1. Option (a) is correct.

$$\text{Let } [L] = [h]^a [c]^b [G]^c$$

$$[L] = [M^1L^2T^{-1}]^a [LT^{-1}]^b [M^{-1}L^3T^{-2}]^c$$

$$\text{Solving, } a = \frac{1}{2}, c = \frac{1}{2}, b = -\frac{3}{2}$$

$$\text{Hence, } L = \sqrt{\frac{hG}{3c^2}}$$

2. Option (d) is correct.

Given,

Two Cars P and Q starts from the same point.

$$\text{Position of Car P, } x_P(t) = at + bt^2$$

$$\text{Position of Car Q, } x_Q(t) = ft - t^2$$

We know, velocity

$$dv = \frac{dx}{dt}$$

$$\text{So, velocity of Car P } \frac{dx_P(t)}{dt} = a + 2bt \quad \dots(i)$$

$$\text{Velocity of Car Q } \frac{dx_Q(t)}{dt} = f - 2t \quad \dots(ii)$$

Velocity of Car P and Car Q

$$\frac{dx_P(t)}{dt} = \frac{dx_Q(t)}{dt}$$

$$\Rightarrow a + 2bt = f - 2t$$

$$\Rightarrow 2bt + 2t = f - a$$

$$\Rightarrow t(2b + 2) = f - a$$

$$\Rightarrow t = \frac{f - a}{2(b + 1)}$$

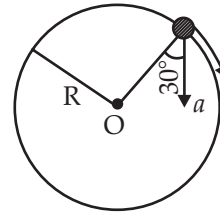
$$\Rightarrow t = \frac{f - a}{2(1 + b)}$$

Hence, at $t = \frac{f - a}{2(1 + b)}$ velocity of car P and Car Q

will be same.

3. Option (c) is correct.

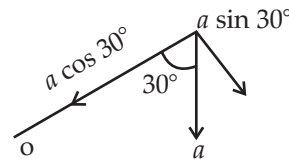
Given,



$$\text{Total acceleration (a) = } 15 \text{ m/s}^2$$

$$\text{Radius of the circle (R) = } 2.5 \text{ m}$$

The speed of the particle (v) = ?



$$\theta = 30^\circ$$

We know that, if any object is moving on circular path then it will have a centripetal acceleration towards the center of the circular path.

$$\text{Centripetal acceleration (} a_c \text{)} = \frac{V^2}{R}$$

But, as per the component of acceleration, $a \cos 30^\circ$ is along to the center of the circle. So, as per the definition of centripetal acceleration.

$$a \cos 30^\circ = \frac{V^2}{R}$$

\Rightarrow Now substituting the value

$$15 \cos 30^\circ = \frac{V^2}{2.5}$$

$$\Rightarrow V^2 = 2.5 \times 15 \times \frac{\sqrt{3}}{2}$$

$$\Rightarrow V = \sqrt{2.5 \times 15 \times \frac{\sqrt{3}}{2}}$$

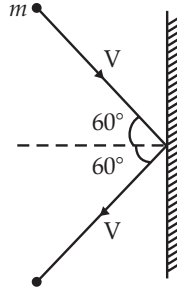
$$V = \sqrt{\frac{64.95}{2}} \text{ m/s}$$

$$\Rightarrow V = \sqrt{32.41} \text{ m/s}$$

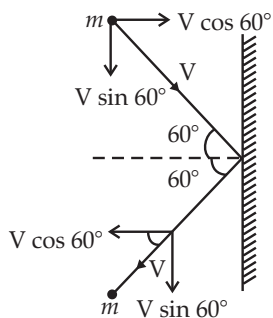
$$\Rightarrow V = 5.7 \text{ m/s}$$

4. Option (c) is correct.

On redrawing the figure



We have



Hence we can write velocity components as :

$$\Delta V = V_f - V_i$$

$$\Delta V = (-V \cos 60^\circ \hat{i} - V \sin 60^\circ \hat{j})$$

$$- (V \cos 60^\circ \hat{i} - V \sin 60^\circ \hat{j})$$

So $\Delta V = -2 V \cos 60^\circ \hat{i}$

Hence the Impulse

$$\begin{aligned} I &= m |\Delta V| \\ &= m (2V \cos 60^\circ) \\ &= mV \end{aligned}$$

5. Option (c) is correct.

It is observed that block rises through height h

$$\begin{aligned} v_1 &= \sqrt{2gh} \\ &= \sqrt{2 \times 10 \times 0.1} \\ &= \sqrt{2} = 1.4 \text{ m/s} \end{aligned}$$

Velocity of bullet after collision will be v .

Using law of conservation of Linear Momentum

or, $0.01 \times 400 = 2 \times 1.4 + 0.01 \times v$

Hence, velocity $v = 120 \text{ m/s}$

6. Option (c) is correct.

From the question, as both bodies are similar and collision is elastic, so velocities will be interchanged after the collision, hence

$$v_A = -0.3 \text{ m/s}$$

$$v_B = 0.5 \text{ m/s}$$

7. Option (c) is correct.

If $\vec{r}_1 = (-2\hat{i} + 5\hat{j})$

and $\vec{r}_2 = (4\hat{j} + 3\hat{k}),$

then $s = \vec{r}_2 - \vec{r}_1$

$$= (4\hat{j} + 3\hat{k}) - (-2\hat{i} + 5\hat{j})$$

$$= 2\hat{i} - \hat{j} + 3\hat{k}$$

Since we are given with force $\vec{F} = 4\hat{i} + 3\hat{j}$, so work done will be :

$$\begin{aligned} W &= \vec{F} \cdot \vec{s} \\ &= (4\hat{i} + 3\hat{j}) \cdot (2\hat{i} - \hat{j} + 3\hat{k}) \\ &= 8 - 3 = 5 \text{ J} \end{aligned}$$

8. Option (c) is correct.

It is known that rotational kinetic energy is given as :

$$\begin{aligned} E &= I \omega^2 / 2 \\ &= L^2 / 2I \end{aligned}$$

Hence, $L^2 \propto I$

Further, $E_A = E_B$

Also, $L_A^2 / 2I_A = L_B^2 / 2I_B$

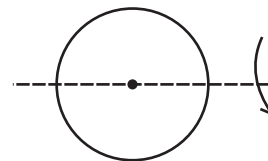
$$I_B > I_A$$

$$L_B > L_A$$

9. Option (b) is correct.

Given,

Mass of solid sphere = M



Radius of solid sphere = R

Let sphere is rotating about the diameter with ω angular speed

Then kinetic energy of rotation (E_1) = $\frac{1}{2} I \omega^2$

Where I is moment of inertia of solid sphere about diameter.

So, kinetic energy of rotation of solid sphere

$$E_1 = \frac{1}{2} \left(\frac{2}{5} MR^2 \right) \omega^2 \quad \dots(i)$$

Now, a cylinder is rotating with 2ω angular speed, which have the same mass and radius as of sphere, Hence rotational

Kinetic energy (E_2) = $\frac{1}{2} I_2 \omega^2$

$$= \frac{1}{2} \left(\frac{1}{2} MR^2 \right) (2\omega)^2$$

$$\left(I_1 = \frac{MR^2}{2} \right)$$

$$\Rightarrow E_2 = \frac{1}{2} \left(\frac{1}{2} MR^2 \right) 4\omega^2$$

$$\Rightarrow E_2 = \frac{1}{4} MR^2 \times 4\omega^2$$

$$\Rightarrow E_2 = MR^2\omega^2 \quad \dots(ii)$$

From equation (i) and (ii)

$$\frac{E_1}{E_2} = \frac{\frac{1}{2} \times \frac{2}{5} MR^2 \omega^2}{MR^2 \omega^2}$$

$$\Rightarrow \frac{E_1}{E_2} = \frac{1}{5}$$

Hence, the required ratio will be 1 : 5

10. Option (a) is correct.

Now,

$$x_1 = m_2 l / (m_1 + m_2)$$

$$x_2 = m_1 l / (m_1 + m_2)$$

$$I = m_1 x_1^2 + m_2 x_2^2$$

$$I = \frac{m_1 m_2}{m_1 + m_2} l^2$$

11. Option (b) is correct.

Since, acceleration due to gravity is given as

$$g = \begin{cases} \frac{4}{3} \pi \rho Gr, & r \leq R \\ \frac{4}{3} \pi \rho G \frac{R^3}{r^2}, & r > R \end{cases}$$

12. Option (b) is correct.

Total mechanical energy of satellite is given by

$$E = -GMm/2r$$

Here, $r = R + h$

And, $GM = g_0 R^2$

So, $E = -mg_0 R^2 / 2(R+h)$

13. Option (b) is correct.

As there are two film surfaces, so increase in surface area

$$= (20 \text{ cm}^2 - 8 \text{ cm}^2) \times 2$$

$$= 12 \times 2 \text{ cm}^2$$

$$= 24 \text{ cm}^2$$

Now work done = TΔS

$$3 \times 10^{-4} = T \times 24 \times 10^{-4}$$

$$\text{or, } T = \frac{3}{24} = 0.125 \text{ N/m}$$

14. Option (b) is correct.

Since,

$$h = 2 \times T \cos \theta / \rho g$$

As $r \propto \cos \theta$ since T, h and ρ being constants, so

$$\rho \uparrow \Rightarrow \theta \downarrow$$

$$\theta_1 < \theta_2 < \theta_3$$

$$[\text{as } \rho_1 > \rho_2 > \rho_3]$$

It shows $0 \leq \theta_1 < \theta_2 < \theta_3 < \pi/2$

15. Option (b) is correct.

If the final common temperature is T_c , C_c and C_h average heat capacities of cold and hot bodies then as per principle of calorimetry,

heat lost = heat gained

$$C_h (100^\circ\text{C} - T_c) = C_c \times T_c$$

$$\text{Now } T_c = C_h / (C_h + C_c) \times 100^\circ\text{C}$$

$$= 100 / [1 + (C_c/C_h)],$$

where $C_c/C_h < 1$

It is seen that $1 + C_c/C_h < 2$

Hence, $T_c > (100/2)^\circ\text{C}$ or $T_c > 50^\circ\text{C}$

16. Out of Syllabus

17. Option (d) is correct.

Given,

Number of mole of mono-atomic gas = 1

$$PV^3 = \text{constant} (k) \quad \dots(i)$$

Heat capacity of the gas = ?

When gas expands, then work done by gas

$$W = - \int_{-V_i}^{V_f} P \cdot dV \quad \dots(ii)$$

Now, from equation (i)

$$P = \frac{k}{V^3}$$

Substituting the values in equation (ii)

$$W = - \int_{V_i}^{V_f} \frac{k}{V^3} dV$$

$$\Rightarrow W = - \int_{V_i}^{V_f} k V^{-3} dV$$

$$\Rightarrow W = -k \int_{V_i}^{V_f} V^{-3} dV$$

$$\Rightarrow W = + \frac{k}{2} [V^{-2}]_{V_i}^{V_f}$$

$$\Rightarrow W = \frac{k}{2} \left[\frac{1}{V_f^2} - \frac{1}{V_i^2} \right]$$

\Rightarrow Now again $k = PV^3$

$$\Rightarrow W = \frac{1}{2} \left[\frac{PV_f^3}{V_f^2} - \frac{PV_i^3}{V_i^2} \right]$$

$$\Rightarrow W = \frac{1}{2} [PV_f - PV_i]$$

$$\Rightarrow W = \frac{P}{2} (V_f - V_i)$$

$$\Rightarrow W = \frac{1}{2} P\Delta V$$

$$(\because \Delta V = V_f - V_i)$$

But from ideal gas equation

$$P\Delta V = nR\Delta T$$

So,
$$W = \frac{1}{2} nR\Delta T$$

From the first law of thermodynamics

$$\Delta U = \Delta W + \Delta Q$$

$$\Rightarrow \Delta Q = \Delta U - \Delta W$$

$$\Rightarrow \Delta Q = \frac{3}{2} nR\Delta T - \frac{1}{2} nR\Delta T$$

$$(\because \text{for mono atomic gas } \gamma = \frac{3}{2})$$

$$\Rightarrow \Delta Q = \frac{2}{2} nR\Delta T$$

$$\Rightarrow \Delta Q = nR\Delta T$$

but $Q = nC_p \Delta T$

So $nC_p \Delta T = nR\Delta T$

$$\Rightarrow C_p = R$$

Shortcut Method:

$$PV^3 = \text{Constant}$$

Now $PV^\alpha = \text{Constant}$

So by comparing, $\alpha = 3$

but
$$C_p = C_v + \frac{R}{1-\alpha}$$

$$\Rightarrow C_p = \frac{3}{2}R + \frac{R}{1-3}$$

$$(\because C_v = \frac{3}{2}R \text{ for mono atomic gas})$$

$$\Rightarrow C_p = \frac{3}{2}R + \frac{R}{1-3}$$

$$\Rightarrow C_p = \frac{3}{2}R + \frac{R}{-2}$$

$$\Rightarrow C_p = \frac{3R}{2} - \frac{R}{2}$$

$$\Rightarrow C_p = \frac{2R}{2}$$

$$\Rightarrow C_p = R$$

18. Out of Syllabus

19. Option (b) is correct.

Given,

Volume of ideal gas = V

Pressure = P

Temperature = T

Mass of each molecule of gas = m

Density of gas = ?

From ideal gas equation

$$pV = nRT$$

$$\Rightarrow n = \frac{pV}{RT} \quad \dots(i)$$

but Density (ρ) = $\frac{\text{Mass (M)}}{\text{Volume (V)}}$

From equation (i)

$$\frac{n}{V} = \frac{p}{RT}$$

$$\Rightarrow \frac{n}{V} = \frac{p}{K_b N_A T} \quad \left(\because K_b = \frac{R}{N_A} \right)$$

$$\Rightarrow \frac{nN_A}{V} = \frac{p}{K_b T}$$

Now, multiplying by m in the equation

$$\frac{mnN_A}{V} = \frac{mp}{K_b T}$$

$$\Rightarrow \frac{mnN_A}{V} = \frac{mp}{K_b T}$$

$$\Rightarrow \rho = \frac{mp}{K_b T} \quad (\because mnN_A = M)$$

$$\left(\text{Density} = \frac{\text{Mass}}{\text{Volume}} \right)$$

Here (K_b) boltzman constant is represented as k.

So,
$$\rho = \frac{mp}{kT}$$

20. Option (d) is correct.

The time period of oscillation is given by

$$T = 2\pi \sqrt{m/k}$$

$$T_1 = 3 = 2\pi \sqrt{m/k}$$

$$T_2 = 5 = 2\pi \left(\frac{m+1}{k} \right)$$

On dividing :

$$3/5 = \sqrt{m/(m+1)}$$

$$9/25 = \sqrt{m/(m+1)}$$

$$9m + 9 = 25m$$

$$16m = 9$$

or

$$m = 9/16$$

21. Option (b) is correct.

On comparing the overtone of two pipes :

$$3V/2L_1 = 3V/4L$$

$$L_1 = 2L$$

22. Option (d) is correct. $(n-1)$ and $(n+1)$ suppose to form frequency n n and n will be at resonance $n-1$ and n produce 1 beat $n+1$ and n produce 1 beat

Number of beats formed are '2'

23. Option (b) is correct.Torque is given by $\tau = pE \sin \theta$

$$\tau = pE \sin \theta = qlE \sin \theta$$

or,

$$q = \tau / lE \sin \theta$$

$$= 4 / (2 \times 10^{-2} \times 0.5 \times 2$$

$$\times 10^5)$$

$$= 2 \text{ mC}$$

24. Option (c) is correct.From the given diagram, C_1, C_2, C_3 are connected in parallel. Further this group is connected in series with C_4 . Let C_{AB} be the equivalent capacitor of the system.

$$\text{Here, } C_1 = \frac{2\varepsilon_0 k_1 A}{3d}, C_2 = \frac{2k_2 \varepsilon_0 A}{3d}$$

$$C_3 = \frac{2\varepsilon_0 k_3 A}{3d}, C_4 = \frac{2\varepsilon_0 k_4 A}{d}$$

$$\text{So, } \frac{1}{C_{AB}} = \frac{1}{C_1 + C_2 + C_3} + \frac{1}{C_4}$$

$$\Rightarrow \frac{1}{k \left(\frac{\varepsilon_0 A}{d} \right)} = \frac{1}{\frac{2\varepsilon_0 A}{3d}} (k_1 + k_2 + k_3) + \frac{1}{\frac{2\varepsilon_0 A}{3d}} k_4$$

$$\frac{1}{k} = \frac{3}{2(k_1 + k_2 + k_3)} + \frac{1}{2k_4}$$

$$\text{or, } \frac{2}{k} = \frac{3}{(k_1 + k_2 + k_3)} + \frac{1}{k_4}$$

25. Option (d) is correct.

On applying KVL in the circuit, the potential difference between the two points can be obtained.

$$V_A - V_B = (2\Omega \times 2A) + 3V + (2A \times 1\Omega) \\ = 4V + 3V + 2V = 9V$$

26. Option (c) is correct.

Given,

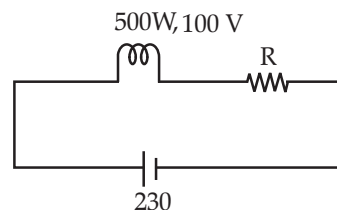
Rating on filament bulb 500 W and 100 V.

Main supply = 230 V

Resistance of the resistor, which is connected in series = R

Power consumption = 500 W

Value of resistor = ?

Let resistance of the bulb is R_1 

So, power consumption in the bulb

$$P = \frac{V^2}{R_1}$$

$$\Rightarrow 500 \text{ W} = \frac{(100)^2}{R_1}$$

$$\Rightarrow R_1 = \frac{100 \times 100}{500}$$

$$\Rightarrow R_1 = 20 \Omega$$

Now, as per the given condition in the question power consumption is 500 W, so current in the bulb

$$I = \frac{P}{V} \quad (\because P = V \cdot I)$$

$$I = \frac{500}{100} = 5 \text{ A}$$

Now, applying kirchoff voltage rule in a closed loop.

$$320 \text{ V} = 100 + V_1$$

$$\Rightarrow 230 \text{ V} = 100 + I \cdot R$$

(\because bulb and resistor are connected in series)

$$\Rightarrow 5 \cdot R = (230 - 100) \text{ V}$$

$$\Rightarrow R = \frac{130}{5} \Omega$$

$$\Rightarrow R = 26 \Omega$$

Hence, the value of R is 26 Ω .**27. Option (b) is correct.**For loop of radius r , magnetic field at the center of the loop is given by :

$$B = \mu_0 n I / 2r$$

Now magnetic field $B = \mu_0 I / 2r$;Here, $n = 1$ When making n number of turns, then radius becomes r'

$$n \times 2\pi r' = 2\pi r$$

$$\text{or, } r' = \frac{r}{n}$$

$$\begin{aligned} \text{Now } B' &= \mu_0 n I / 2r' \\ &= n^2 \times \mu_0 I / 2r \\ &= n^2 B \end{aligned}$$

28. Option (b) is correct.

Torque on magnet is given by $\tau = MB \sin \theta$

$$\text{Now, } W = MB (\cos \theta_1 - \cos \theta_2)$$

$$W = MB (\cos 0^\circ - \cos 60^\circ)$$

$$MB = 2 W$$

$$\tau = MB \sin \theta = 2 W \sin 60^\circ = \sqrt{3} W$$

29. Option (a) is correct.

Given :

$$B = 3.57 \times 10^{-2} \text{ T}$$

$$e/m = 1.76 \times 10^{11} \text{ C/kg}$$

Frequency of revolution of charge in magnetic field is given as $f = eB/2\pi m$

Putting values

$$= \frac{(1.76 \times 10^{11} \text{ C/kg}) \times 3.57 \times 10^{-2} \text{ T}}{(2 \times 3.14)}$$

$$= 10^9 \text{ Hz}$$

$$= 1 \text{ GHz}$$

30. Option (c) is correct.

In any LCR circuit, if selectivity of the circuit is high, then quality factor also will be high.

$$\text{So, } Q = \frac{\sqrt{L}}{R\sqrt{C}}$$

Now, substituting the value one by one and checking for each option.

$$(a) \quad Q_1 = \frac{\sqrt{15H}}{20\Omega\sqrt{35\mu F}}$$

$$\Rightarrow Q_1 = \frac{\sqrt{15}}{30\sqrt{35 \times 10^{-6}}}$$

$$\Rightarrow Q_1 = \frac{1}{20 \times 10^{-3}} \sqrt{\frac{15}{35}}$$

$$\Rightarrow Q_1 = 10.35$$

$$(b) \quad R = 25 \Omega, L = 2.5 \text{ H}, C = 45 \mu F$$

$$Q_2 = \frac{1}{25} \sqrt{\frac{2.5}{45 \times 10^{-6}}}$$

$$\Rightarrow Q_2 = \frac{1}{25 \times 10^{-3}} \sqrt{\frac{2.5}{45}}$$

$$\Rightarrow Q_2 = 9.43$$

$$(c) \quad R = 15 \Omega, L = 3.5 \text{ H}, C = 30 \mu F$$

$$Q_3 = \frac{1}{15} \sqrt{\frac{L}{C}}$$

$$\Rightarrow Q_3 = \frac{1}{15} \sqrt{\frac{3.5}{30 \times 10^{-6}}}$$

$$\Rightarrow Q_3 = \frac{1}{15 \times 10^{-3}} \sqrt{\frac{3.5}{30}}$$

$$\Rightarrow Q_3 = 22.77$$

$$(d) \quad R = 25 \Omega, L = 1.5 \text{ H}, C = 45 \mu C$$

$$Q_4 = \frac{1}{R} \sqrt{\frac{L}{C}}$$

$$\Rightarrow Q_4 = \frac{1}{25} \sqrt{\frac{1.5}{45 \times 10^{-6}}}$$

$$\Rightarrow Q_4 = \frac{1}{25 \times 10^{-3}} \sqrt{\frac{1.5}{45}}$$

$$\Rightarrow Q_4 = 7.30$$

So, from the above, we can conclude that

$$Q_3 > Q_1 > Q_2 > Q_4$$

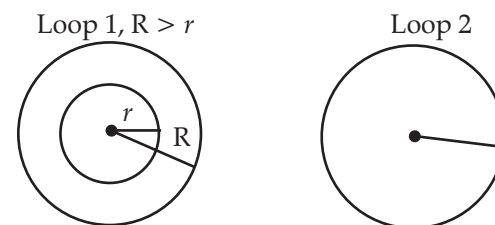
31. Option (d) is correct.

Given,

Radius of region = r

Uniform magnetic field = B

Change in magnetic field with respect to time = $\frac{dB}{dt}$


For loop 1

We know that,

$$\text{Induced emf } (e) = - \frac{d\phi}{dt}$$

$$\text{But } \phi = B \times A$$

$$\therefore e = -A \times \frac{dB}{dt}$$

$$e = -\pi r^2 \left(\frac{dB}{dt} \right)$$

For loop 2

As per the given condition in the question, loop 2 is outside to the magnetic region

Hence, no change in magnetic flux in loop 2

$$\frac{d\phi}{dt} = 0$$

Hence emf (e) = 0

32. Option (c) is correct.

Given,

Potential difference across the resistance (V_R) = 80 VPotential difference across the capacitance (V_C) = 40 VAnd Potential difference across the inductance (V_L) = 100 V

Power factor of the circuit = ?

$$\text{Power factor } \cos \phi = \frac{R}{Z}$$

$$\Rightarrow \cos \phi = \frac{IR}{IZ}$$

(Multiplying and dividing by I)

$$\Rightarrow \cos \phi = \frac{V_R}{\sqrt{I^2 R^2 + (I \times L - I \times C)^2}}$$

$$(\because V_C = I X_C, V_L = I X_L)$$

$$\Rightarrow \cos \phi = \frac{V_R}{\sqrt{V_R^2 + (V_L - V_C)^2}}$$

$$\Rightarrow \cos \phi = \frac{80}{\sqrt{80^2 + (100 - 40)^2}}$$

$$\Rightarrow \cos \phi = \frac{80}{\sqrt{6400 + 60^2}}$$

$$\Rightarrow \cos \phi = \frac{80}{\sqrt{6400 + 3600}}$$

$$\Rightarrow \cos \phi = \frac{80}{\sqrt{10,000}}$$

$$\Rightarrow \cos \phi = \frac{80}{100}$$

$$\Rightarrow \cos \phi = 0.8$$

33. Option (a) is correct.

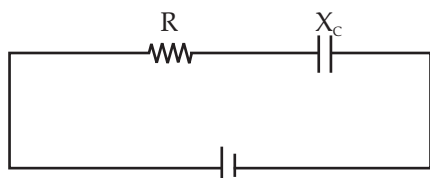
Given,

Resistance of the resistor (R) = 100 Ω Reactance of the capacitor (X_C) = 100 Ω Source potential (V) = 220 V

$$V_{\text{rms}} = V\sqrt{2} = 220\sqrt{2}$$

Capacitor was charged by 50%

Peak value of displacement current = ?



$$\text{Impedance } (Z) = \sqrt{R^2 + X_C^2}$$

$$\Rightarrow Z = \sqrt{100^2 + 100^2} \Omega$$

$$\Rightarrow Z = \sqrt{2 \times 100^2} \Omega$$

$$\Rightarrow Z = 100\sqrt{2} \Omega$$

Hence, the peak value of displacement current = Maximum conduction

$$\Rightarrow I = \frac{V_{\text{rms}}}{Z}$$

$$\Rightarrow I = \frac{220\sqrt{2}}{100\sqrt{2}}$$

$$\Rightarrow I = 2.2 \text{ A}$$

34. Option (d) is correct.

$$\text{Now } 1/f = (\mu_g - 1) \times 2/R$$

$$= 1/R, (\mu_g = 3/2), R = f$$

$$1/f_1 = -(\mu_w - 1) \times 2/R$$

$$= -2/3R = -2/3f$$

$$1/f_{\text{eq}} = 1/f + 1/f + 1/f_1$$

$$= 1/R + 1/R - 2/3R$$

$$1/f_{\text{eq}} = 1/f + 1/f - 2/3f$$

$$= 2/f - 2/3f = 4/3f$$

$$\text{so } f_{\text{eq}} = 3f/4$$

35. Option (c) is correct.

$$\text{Seeing from one end, } h_1 = \mu \times (h - b)$$

$$= 3/2 \times 5 = 15/2 \text{ cm}$$

$$\text{From other end of the slab, } h_2 = \mu \times h$$

$$= 3/2 \times 3 = 9/2 \text{ cm}$$

Now total height,

$$(15/2 + 9/2) = 24/2 = 12 \text{ cm}$$

36. Option (b) is correct.

Maximum Intensity is given as

$$I_{\text{max}} = (\sqrt{I_1} + \sqrt{I_2})^2$$

Minimum intensity is given as

$$I_{\text{min}} = (\sqrt{I_1} - \sqrt{I_2})^2$$

$$\text{Now } I_1 / I_2 = n$$

$$I_{\text{max}} = (\sqrt{I_1} + \sqrt{I_2})^2$$

$$= (\sqrt{n-1})^2 \times I_2$$

$$I_{\text{min}} = (\sqrt{I_1} - \sqrt{I_2})^2$$

$$= (\sqrt{n-1})^2 \times I_2$$

$$\text{Now, } (I_{\text{max}} - I_{\text{min}}) / (I_{\text{max}} + I_{\text{min}})$$

$$= \frac{2\sqrt{n}}{(n+1)}$$

37. **Out of Syllabus**38. **Option (d) is correct.**

$$\text{Phase difference } \theta = \lambda/a$$

$$\text{Path difference } a = 2\pi\Delta x$$

$$\text{Hence } \theta = \lambda/a = Y/f$$

$$\text{Now } Y = f\lambda/a$$

$$= \frac{5 \times 10^{-5} \times 10^{-2} \times 60 \times 10^{-2}}{2 \times 10^{-4}}$$

$$= 150 \times 10^{-5}$$

$$= 1.5 \times 10^{-3}$$

$$= 0.15 \text{ cm}$$

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

It is observed that energy is given by,

$$E = hv = hc/\lambda = p^2/2m$$

$$= \frac{(h/\lambda)^2}{2m} = \frac{h^2}{m\lambda^2}$$

For certain frequency, maximum wavelength that can be emitted is λ_0 which is cut off wavelength obtained at cut off frequency,

$$E_0 = hc/\lambda_0$$

$$\text{Since, } E = E_0$$

$$\frac{h^2}{2m\lambda^2} = \frac{hc}{\lambda_0}$$

$$\text{or, } \lambda_0 = \frac{2mc\lambda^2}{h}$$

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

Stopping potential is the voltage which is needed to stop energetic photo electron for reaching towards cathode.

Stopping potential,

$$\phi = E - K_{\max}$$

$$2 \text{ eV} = 5 \text{ eV} - \phi$$

$$\text{or } \phi = 3 \text{ eV}$$

$$\begin{aligned} \text{Now } eV_0 &= E' - \phi \\ &= 6 \text{ eV} - 3 \text{ eV} \\ &= 3 \text{ eV} \end{aligned}$$

Hence stopping potential is -3 V 41. **Option (c) is correct.**

We know that de Broglie wavelength is

$$\lambda = 1/R [1/n_L^2 - 1/n_H^2]$$

Using the equation data,

$$\lambda = 1/R [1/2^2 - 1/3^2] = \frac{36}{5R}$$

On jumping from 4th orbit to 3rd orbit,

$$\lambda' = 1/R [1/3^2 - 1/4^2] = \frac{16 \times 9}{7R}$$

Now corresponding wavelength of photon is

$$\lambda' = \lambda \times \frac{16 \times 9}{5R} \quad \text{or} \quad \lambda' = \frac{20\lambda}{7}$$

42. **Out of Syllabus**43. **Out of Syllabus**44. **Option (a) is correct.**Current will not flow through D_1 as it is reversed biased.Current will flow through resistor R_1 , diode D_2 and resistor R_3

$$\text{Now current } (i) = 10/(2 + 2) = 2.5 \text{ A}$$

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

Applying De Morgan's law :

$$\begin{aligned} \text{Output } Y &= [(A \cdot B) \cdot C]' \\ &= A' + B' + C' \end{aligned}$$

When A, B, C are 0

$$\Rightarrow Y = 1$$

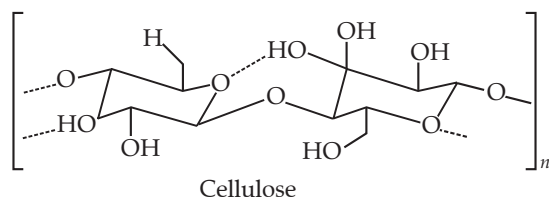
When A, B, C are 1

$$\Rightarrow Y = 0$$

CHEMISTRY

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

The hydrogen bond which is present on between two atoms of same molecule is known as intramolecular hydrogen bond. Here, cellulose have intramolecular hydrogen bond.

47. **Option (b) is correct.**

$$\text{Molar conductivity, } \lambda_m = \frac{\kappa \times 1000}{\text{Molarity}}$$

(where κ = Electrolytic conductivity)

$$= \frac{5.76 \times 10^{-3} \times 1000}{0.5} = 11.52 \text{ S cm}^2 \text{ mol}^{-1}$$

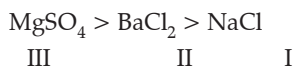
48. **Option (a) is correct.**

At low pressure, it is first order where rate is proportional to the surface coverage where as at high pressure it is zero order kinetics due to complete coverage of surface area.

49. Option (c) is correct.

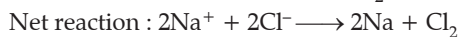
$$\text{Coagulating power} \propto \frac{1}{\text{Coagulating value}}$$

So, the correct order is :



50. Option (b) is correct.

The following reaction takes place to the corresponding electrodes of molten sodium chloride,



According to Faraday's second law of electrolysis

$$W = \frac{EIt}{F} = \frac{E \times I \times t}{96,500}$$

$$\Rightarrow 0.10 \times 71 = \frac{35.5 \times 3 \times t}{96500}$$

$$t = \frac{0.10 \times 71 \times 96500}{35.5 \times 3}$$

$$t = 6433.33 \text{ s}$$

$$t = \frac{6433.33}{60} \text{ min} = 107.22 \text{ min}$$

$$\approx 110 \text{ min}$$

51. Option (b) is correct.

For $n = 3$ and $l = 1$, the subshell is $3p$ and a particular $3p$ orbital can accommodate maximum number of six electrons.

52. Option (b) is correct.

For an ideal gas undergoing reversible expansion, the entropy is related with temperature and pressure as follows :

$$\Delta S = nC_p \ln \frac{T_f}{T_i} + nR \ln \frac{P_i}{P_f}$$

For an isothermal process, $T_i = T_f$,

$$\text{so, } \ln 1 = 0$$

$$\Delta S = nR \ln \left(\frac{P_i}{P_f} \right)$$

Where T_i = Initial temperature

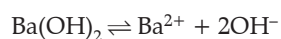
T_f = Final temperature

P_i = Initial pressure

P_f = Final pressure

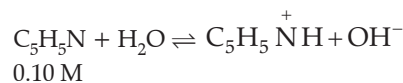
53. Option (d) is correct.

$\text{Ba}(\text{OH})_2$ being a strong electrolyte undergoes complete dissociation as follows:



Therefore, van't Hoff factor $i = 3$.

54. Option (b) is correct.



$$\alpha = \sqrt{\frac{K_b}{c}}$$

$$= \sqrt{\frac{1.7 \times 10^{-9}}{0.1}} = 1.30 \times 10^{-4} \times 100$$

$$= 0.013\%$$

55. Out of Syllabus

56. Option (a) is correct.

$$\Delta G^\circ = -nFE_{\text{cell}}^\circ$$

When $E_{\text{cell}}^\circ = -ve$ then $\Delta G^\circ = +ve$ i.e. ; $\Delta G^\circ > 0$

$$\Delta G^\circ = -nRT \log K_{eq}$$

For $\Delta G^\circ = +ve$, $K_{eq} = -ve$ i.e., $K_{eq} < 1$

57. Option (d) is correct.

For ideal solution,

$$\Delta H_{\text{mix}} = 0, \Delta V_{\text{mix}} = 0$$

Again we know that,

$$\Delta H_{\text{mix}} = \Delta U_{\text{mix}} - P\Delta V_{\text{mix}}$$

$$\Rightarrow \sigma = \Delta U_{\text{mix}} - P\Delta V_{\text{mix}}$$

$$\Rightarrow \Delta U_{\text{mix}} = 0$$

For an ideal solution,

$$P_A = P_A^0 X_A, P_B = P_B^0 X_B$$

$$\Delta P_A = P_{\text{observed}} - P_{\text{calculated}} = 0$$

From Gibb's free energy equation,

$$\Delta G_{\text{mix}} = \Delta H_{\text{mix}} - T\Delta S_{\text{mix}}$$

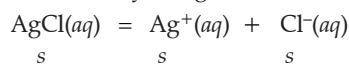
But for an ideal solution,

$$\Delta S_{\text{mix}} \neq 0$$

Hence, $\Delta G_{\text{mix}} \neq 0$

58. Option (b) is correct.

Let the solubility of AgCl be S mol L^{-1}



In presence of 0.1 M NaCl total concentration of Cl^- ions = $(s + 0.1)$

$$\therefore K_{sp} = [\text{Ag}^+][\text{Cl}^-]$$

$$\Rightarrow 1.6 \times 10^{-10} = s(s + 0.1)$$

$$\Rightarrow 1.6 \times 10^{-10} = s^2 + 0.1s \quad [\because s \ll 0.1 \text{ } s^2 \text{ is neglected here}]$$

$$\Rightarrow s = \frac{1.6 \times 10^{-10}}{0.1} = 1.6 \times 10^{-9} \text{ M}$$

59. Option (a) is correct.

Let the atomic weight of X and Y are x and y respectively.

For XY_2 ,

$$n = \frac{w}{\text{Mol. wt}}$$

$$0.1 = \frac{10}{x+2y} \quad \dots(i)$$

For X_3Y_2 ,

$$n = \frac{w}{\text{Mol. wt}}$$

$$0.05 = \frac{9}{3x+2y} \quad \dots(ii)$$

Equation (i) divide by (ii)

$$\frac{0.1}{0.05} = \frac{10}{x+2y} \times \frac{3x+2y}{9}$$

$$\Rightarrow \frac{10}{5} = \frac{10}{9} \times \left(\frac{3x+2y}{x+2y} \right)$$

$$\Rightarrow 15x + 10y = 9x + 18y$$

$$\Rightarrow 6x = 8y$$

$$\Rightarrow x = \frac{8y}{6} = \frac{4y}{3} \quad \dots(iii)$$

From (i)

$$0.1 = \frac{10}{\frac{4y}{3} + 2y}$$

$$\Rightarrow \frac{1}{10} = \frac{10}{\frac{4y+6y}{3}}$$

$$\Rightarrow \frac{1}{10 \times 10} = \frac{3}{10y}$$

$$\Rightarrow y = 30$$

$$\text{From (iii) we get } x = \frac{4 \times 30}{3} = 40$$

60. Option (c) is correct.

We know that,

$$Q = It \Rightarrow Q = 1 \times 60 \text{ C}$$

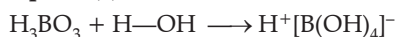
Again,

$$1.60 \times 10^{-19} \text{ C charges is carried by 1 electron}$$

\therefore 60 C charges is carried by

$$\begin{aligned} 60 \text{ C} &= \frac{60}{1.6 \times 10^{-19}} \text{ electrons} \\ &= 3.75 \times 10^{20} \text{ electrons} \end{aligned}$$

61. Option (c) is correct.



62. Option (b) is correct.

Anhydrous HF does not give F^- as HF molecules are bonded through hydrogen bonding. But in presence of KF AlF_3 is soluble due to formation of complex, $\text{K}_3[\text{AlF}_6]$.
 $\text{AlF}_3 + 3\text{KF} \longrightarrow \text{K}_3[\text{AlF}_6]$

63. Out of Syllabus

64. Out of Syllabus

65. Option (c) is correct.

We know that,

$$\text{Hybridisation (H)} = \frac{1}{2} [\text{Valence electrons} + \text{Monovalent atoms} - \text{cations} + \text{anions}]$$

$$\text{H}_{\text{NO}_2^+} = \frac{1}{2} [5 - 1] = 2 \rightarrow sp$$

$$\text{H}_{\text{NO}_3^-} = \frac{1}{2} [5 + 1] = 3 \rightarrow sp^2$$

$$\text{NH}_4^+ = \frac{1}{2} [5 + 4 - 1] = 4 \rightarrow sp^3$$

66. Option (b) is correct.

$\text{BF}_3 \rightarrow$ Lewis acid (incomplete octet)

$\text{PF}_3 \rightarrow$ Lewis base (presence of lone pair of electron on P atom)

$\text{CF}_4 \rightarrow$ Complete octet

$\text{SiF}_4 \rightarrow$ Lewis acid (Presence of empty d -orbital in Si atom)

67. Option (a, d) is correct.

$$\text{H}_{\text{CO}_3^-} = \frac{1}{2} [4 + 2] = 3 \rightarrow sp^2$$

Triangular Planar

$$\text{Total no. of electrons} = 6 + 3 \times 8 + 2 = 32$$

$$\text{H}_{\text{NO}_3} = \frac{1}{2} [5 + 1] = 3 \rightarrow sp^2$$

Triangular Planar

$$\text{Total no. of electrons} = 7 + 3 \times 8 + 1 = 32$$

$$\text{H}_{\text{ClO}_3} = \frac{1}{2} [7 + 1] = 4 \rightarrow sp^3$$

Lone pair of electrons = $4 - 3 = 1$

The radical have pyramidal shape.

$$\text{Total no. of electrons} = 17 + 3 \times 8 + 1 = 42$$

$$\text{H}_{\text{SO}_3^-} = \frac{1}{2} [6 + 2] = 4$$

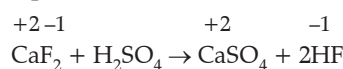
Lone pair of electrons = $4 - 3 = 1$

SO_3^{2-} have also pyramidal shape.

$$\text{Total no. of electrons} = 16 + 3 \times 8 + 2 = 42$$

68. Out of Syllabus

69. Option (d) is correct.



No change in oxidation number is observed, so, it is not a redox reaction.

70. Option (c) is correct.

In $d_{x^2-y^2}$ and d_{z^2} orbitals have electron density along the axes while in d_{xy} , d_{yz} , d_{zx} orbitals have electron density in between the axes.

71. Option (d) is correct.

$$\text{XeF}_4 : \text{H} = \frac{1}{2}[8 + 4] = 6 \rightarrow sp^3d^2$$

Lone pair of electron = 6 - 4 = 2

Hence the molecule is AB_4L_2 type so, it has square planar geometry.

72. Option (c) is correct.

$$\text{SeF}_4 : \text{H} = \frac{1}{2}[6 + 4] = 5 \rightarrow sp^3d$$

Lone pair of electrons = 5 - 4 = 1

Therefore it has see saw structure.

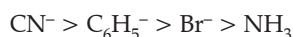
$$\text{CH}_4 : \text{H} = \frac{1}{2}[4 + 4] = 4 \rightarrow sp^3$$

Lone pair of electrons = 4 - 4 = 0

It has tetrahedral structure.

73. Option (b) is correct.

The intensity of the *trans*-effect (as measured) by the increase in rate of substitution of the *trans* ligand follows the sequence :



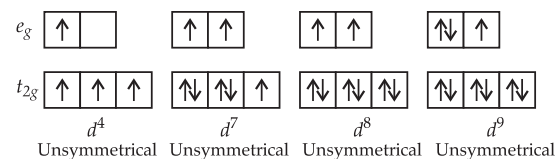
74. Option (c) is correct.

Like calcium, the Lanthanoid series of the first few members are quite reactive. But with the increasing of atomic number, their reactivity becomes similar to that of Aluminium.

75. Option (b) is correct.

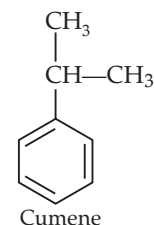
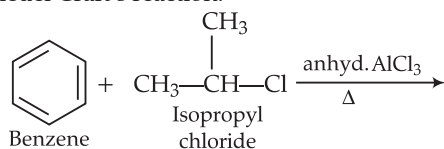
Jahn-Teller distortion is usually significant for asymmetrically occupied e_g orbitals since the ligands are approaches along the axes and the energy gain is considerably more.

In case of unevenly occupied t_{2g} orbitals, the Jahn-Teller distortion is very weak since, the t_{2g} set does not point directly to the approaching ligands and therefore the energy gain is much less.



76. Option (d) is correct.

In Chlorobenzene, bromobenzene or chloroethene the lone pair of electron of halogen is delocalized due to +M effect and having C—X bond double bond character. Formation of electrophile becomes difficult and this is why can not take part in Friedel Craft's reaction. But isopropyl chloride can easily takes part in Friedel Craft's reaction.



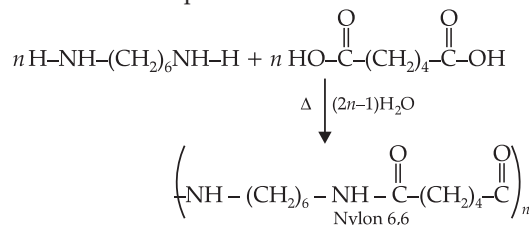
Cumene

77. Option (a) is correct.

Biphenyl is coplanar as all carbon atoms are sp^2 hybridised.

78. Option (d) is correct.

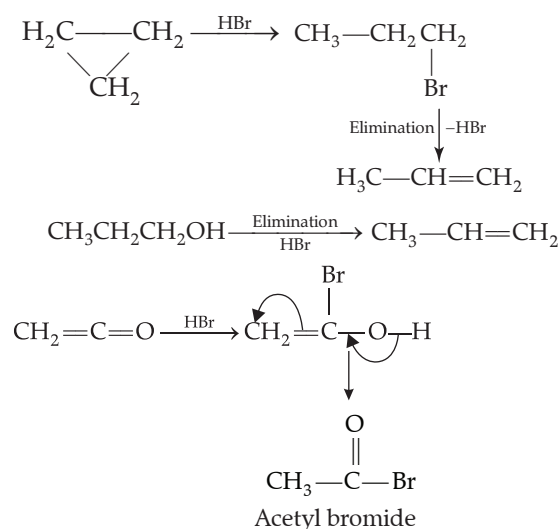
Nylon-6, 6 polymer is formed from hexamethylene diamine and adipic acid.



79. Option (d) is correct.

Pyrrrole has maximum electron density on 2 and 5. It generally reacts with electrophiles at the C-2 or C-5 due to the highest degree of stability of the protonated intermediate.

80. Option (c) is correct.



81. Option (c) is correct.

Tertiary nitroalkanes don't takes part in the reaction with nitrous acid due to absence of α -hydrogen.

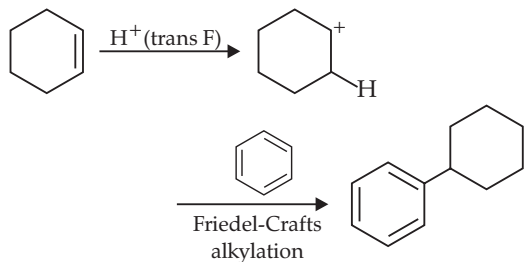
82. Option (c) is correct.



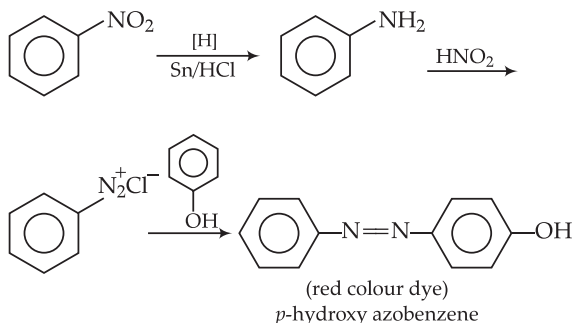
83. Option (d) is correct.

D-erythrose, D-threose, L-erythrose, L-threose

84. Option (c) is correct

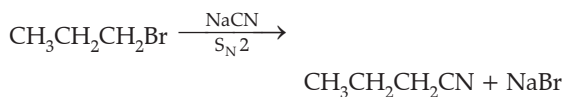


85. Option (b) is correct.

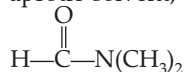


86. Option (c) is correct.

For the reaction,

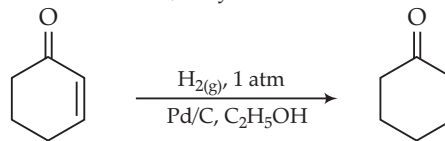


This reaction is possible in the presence of polar aprotic solvent, i.e., *N,N'*-dimethylformide (DMF),



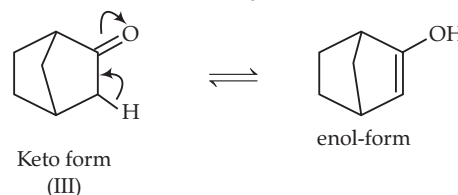
87. Option (b) is correct.

In presence of Pd/C, only C=C bond is reduced.



88. Option (a) is correct.

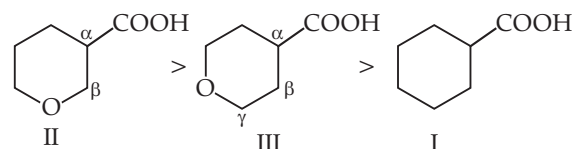
Bridge head α -hydrogen don't participate in tautomerism. Thus only (III) exhibits tautomerism



89. Option (b) is correct.

As we know that

Acidic strength $\propto -I$ effect



$-I$ effect decreases with increase of position of electronegative atom oxygen in carboxylic acids.

90. Option (a) is correct.

Alkenes reacts more readily with gaseous bromine. Out of $CH_3-CH=CH_2$ and $CH_2=CH_2$ the former one will react fast due to $+I$ effect of $-CH_3$ group favours attack of bromine.

BIOLOGY

91. Option (b) is correct.

Cell walls of fungi are made up of chitin and polysaccharides.

92. Option (b) is correct.

The bacteria belonging to Archaeobacteria such as halophiles, thermoacidophiles and methanogens are the ones living in the most harsh habitats.

93. Option (a) is correct.

The walls are embedded with silica and thus the walls are indestructible. Thus, diatoms have left behind large amount of cell wall deposits in their habitat; this accumulation over billions of years is referred to as 'diatomaceous earth'.

94. Option (d) is correct.

Herbarium is a space where plant specimens are collected, dried, pressed, and preserved on sheets. These sheets are arranged based on the system of classification which is accepted universally. It consists of information about date and place of collection, their names in english, local language, and botanical

names, family, collector's name. But it does not have the information about the height of the plant.

95. Option (c) is correct.

The leaves in gymnosperms are well adapted to withstand extremes of temperature, humidity and wind. The needle-like leaves reduce the surface area. Their thick cuticle and sunken stomata help to reduce water loss.

96. Option (b) is correct.

Certain marine brown and red algae produce large amounts of hydrocolloids (water holding substances), e.g., algin (brown algae) and carrageen (red algae) are used commercially.

97. Option (b) is correct.

When the stamens are united into more than two bundles, it is known as polyadelphous.

98. Option (b) is correct.

Androecium is diadelphous in the family Fabaceae. The plants belonging to this family are *Indigofera*, *Sesbania*, groundnut and gram.

99. Option (a) is correct.

Radial symmetry is found in the flowers of *Brassica*. When from any vertical plane, flower is divided into two equal halves, then the symmetry is known as radial. Whereas, other flowers mentioned in the options, i.e., *Trifolium*, *Pisum* and *Cassia* shows bilateral symmetry. It is the symmetry in which flower is divided into two equal halves through a single vertical plane.

100. Option (a) is correct.

Free-central placentation is found in *Dianthus*. In this type of placentation, ovules are borne on central axis and septa are absent. On the other hand, parietal placentation is found in *Argemone* and *Brassica* and axile placentation in *Citrus*.

101. Option (a) is correct.

Cortex is the region found between epidermis and stele. This layer consists of parenchyma, collenchyma and sclerenchyma tissues. It is multilayered and distinct in dicots.

102. Out of Syllabus**103. Option (b) is correct.**

RNA enzymes are ribonuclease or ribozyme.

104. Option (b) is correct.

Large central vacuoles are characteristics of plant cells.

105. Option (b) is correct.

Pili and fimbriae are the additional structures other than flagellum. There are two surface structures of the bacteria. They do not help in locomotion. Pili are long tubular structure made up of special protein. Sex pili in certain bacteria helps in forming conjugation tube during sexual reproduction. The fimbriae are small bristle like fibres sprout out from the cell. They act like adhesion structure to rocks and host tissue.

106. Option (a) is correct.

The isolated lysosomal vesicles have been found to be very rich in almost all types of hydrolytic enzymes (hydrolases – lipases, proteases, carbohydrases) optimally active at the acidic pH.

107. Option (a) is correct.

During the 'S' phase of interphase, the DNA of the cell is replicated in the nucleus in preparation for cell division and its amount doubles. The chromosome number remains the same.

108. Option (d) is correct.

Fatty acids would be broken down to acetyl Co-A before entering the respiratory pathway when it is used as a substrate. But when the organism needs to synthesise fatty acids, acetyl Co-A would be withdrawn from the respiratory pathway for it. Hence, the respiratory pathway comes into the picture both during breakdown and synthesis of fatty acids. Similarly, during breakdown and synthesis of protein too, respiratory intermediates form the link.

109. Option (b) is correct.

The phloem sap is alkaline in nature. It continuously pumps protons from its companion cells to the other neighbouring cells during transport of sugars.

110. Option (b) is correct.

Cytokinin promote cell division in tissue culture. Auxin is a plant growth hormone, which promote elongation of stem. For division in tissue cytokinin should be proportionate in order to allow shoot and root development.

111. Option (d) is correct.

The phytochromes is a kind of chromoprotein. The phytochromes are photoreceptors. They are of two types called type I and type II. Both of them are interchangeable. When plants absorb red light, the type I converted into type II phytochrome and vice versa.

112. Option (c) is correct.

Calcium is important in cell division as it plays a role in the mitotic spindle formation and it forms calcium pectate in the middle lamella.

113. Option (c) is correct.

The C_4 plants have special type of leaf anatomy, they tolerate higher temperatures. They show a response to highlight intensities, have greater productivity of biomass and lack a process called photorespiration.

114. Option (c) is correct.

The stem consists of nodes and internodes. The regions from which leaves are born called nodes. The place between to nodes of a stem is called internode. In potato, banana, and ginger are modified stems. The plantlets are developed from nodes of the modified stem, but not from internodes.

115. Option (c) is correct.

If there are differences in terms of characteristics within very closely related groups of organisms are called variation. These variations caused during sexual reproduction by means of genetic recombination. The genetic recombination occurs by crossing over during pachytene. When two different gametes from two different organisms of the same species are united during fertilisation randomly can also leads to genetic variation.

116. Option (d) is correct.

- (a) Pistils fused together – Syncarpous
- (b) Formation of gametes – Gametogenesis
- (c) Hyphae of higher ascomycetes – Dikaryotic
- (d) Unisexual female flower – Pistillate

117. Option (c) is correct.

Megaspore mother cell divide meiotically to form four haploid megaspores which undergoes mitosis so that a haploid female gamete is formed. Antipodal cells are three in number. A large central cell is present in the embryo sac. The synergids bears filiform apparatus.

118. Option (b) is correct.

In a majority of aquatic plants such as water hyacinth and water lily, the flowers emerge above the level of water and are pollinated by insects or wind as in most of the land plants.

119. Option (a) is correct.

The ovule is the integumented megasporangium

120. Option (b) is correct.

Taylor conducted the experiments on *Vicia faba* in 1958 which involves the usage of thymidine to detect the distribution of newly synthesised DNA in the chromosomes. His experiment proved that DNA in chromosomes replicate semi-conservatively.

121. Option (c) is correct.

The process of integration of a chromosomal segment or a gene into non-homologous chromosome is called translocation. It is of two types called simple translocation and reciprocal translocation. When a terminal segment of a chromosome is integrated into another end of the non-homologous chromosome, it is called simple translocation. When two non-homologous chromosomes exchange their segments, it is called reciprocal translocation.

122. Option (b) is correct.

A small gene that encodes for RNA or protein other than regulatory protein is called structural gene. Cistron is small segment of DNA. A cistron will have an average of 1200 nucleotides. It can determine the synthesis a protein or polypeptide. Hence, it is considered as same to that of structural gene.

123. Option (c) is correct.

The plant when produced continuously by self-pollination, they show stable inheritance of a trait for several generation. Such plants are called true breeding plants. Mendel conducted artificial pollination by using true-breeding pea lines. They have homozygous gene for a character like TT for tall or tt for dwarf plant. They always produce their own offsprings.

124. Option (c) is correct.

23 srRNA, present in bacteria is a type of ribozyme i.e. catalytic RNA which catalyses and enhance the rate of peptide bond formation. In eukaryotes 28 srRNA does the same function.

125. Option (c) is correct.

The stirrer facilitates even mixing and oxygen availability throughout the bioreactor.

126. Option (d) is correct.

When cut by the same restriction enzyme, the resultant DNA fragments have the same kind of 'sticky-ends' which are joined together using DNA ligases.

127. Option (d) is correct.

It is a series of processes such as separation and purification of products after the biosynthetic stage.

128. Option (b) is correct.

Blunt ends have no overlap. *EcoRV* is a type II restriction endonuclease isolated from strains of *E. coli*.

129. Option (a) is correct.

Gene therapy is a collection of methods that allows correction of a gene defect that has been diagnosed in a child/embryo.

130. Option (c) is correct.

Norman Myer was an environmentalist. He noted about 34 hotspots of biodiversity in the world and have been identified till date. These biodiversity hotspot shows the high levels of endemism and higher levels of species richness.

131. Option (b) is correct.

There are certain habitats like thermal springs and deep-sea hydrothermal vents where the temperature is more than 100°C. At that place the primary producers are chemosynthetic bacteria. Most of them belong to archaeobacteria.

132. Option (a) is correct.

r-selected are the species having the ability to produce large no. of progenies (off springs) with small size. The population growth of these species is a function of biotic potential.

133. Option (d) is correct.

Parasitism is a relationship between two living organisms of different species in which one organism, i.e. parasite obtains its food directly from the host. In this relationship the parasite is benefitted (+) and the host is harmed (-). So, this type of population interaction is represented by '+ '-'.

134. Option (c) is correct.

When the non-native species invade a habitat, they spread and cause threat to the biodiversity are Invasive Alien Species. *Parthenium* is a non-native species. It is a kind of weed. It causes threat to indigenous species by invading.

135. Option (c) is correct.

Red List or Red data book is a catalogue of taxa facing risk of extinction. It was initiated in 1963 and maintained by International Union for Conservation of Nature and Natural Resources. Threatened species are the one which are at more risk of extinction if not given proper protection.

136. Option (a) is correct.

Cholera and tetanus are the set of diseases caused by bacteria. Cholera is caused by *Vibrio cholerae* and tetanus is caused by *Clostridium tetani*. Whereas in the other set of diseases, typhoid is caused by bacterium but it is not paired with a bacterial disease. All other given diseases like mumps, smallpox, herpes and influenza are caused by virus.

137. Option (a) is correct.

The housefly (*Musca domestica*) is placed under kingdom Animalia, phylum Arthropoda, class Insecta, order Diptera, family Muscidae, genus *Musca* and species *domestica*.

138. Option (b) is correct.

Cyclostomes have a sucking and circular mouth without jaws. Their body is devoid of scales and paired fins.

139. Option (c) is correct.

Ernst Mayr was a German evolutionary biologist. He was called as "The Darwin of the 20th century." He was proposed the definition of biological species. Most of the unicellular organisms reproduce by binary fission and produce two daughter cells. When these daughter cells are grown, again they under to binary fission. Their reproduction is synonymous with growth.

140. Out of Syllabus**141. Option (a) is correct.**

Smooth muscle fibre is a small spindle-shaped cell containing a single, centrally located nucleus. These fibres are under involuntary control and non-striated hence smooth.

142. Option (d) is correct.

Unlike photophosphorylation where it is the light energy that is utilised for the production of proton gradient required for phosphorylation, in respiration it is the energy of oxidation-reduction utilised for the same process. It is for this reason that the process is called oxidative phosphorylation.

143. Option (a) is correct.

Various types of bonds or interactions such as covalent bonds, ionic bonds, hydrogen bonds, van der waals and hydrophobic bonds are found during the coiling of polypeptide.

144. Option (b) is correct.

The graph shows the activation energies of catalysed and uncatalysed reactions. A transition state is observed when the reactants are at the crest of the hump. At this state, they are ready to be converted as products. If the products are at a lower level than the reactants, the reaction is exothermic.

145. Option (a) is correct.

The dividing cell check their mass, state of DNA replication and DNA damage at certain point of cell cycle. These points are called check point. These check points ensure that all the necessary conditions are satisfied. Otherwise the cell cycle is stopped at that particular point.

Synthesis of DNA occurs during S-phase when a fold is formed. If the synthesis of DNA occurs completely then only it goes to the next phase called G₂ phase. If the fork is stalled, the synthesis of DNA is stopped during S-phase. Hence, the cell does not go to G₂ phase. The check point must be at G₁/S.

146. Option (a) is correct.

In **Pachytene** phase of meiosis, crossing over takes place. During this process, non-sister chromatids of two homologous chromosomes get exchanged and form recombinants.

In **Metaphase-I**, maximum condensation of chromosomes take place and they arranged and aligned at equatorial plate.

In **Diakinesis**, terminalisation of chiasmata occurs. This takes place due to the shifting of chiasmata towards the end of the chromosome.

In **Zygotene**, synapsis or pairing of homologous chromosomes occurs. In this, one chromosome of the pair comes from the male parent while the other from the female parent.

147. Option (c) is correct.

Cholecystokinin-Pancreozymin causes contraction of gall bladder to release bile. It also stimulates pancreas to secrete and release digestive enzymes in the pancreatic juice.

Secretin stimulates the release of bicarbonate in the pancreatic juice, increases secretion of bile, decreases gastric secretion and motility.

148. Option (b) is correct.

The pO₂ in alveoli is higher than in tissues, so oxygen diffuses into the tissues through blood.

149. Out of Syllabus**150. Out of Syllabus****151. Option (a) is correct.**

Increase in Ca⁺⁺ level leads to the binding of calcium with a subunit of troponin on actin filaments and thereby remove the masking of active sites for myosin.

152. Option (d) is correct.

Platelets also called thrombocytes are cell fragments produced from megakaryocytes (special cells in the bone marrow). Blood normally contains 1,50,000–3,50,000 platelets per microlitres of blood. Platelets can release a variety of substances most of which are involved in the coagulation or clotting of blood. A reduction in their number can lead to clotting disorders which will lead to excessive loss of blood from the body.

153. Option (a) is correct.

Insulin is a peptide hormone, which plays a major role in the regulation of glucose homeostasis. Insulin acts mainly on hepatocytes and adipocytes (cells of adipose tissue), and enhances cellular glucose uptake and utilisation. As a result, there is a rapid movement of glucose from blood to hepatocytes and adipocytes resulting in decreased blood glucose levels (hypoglycemia).

154. Option (c) is correct.

Age-related disorder characterised by decreased bone mass and increased chances of fractures. The decrease in the levels of estrogen is a common cause.

155. Option (c) is correct.

Plasma without the clotting factors is called serum.

156. Option (b) is correct.

Lungs do not collapse between breaths and some air always remains in the lungs which can never be expelled because there is a negative intrapleural pressure pulling at the lung walls. This pressure creates suction and keeps the lungs inflated. Thus, prevents them from collapsing.

157. Option (b) is correct.

The posterior pituitary or neurohypophysis does not synthesise hormones, it does store and releases two hormones, oxytocin and vasopressin, which are actually synthesised by the hypothalamus.

158. Option (b) is correct.

Active reabsorption of sodium takes place in proximal convoluted tubule. It is lined by simple cuboidal brush border epithelium which increases the surface area for reabsorption.

159. Option (a) is correct.

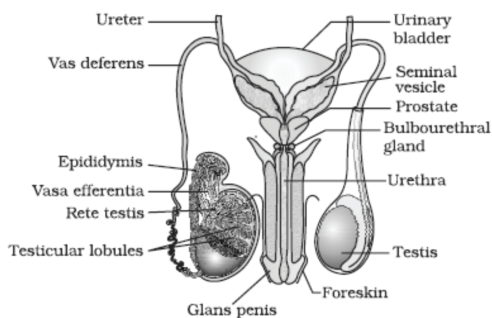
The process of preventing fertilisation to prevent the pregnancy in women is called contraception. It is most widely accepted method to delay pregnancy or space children. LNG-20 is a kind of contraceptive. It is used as intra uterine device. It releases hormone called levonorgestrel 20 mg. It leads to phagocytosis of sperms. So that, a woman can avoid the pregnancy.

160. Option (b) is correct.

Vasectomy is the surgical sterilisation technique for the males. The two vasa deferentia are cut and tied. It blocks sperm transport. Sperm production and testosterone secretions are normal and done by testis.

161. Option (a) is correct.

When the zygote or embryos is more than 16 blastomeres, it is directly placed into the uterus for its further complete development. This method is called IUT.

162. Option (a) is correct.

Diagrammatic view of male reproductive system
(part of testis is open to show inner details)

163. Option (b) is correct.

- (a) Mons pubis – Female external genitalia
- (b) Antrum – Graafian follicle
- (c) Trophoblast – Embryo development
- (d) Nebenkern – Sperm

164. Option (b) is correct.

Placenta also acts as an endocrine tissue and produces several hormones like human chorionic gonadotropin (hCG), human placental lactogen (hPL), estrogens, progesterones, etc. In the later phase of pregnancy, a hormone called relaxin is also secreted by the ovary.

165. Option (a) is correct.

Colour blindness is an X-linked disease. Hence, woman whose father was colour blind will be carrier for the disease.

166. Option (a) is correct.

When migration of a section of population to another place and population occurs, gene frequencies change in the original as well as in the new population. There would be a gene flow if this gene migration, happens multiple times. If the same change occurs by chance, it is called genetic drift.

167. Option (b) is correct.

In a diploid, p and q are the frequencies of alleles A and a respectively. The frequency of $AA = p^2$ (*i.e.* the probability of an allele A with frequency p is the product of the probabilities, *i.e.* p^2)

The frequency of $aa = q^2$; The frequency of $Aa = 2pq$

168. Option (b) is correct.

The chronological order of human evolution from early to the recent is Dryopithecus (common ancestor of man and apes) → *Ramapithecus* (earliest hominid fossil) → *Australopithecus* (first ape man) → *Homo habilis* (first hominid tool maker) → *Homo erectus* (erect man) → *Homo neanderthalensis* (first civilised man) → *Homo sapiens* (modern man).

169. Option (c) is correct.

The correct sequence of events in the origin of life is-

II. Synthesis of organic monomers.



III. Synthesis of organic polymers.



I. Formation of protobionts.



IV. Formation of DNA-based genetic systems.

170. Option (c) is correct.

A molecule that can act as a genetic material must fulfill the traits given in the options, except it should be unstable structurally and chemically. Instead, it is necessary for the genetic material to show stability both in its structure and chemical composition because genetic material is the substance which controls the inheritance of the traits from one generation to another.

171. Option (a) is correct.

DNA-dependent RNA polymerase catalyses transcription on one strand of the DNA which is called the template strand. This enzyme catalyses the polymerisation in the direction $5' \rightarrow 3'$ and the template strand has $3' \rightarrow 5'$ polarity and also known as antisense strand. A template strand can be considered as the master strand and it have the ability to decode the information directly through the RNA polymerase.

172. Option (b) is correct.

It is the breeding of the unrelated animals which may be between individuals of the different related species.

173. Option (b) is correct.

The correct statement regarding AIDS causative agent HIV is- HIV is enveloped virus that contains two identical molecules of single stranded RNA and two molecules of reverse transcriptase.

HIV is retrovirus and comes under the retroviridae family. It attacks helper T cells due to which immune system fails to produce B cells, which produce antibodies to kill the infected cells. Thus, body becomes weak and immunodeficient.

174. Out of Syllabus**175. Option (b) is correct.**

- (a) Citric acid – *Aspergillus*
- (b) Cyclosporin – *Trichoderma*
- (c) Statins – *Monascus*
- (d) Butyric acid – *Clostridium*

176. Option (c) is correct.

Unlike domestic sewage, waste water from industries like petroleum, paper manufacturing, metal extraction and processing, chemical manufacturing, etc., often contain toxic substances, notably, heavy metals etc., BOD will be high which is not good for water bodies.

177. Option (b) is correct.

The principle of competitive exclusion was stated by GF Gause. According to this principle, two closely related species which are competing for the same limited food resources cannot coexist at the same niche indefinitely. This leads to the extinction of the weaker

competitor or their evolutionary shift to the different ecological niche.

178. Option (d) is correct.

A national park is an area of land of reserved and owned by national governments. It is aimed to protect wild life from pollution and damage caused in the name of development by human beings.

Dachigam National Park is located in Jammu and Kashmir. It is home for the famous musk deer or hangul.

179. Option (d) is correct.

The water bodies become rich in nutrients due to draining of sewage and discharged wastes from agricultural field. This would lead to excessive growth of plant. The decomposing plant take more oxygen in water. This would lead to lack of oxygen. This is called eutrophication. The excessive growth and decomposition of plants would cause depletion of oxygen. The depletion of would cause more biological oxygen demand. This will increase the mortality of fish due to lack of oxygen.

180. Option (b) is correct.

Dichloro diphenyl trichloro ethane (DDT) is a kind of organic synthetic pesticide. It is mostly used in agricultural field. The process of increasing the concentration pesticides through the food chain is called biomagnification. DDT accumulates in the sequence order give below.

Phytoplanktons → Eel → Crab → Seagull

The concentration of DDT increases in the successive trophic level. Finally, the organisms in the top of the trophic level will receive highest DDT concentration. As Seagull is the top carnivore, it receives the highest concentration DDT in aquatic food chain.

□□□