

SOLUTIONS

PHYSICS

1. (a) : The critical frequency of a sky wave for reflection from a layer of atmosphere is given by

$$f_c = 9(N_{\max})^{1/2}$$

where N is the density of electron/m³.

$$10 \times 10^6 = 9(N_{\max})^{1/2}$$

$$N_{\max} = \left(\frac{10 \times 10^6}{9} \right)^2 \simeq 1.2 \times 10^{12} \text{ m}^{-3}.$$

2. (d) : NAND and NOR gate are used as universal gate.

3. (b) : Core of acceptance angle $\theta = \sin^{-1} \sqrt{n_1^2 - n_2^2}$

4. (b) : As a constant magnetic field conducting ring oscillates with a frequency of 100 Hz.

i.e. $T = \frac{1}{100}$ s, for $\frac{T}{2}$, it goes up to B

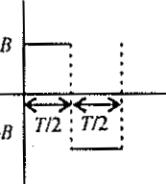
∴ The corresponding frequency is 200 Hz.

Induced emf = $\frac{\text{change in flux}}{\text{time}}$

$$= \frac{2BA\cos\theta}{T} = 2BAf\cos\theta$$

$$= \pi r^2 \times 2 \times 0.01 \times 200 \text{ as } r = 1 \text{ m}$$

$$= \pi r^2 \times 2 \times 0.01 \times 200 = 4\pi \text{ V.}$$



Non-electrostatic induced electric field along the circle,

$$E = \frac{1}{2\pi r} \times \left(\pi r^2 \times \frac{dB}{dt} \right) = \frac{e}{2\pi r} = \frac{4\pi}{2\pi r} = 2 \text{ V/m.}$$

5. (b) : Current gain = $\frac{\Delta I_C}{\Delta I_B}$

$$\therefore \Delta I_B = \frac{1 \text{ mA}}{100} = 10^{-2} \text{ mA.}$$

$$\text{As } \Delta I_E = \Delta I_B + \Delta I_C = (0.01 + 1) \text{ mA} = 1.01 \text{ mA.}$$

6. (a) : From the formula for convex lens,

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\therefore v = \frac{f \times u}{u - f} = \frac{200 \times 200 \times 10^3}{[200 \times 10^3 - 200]} = \frac{200 \times 10^3}{999}.$$

Also, magnification,

$$m = \left| \frac{v}{u} \right| = \left| \frac{I}{O} \right|$$

$$= \frac{200 \times 10^3}{999 \times 200 \times 10^3} = \frac{I}{50 \times 100}$$

$$I = \frac{5000}{999} \simeq 5 \text{ cm.}$$

7. (b) : Total energy = kinetic energy + potential energy

$$\text{Potential energy} = 2 \text{ total energy}$$

$$= -2 \times 13.6 = -27.2 \text{ eV.}$$

8. (b) : According to Moseley's law

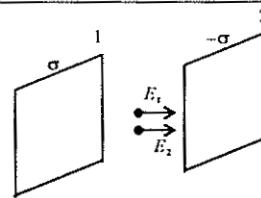
$$(Z - \sigma) \propto \sqrt{f} \quad \text{or, } f \propto (Z - \sigma)^2.$$

Note : The correct answer should have been $f \propto (Z - \sigma)^2$ where σ is the screening constant. Many authors use at this level, $\sigma = 1$ approximately.

9. (c) : Electric field between the plates is

$$= \frac{\sigma}{2\epsilon_0} - \frac{(-\sigma)}{2\epsilon_0}$$

$$= \frac{\sigma}{\epsilon_0} \text{ volt/meter.}$$



10. (a) : $\mu_e > \mu_n$ because electron is lighter than hole.

11. (a) : $\vec{L} = n \cdot \frac{\hbar}{2\pi}$,

$$\mu_n = \frac{e}{2m} \cdot n \cdot \frac{\hbar}{2\pi} \quad \text{i.e. } \mu \propto n.$$

12. (c) : $T_{1/2} = 10$ days, $T = 30$ days

$$T = n \times T_{1/2}, \quad n \equiv \frac{T}{T_{1/2}} = \frac{30}{10} = 3$$

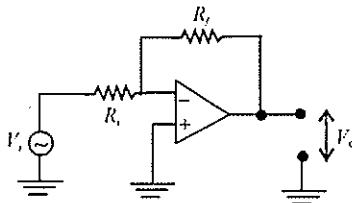
$$\frac{N}{N_0} = \left(\frac{1}{2} \right)^n = \left(\frac{1}{2} \right)^3 = \frac{1}{8} = 0.125.$$

13. (a) : Hubble's law is a statement of a direct correlation between the distance (r) to a galaxy and its recessional velocity as determined by the red shift (Z). It is stated as $Z = H_0 r$, where Z = recessional velocity. H_0 = Hubble constant and r = distance.

14. (a) : The colour in the oil film is formed due to interference of sunlight where the colour of the film will depend upon the thickness and the angle of inclination.

15. (b) : Parsec (pc) is an astronomical unit of length equal to the distance at which a baseline of one astronomical unit subtends an angle of one second of arc. 1 parsec = 3.085677×10^{16} m = 3.26 light years.

16. (b) : This is an example of operational amplifier in this voltage gain.



$$A = \frac{V_o}{V_i} = \frac{R_f}{R_i}$$

$$= \frac{100 \text{ k}\Omega}{1 \text{ k}\Omega} = 100.$$

17. (b) : $v = 50$ Hz, $V = 20$ V, $V_R = 12$ V

In case of RC circuit, $V = \sqrt{V_R^2 + V_C^2}$

$$\Rightarrow (20)^2 = (12)^2 + (V_C)^2$$

$$\Rightarrow (V_C)^2 = 400 - 144 = 256 \Rightarrow V_C = 16 \text{ V.}$$

18. (a) : Impulse = change in momentum

$$= m\Delta V = \frac{m\Delta x}{\Delta t} = 0.1 \times \frac{4 - 0}{2 - 0} = 0.2 \text{ kgmsec}^{-1}.$$

19. (c) : Pressure = Force/area

$$I = \frac{\text{Energy}}{\text{area-time}} = \frac{F \cdot S}{At} = \frac{Fc}{A}, \quad I/c = P.$$

20. (a) : According to work energy theorem,

$$W = \Delta \text{K.E.} \Rightarrow W = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2$$

$$\Rightarrow F \cdot dx = \text{K.E.}_F - \frac{1}{2} \times 10 \times 100$$

$$\Rightarrow F \cdot dx = \text{K.E.}_F - 500$$

$$\Rightarrow \int_{20}^{30} -0.1x \, dx = \text{K.E.}_F - 500$$

$$\Rightarrow -0.1 \left[\frac{x^2}{2} \right]_{20}^{30} = \text{K.E.}_F - 500$$

$$\Rightarrow -0.1 \left[\frac{900 - 400}{2} \right] = \text{K.E.}_F - 500$$

$$\Rightarrow \text{K.E.}_F = 500 - 25 = 475 \text{ J.}$$

21. (a)

22. (c) : The criterion for a star to be black hole is

$$\frac{GM}{c^2 R} \geq \frac{1}{2} \quad \text{or,} \quad \sqrt{\frac{2GM}{R}} \geq c.$$

23. (a) : Amorphous solids are the solids in which atoms are arranged in a completely irregular manner. They are also known as glassy solids.

24. (b) : Bulk modulus $\propto \frac{1}{\Delta V/V}$

25. (a) : $y = \sin \omega t - \cos \omega t$

$$\frac{dy}{dt} = \omega \cos \omega t + \omega \sin \omega t$$

$$\frac{dy}{dt} = -\omega^2 \sin \omega t + \omega^2 \cos \omega t$$

$$= -\omega^2(\sin \omega t - \cos \omega t).$$

$$a = -\omega^2 y. \quad \therefore a \propto -y.$$

which is the condition of simple harmonic motion.

26. (b) : The magnitude of electric field vector varies periodically with time because it is the form of electromagnetic wave.

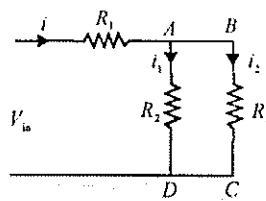
27. (a)

28. (c) : As the voltage in R_2 and R_3 is same therefore, according to,

$$H = \frac{V^2}{R} \cdot t, \quad R_2 = R_3 \quad V_u$$

Also the energy in all resistance is same.

$$\therefore i^2 R_1 t = i_1^2 R_2 t$$



$$\text{Using } i_1 = \frac{R_3}{R_2 + R_3} i = \frac{R_3}{R_3 + R_3} i = \frac{1}{2} i$$

$$\text{Thus } i^2 R_1 t = \frac{i^2}{4} R_2 t \quad \text{or, } R_1 = \frac{R_2}{4}.$$

29. (b) : $\frac{n_2}{n_1} = \frac{\text{real depth}}{\text{apparent depth}}$ or, $\frac{n_2}{n_1} = \frac{h}{x}$

Differentiating with respect to time,

$$\frac{n_2}{n_1} = \frac{dh/dt}{dx/dt}$$

Change in real depth = $\frac{n_2}{n_1} \times$ change in apparent depth

$$\frac{dh}{dt} = \frac{n_2}{n_1} x \text{ cm/min.}$$

The amount of water drained in c.c. per minute

$$= \frac{dh}{dt} \times \pi R^2 = x \pi R^2 \frac{n_2}{n_1}.$$

30. (b) : Initial weight of the candle = weight of liquid displaced

$$\rho_C V_C g = \rho_L (\text{volume displaced}) g$$

$$\Rightarrow \rho_C \pi \left(\frac{d}{2}\right)^2 2L = \rho_L \pi \frac{d^2}{2} L g \Rightarrow \frac{\rho_C}{\rho_L} = \frac{1}{2} \quad \dots (\text{i})$$

When 2 cm has been burnt, total length = $2L - 2$

But $\rho_C(2L - 2) = \rho_L(L - x)$

$$\rho_C 2(L - 1) = 2\rho_C(L - x) \quad [\text{Using eqn. (i)}]$$

$\therefore x = 1 \text{ cm.}$

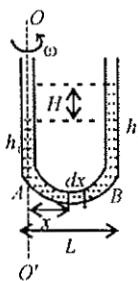
Outside also it has decreased 1 cm as the total decrease is 2 cm. The level of the candle comes down at half the rate of burning.

31. (a) : Due to rotation about the axis OO' , a force is acting on the liquid column AB outwards, pushing up the liquid column on the right. This centrifugal force acting on the small element dx of area of cross-section dx , distant x from the axis is

$$dm \omega^2 x = Adx \rho \omega^2 x$$

The total force due to column of length L ($= AB$) is

$$\int_0^L A \rho \omega^2 \cdot x dx = A \rho \omega^2 \frac{L^2}{2}$$



$$\text{Pressure at } B = \text{atmospheric pressure} + h_1 \rho g + \frac{A \rho \omega^2 L^2}{2}$$

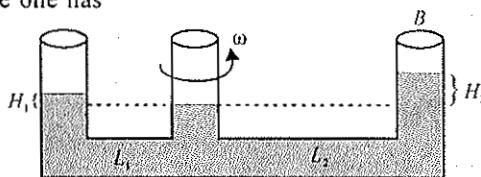
Pressure at B due to liquid column on the right hand side
= atmospheric pressure + $h_2 \rho g$

Net pressure due to the left hand side = pressure at B due to liquid column

$$\text{atm. pressure} + h_1 \rho g + \rho \omega^2 \frac{L^2}{2} = \text{atm. pressure} + h_2 \rho g$$

$$\therefore h_2 - h_1 = H_0 = \frac{\omega^2 L^2}{2g}.$$

Here one has



$$H_2 = \frac{\omega^2 L_2^2}{2g}, \quad H_1 = \frac{\omega^2 L_1^2}{2g}$$

As ω is the same, and $L_2 > L_1$, $H_2 > H_1$.
But both will go up.

32. (a) : As $v^2 = u^2 + 2as$

$$\therefore u^2 \propto s \quad \dots (\text{i})$$

$$\text{For given condition, } u'^2 \propto 3s \quad \dots (\text{ii})$$

From eqn. (i) and (ii),

$$\frac{u'^2}{u^2} = 3 \Rightarrow u' = \sqrt{3} v_0.$$

33. (a) : From conservation of energy

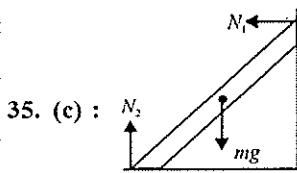
Potential energy = translational kinetic energy
+ rotational kinetic energy

$$mgh = \frac{1}{2} mv^2 + \frac{1}{2} \left(\frac{2}{5}\right) mR^2 \cdot \frac{v^2}{R^2}$$

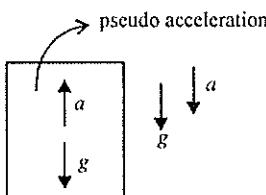
$$\Rightarrow \frac{7}{10} mv^2 = mgh \Rightarrow v \geq \sqrt{\frac{10}{7} gh}.$$

34. (b) : According to law of conservation of momentum,
 $\omega = \text{constant}$.

When viscous fluid of mass m is dropped and start spreading out then its moment of inertia increases and angular velocity decreases. But when it starts falling then its moment of inertia again starts decreasing and angular velocity increases.



36. (b) : When elevator moves downward with constant acceleration, $a = g$. Then person standing in an elevator find himself weightless. (g' with respect to the lift is $(g - a)$).



37. (a) : As the north pole approaches, a north pole is developed at that face i.e. the current flows anticlockwise. Finally when it completes the oscillation, when it is ready, no emf is present. Now south pole approaches the other side R.H.S. the current flows clockwise to repel the south pole. This means the current is anticlockwise at the L.H.S. as before. This is possible in (a). The breaks show when the pendulum is at the extreme and momentarily stationary.

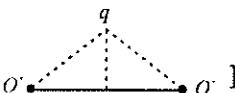
38. (c) : $|Q_B| > |Q_A|$ (given). Inside the shell B , the potential is a constant and negative. But V_A inside r_A is positive and greater than that of B because $r_A < r_B$. Upto r_B , one gets hence positive potential. Beyond r_A , $V_A \propto (1/r)$, this is $> V_B$, one gets the course $\propto 1/r$. At B , the negative potential is more therefore the potential line is still negative. (c) explains all these factors.

Note : However the question asked is the field and the diagrams given are for the potential. This is an error.

39. (b) : Resistance = $\frac{\text{potential difference}}{\text{current}}$

$$= \frac{ML^2 T^{-3} A^{-1}}{A} = ML^2 T^{-3} A^{-2}$$

40. (a) : The negative charge oscillates, the resultant force acts as a restoring force and is $\cos\theta$ component, proportional to displacement. When it reaches the plane XY , the resultant force is zero and the mass moves down due to inertia. Thus oscillation is set.

[This problem is similar to ]

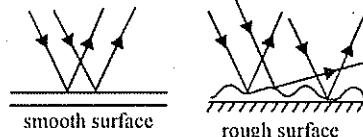
41. (a) : Specific gravity is former name of relative density and relative density is the density of a substance divided by the density of water.

\therefore Specific gravity = relative density

$$= \frac{\text{density of substance}}{\text{density of water}} = \text{dimensionless.}$$

42. (d) : Frictional work is not completely recoverable. When the force of friction is the total mechanical energy is not conserved. The friction force is therefore called a nonconservative or a dissipative force.

43. (c) : When glass surface is made rough then the light falling on it is scattered in different direction due to which its transparency decreases.



44. (b) : In optical communication, a semiconductor bases laser (diode laser) is used to generate analog signals or digital pulses for transmission through optical fibres. The advantages of diode lasers are their small size and low power input.

45. (b) : Diamond glitters brilliantly because light enters in diamond suffers total internal reflection. All the light entering in it comes out of diamond after number of reflections and no light is absorb by it.

46. (a) : Momentum of a platform is given by
 $p = h/\lambda$ (by de Broglie hypothesis) ... (i)

Also the photon is a form of energy packet behave as a particle and having energy

$$E = hc/\lambda \quad \dots \text{(ii)}$$

From (i) and (ii), $p = \frac{E}{c}$ or, $\frac{h\nu}{c}$.

47. (c) : The clouds consists of dust particles and water droplets. Their size is very large as compared to the wavelength of the incident light from the sun. So there is very little scattering of light. Hence the light which we receive through the clouds has all the colours of light. As a result of this, we receive almost white light. Therefore, the cloud are generally white.

48. (d) : In sky wave propagation, the radio waves having frequency range 2 MHz to 30 MHz are reflected back by the ionosphere. Radio waves having frequency

nearly greater than 30 MHz penetrates the ionosphere and is not reflected back by the ionosphere. The TV signal having frequency greater than 30 MHz therefore cannot be propagated through sky wave propagation. In case of sky wave propagation, critical frequency is defined as the highest frequency that is returned to the earth by the considered layer of the ionosphere after having sent straight to it. Above this frequency, a wave will penetrate the ionosphere and is not reflected by it.

49. (d) : In diode the output is in same phase with the input therefore it cannot be used to built NOT gate.

50. (a) : Resolving power of telescope = $\frac{D}{1.22\lambda}$

where D is the diameter of the objective lens and λ is the wavelength of the light used.

With increase in D , resolving power of telescope increases. A telescope will have large light gathering power if the diameter of the objective lens is large. Hence a bright image will be formed by the telescope.

51. (a) : In a perfectly reversible system, there is no loss of energy. Losses can be minimised, friction can be reduced, the resistance in $L-C$ oscillating system can also be negligible. But one cannot completely eliminate energy losses. This makes a perfectly reversible system, an ideal.

52. (a) : When external torque acting on the system is zero then only the total angular momentum of system is considered to be conserved.

If $\vec{L} = I\omega = \text{constant}$, $\tau = I\alpha = 0$.

$$\therefore \alpha = \frac{d\omega}{dt} = 0 \text{ for constant } \omega.$$

53. (a) : Adiabatic expansion produces cooling.

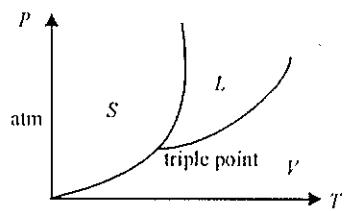
54. (c) : The process of nuclear fusion can be explained with the help of concept of binding energy per nucleon of very light nuclei and the intermediate nuclei. Binding energy per nucleon of very light nuclei is less than that of intermediate nuclei. It means light nuclei are less stable than that of intermediate nuclei. As ^{35}Cl has a large binding energy therefore it cannot be used as fuel for fusion energy.

55. (a) : According to law of mass action, $n_i^2 = n_e n_h$
In p -type semiconductor $n_h > n_e$

56. (c) : A good amplifier stage is one which has high input resistance and low output resistance. A transistor in CB configuration has a very low resistance ($\approx 20 \Omega$) and a very high output resistance ($\approx 1 \text{ M}\Omega$). It is just the reverse of what is required. The CE configuration is better, its input resistance is about $1 \text{ k}\Omega$ and output resistance about $10 \text{ k}\Omega$. Although input resistance of CE is not very high but it still prefers better amplifier.

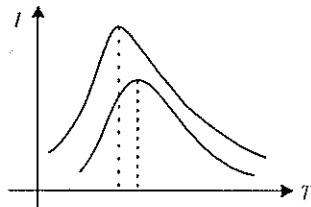
57. (a) : According to Kirchhoff's law, $a = e$. or the absorptivity of a body equals its emissivity. A good absorber is a good emitter. As a good absorber is poor reflector, emitting (or radiating) ability of body is oppositely related to its ability to reflect. Therefore good emitter (or radiator) is a poor reflector.

58. (a) : The negative slope is because of change of



phase. This happens to liquids which contract on melting.

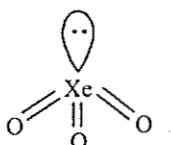
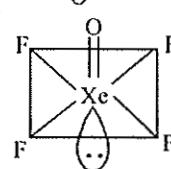
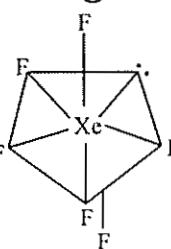
59. (b) : Wien's relation gives λ at maximum intensity, $\lambda_m \cdot T = \text{constant}$.



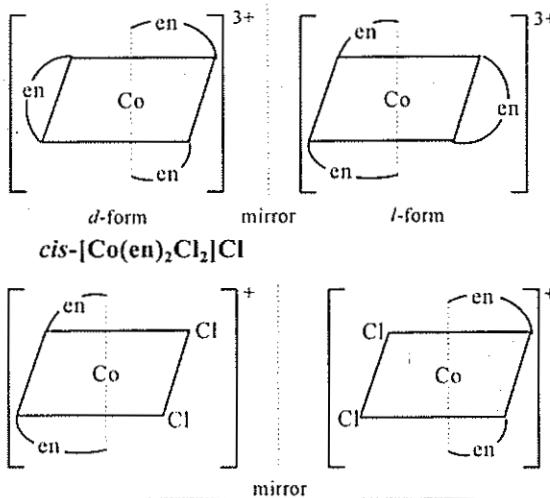
Stefan's law,
 σT^4 = intensity of emission of a particular wavelength does not explain the shift of λ_m with absolute temperature.

60. (a) : Reynold's number represents the ratio of the inertial force to the viscous force per unit area. When $R_e > 2000$, the flow is often turbulent in that case internal force dominate viscous force.

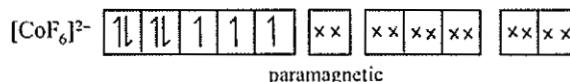
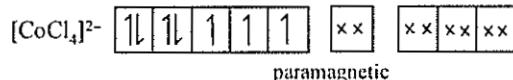
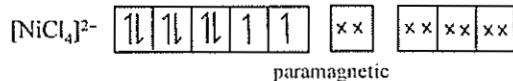
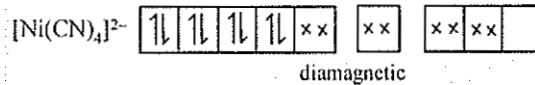
CHEMISTRY

 61. (d) : XeO_3 :

 XeOF_4 :

 XeF_6 :


62. (c) : CoCl_2 is a weak Lewis acid, reacting with chloride ion to produce salt containing the tetrahedral $[\text{CoCl}_4]^{2-}$ ion. CoCl_2 is blue when anhydrous, and a deep magenta colour when hydrated, for this reason it is widely used as an indicator for water.

 63. (b) : $[\text{Co}(\text{en})_3]\text{Cl}_3$


64. (a) :


 65. (a) : $\text{IO}_3^- + a\text{I}^- + b\text{H}^+ \rightarrow c\text{H}_2\text{O} + d\text{I}_2$

 Step 1 : $\text{I}^- \rightarrow \text{I}_2$ (oxidation)

 $\text{IO}_3^- \rightarrow \text{I}_2$ (reduction)

 Step 2 : $2\text{IO}_3^- + 12\text{H}^+ \rightarrow \text{I}_2 + 6\text{H}_2\text{O}$

 Step 3 : $2\text{IO}_3^- + 12\text{H}^+ + 10e^- \rightarrow \text{I}_2 + 6\text{H}_2\text{O}$
 $2\text{I}^- \rightarrow \text{I}_2 + 2e^-$

 Step 4 : $2\text{IO}_3^- + 12\text{H}^+ + 10e^- \rightarrow \text{I}_2 + 6\text{H}_2\text{O}$
 $[2\text{I}^- \rightarrow \text{I}_2 + 2e^-]$

 Step 5 : $2\text{IO}_3^- + 10\text{I}^- + 12\text{H}^+ \rightarrow 6\text{I}_2 + 6\text{H}_2\text{O}$
 $\text{IO}_3^- + 5\text{I}^- + 6\text{H}^+ \rightarrow 3\text{I}_2 + 3\text{H}_2\text{O}$

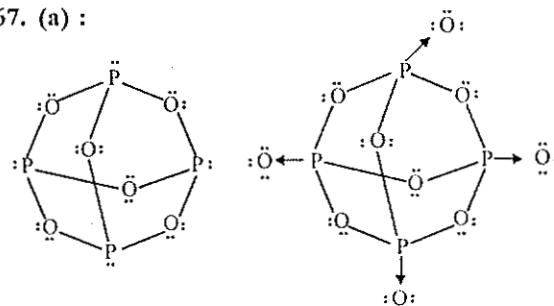
 On comparing, $a = 5$, $b = 6$, $c = 3$, $d = 3$.

66. (a) : Tl^+ ions are more stable than Tl^{3+} and thus, Tl^{3+} ions change to Tl^+ ions thereby acting as oxidising agents.

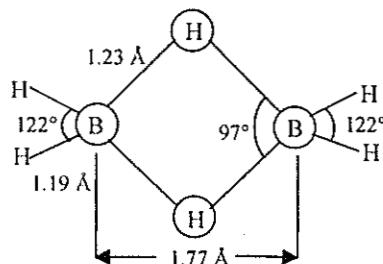
 Tl^{3+} compounds + $2e^- \rightarrow \text{Tl}^+$ compounds

(less stable oxidising agent) (more stable reducing agent)

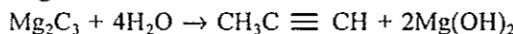
67. (a) :



68. (b) : Dilthey in 1921 proposed a bridge structure for diborane. Four hydrogen atoms, two on the left and two on the right, known as terminal hydrogens and two boron atoms lie in the same plane. Two hydrogen atoms forming bridges, one above and other below, lie in a plane perpendicular to the rest of molecule.

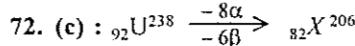


69. (b) : Propyne can be prepared by the hydrolysis of magnesium carbide.



70. (d) : Both Be(OH)_2 and Zn(OH)_2 are amphoteric in nature.

71. (b) : Pyrolusite = MnO_2
Malachite - $\text{CuCO}_3\cdot\text{Cu}(\text{OH})_2$
Diaspore - $\text{Al}_2\text{O}_3\cdot\text{H}_2\text{O}$
Cassiterite - SnO_2



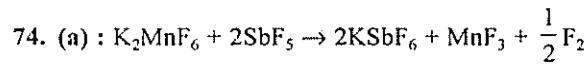
Number of protons = 82

Number of neutrons = 124

$$\text{Neutron/proton ratio in the product nucleus} = \frac{124}{82} = \frac{62}{41}$$

73. (a) : The absorption of energy or the observation of colour in a complex transition compound depends on the charge of the metal ion and the nature of the ligands attached. The same metal ion with different ligands shows different absorption depending upon the type of ligand. The presence of weak field ligands make the central metal ion to absorb low energies i.e. of higher wavelength. The field strength of ligands can be obtained from spectrochemical series. i.e.

(Weak field) $\text{I}^- < \text{Br}^- < \text{S}^{2-} < \text{Cl}^- < \text{NO}_3^- < \text{F}^- < \text{OH}^- < \text{H}_2\text{O} < \text{NH}_3 < \text{NO}_2^- < \text{CN}^- < \text{CO}$ (strong field)



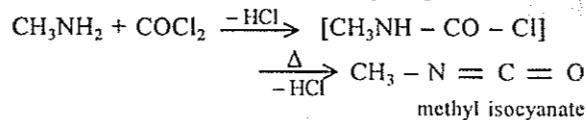
In this reaction, the stronger Lewis acid SbF_5 displaces the weaker one, MnF_4 from its salt. MnF_4 is unstable and readily decomposes to give MnF_3 and fluorine.

75. (d) : Number of electrons in ClO_2^-
 $= 7 + 6 + 6 + 1 = 20$

Number of electrons in ClF_2^+ = $7 + 7 + 7 - 1 = 20$.

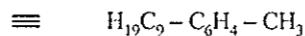
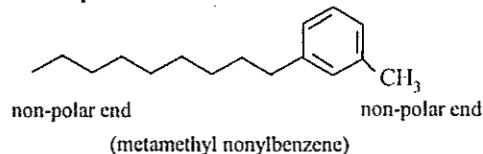
76. (c) : Methyl isocyanate is industrially prepared by

the action of methyl amine with phosgene.



77. (c) : Rutherford first of all used zinc sulphide (ZnS) as phosphor in detection of α -particles.

78. (c) : Benzene is non polar in nature. As we know that non-polar disperses more to non-polar substances. Therefore, meta-methyl nonylbenzene being nonpolar from both sides will disperse more to benzene. All other substances (a, b and d) have either one side polar or both sides polar.



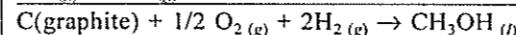
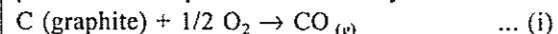
79. (b) : $2\text{AgCl}_{(s)} + \text{H}_2_{(g)} \rightarrow 2\text{HCl}_{(aq)} + 2\text{Ag}_{(s)}$
The activities of solids and liquids are taken as unity and at low concentrations, the activity of a solute is approximated to its molarity.

The cell reaction will be



80. (b) : Number of tetrahedral voids in the unit cell
 $= 2 \times \text{number of atoms} = 2Z$

81. (b) : Methanol can be prepared synthetically by heating carbon monoxide and hydrogen gases under pressure in the presence of a catalyst.



82. (c) : Endothermic reactions are those which involve absorption of heat. High activation energy means potential energy of product must be much greater than reactants.

83. (c) : $\text{p}K_a = -\log K_a, \text{p}K_b = -\log K_b$

$$\text{pH} = -\frac{1}{2}[\log K_a + \log K_w - \log K_b]$$

$$= -\frac{1}{2}[-5 + \log(1 \times 10^{-14}) - (-5)]$$

$$= -\frac{1}{2}[-5 - 14 + 5] = -\frac{1}{2}(-14) = 7.$$

84. (c) : Most probable radius = a_0/Z
 where $a_0 = 52.9$ pm. For helium ion, $Z = 2$.

$$r_{mp} = \frac{52.9}{2} = 26.45 \text{ pm.}$$

85. (a) : Bomb calorimeter is commonly used to find the heat of combustion of organic substances which consists of a sealed combustion chamber, called a bomb. If a process is run in a sealed container then no expansion or compression is allowed, so $w = 0$ and $\Delta U = q$.
 $\Delta U < 0, w = 0.$

86. (b) : $aA \rightarrow xP$

Rate of reaction = $[A]^a$

Order of reaction = a .

$$[A]_1 = 2.2 \text{ mM}, r_1 = 2.4 \text{ m M s}^{-1} \quad \dots \text{(i)}$$

$$[A]_2 = \frac{2.2}{2} \text{ mM}, r_2 = 0.6 \text{ mM s}^{-1} \text{ or, } \frac{2.4}{4} \quad \dots \text{(ii)}$$

On reducing the concentration of A to half, the rate of reaction is decreased by four times.

Rate of reaction = $[A]^2$

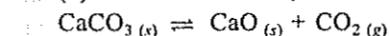
Order of reaction = 2.

87. (d) : $2\text{NOCl}_{(g)} = 2\text{NO}_{(g)} + \text{Cl}_2_{(g)}$

$$K_p = K_C (RT)^{\Delta n}$$

$$K_p = 3 \times 10^{-6} (0.0821 \times 700) = 172.41 \times 10^{-6} = 1.72 \times 10^{-4}.$$

88. (a) : For the reaction,



$$K_p = p_{\text{CO}_2} \text{ and } K_C = [\text{CO}_2]$$

($\because [\text{CaCO}_3] = 1$ and $[\text{CaO}] = 1$ for solids)

According to Arrhenius equation we have

$$K = Ae^{-\Delta H_r^\circ / RT}$$

Taking logarithm, we have

$$\log K_p = \log A - \frac{\Delta H_r^\circ}{RT(2.303)}$$

This is an equation of straight line. When $\log K_p$ is plotted against $1/T$, we get a straight line.

The intercept of this line = $\log A$, slope = $-\Delta H_r^\circ / 2.303R$
 Knowing the value of slope from the plot and universal gas constant R , ΔH_r° can be calculated.

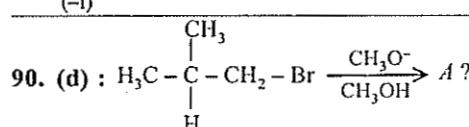
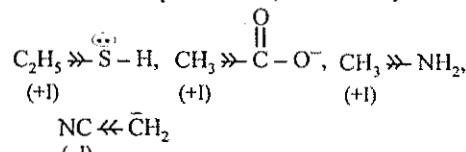
(Equation of straight line : $Y = mx + C$. Here,

$$\log K_p = -\frac{\Delta H_r^\circ}{2.303R} \left(\frac{1}{T} \right) + \log A$$

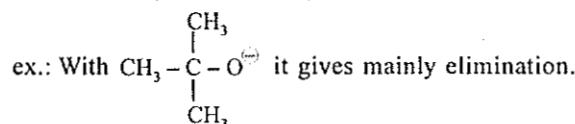
$$Y \quad m \quad x \quad C)$$

89. (a) : Nucleophiles are those substances which can donate a pair of electrons. These can be neutral or

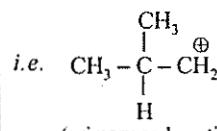
negative. The nucleophilic power depends on the tendency of species to donate electrons. This is more, when an electron pushing group (+I group) is present. Among the alkyl groups, those have higher number of C-atoms will push more, hence ethyl > methyl.



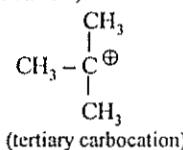
Alkyl halide is 1°.
 Keep in mind 1° halide give product by $S_N2/E-2$ mechanism and 1° halide always gives substitution reaction except when strongly hindered base is used.



The reaction involves carbocation intermediate.



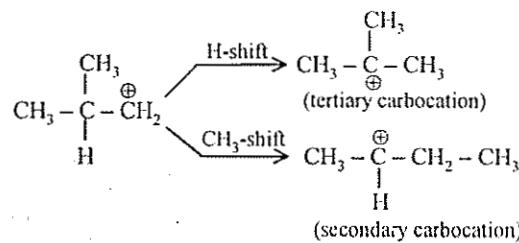
but as it is a primary carbocation it will rearrange to give a tertiary carbocation, which completes the reaction



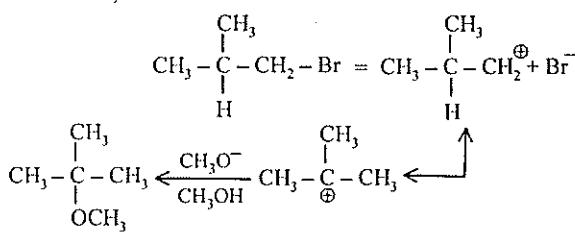
Stability of carbocation : $3^\circ > 2^\circ > 1^\circ > \text{CH}_3^\oplus$

It is because the stability of a charged system is increased by dispersal of the charge. The more stable the carbocation, the faster it is formed.

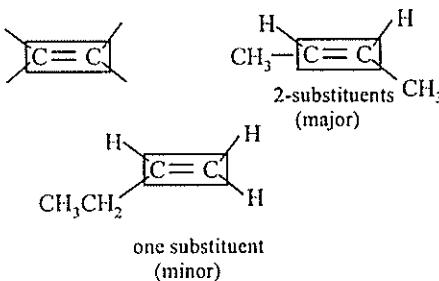
N.B. - Rearrangement can be done in two ways.



Therefore,

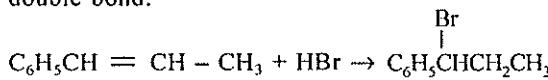


91. (b) : According to Saytzeff's rule, the major product will be that one which contains more number of substituents around the double bond.

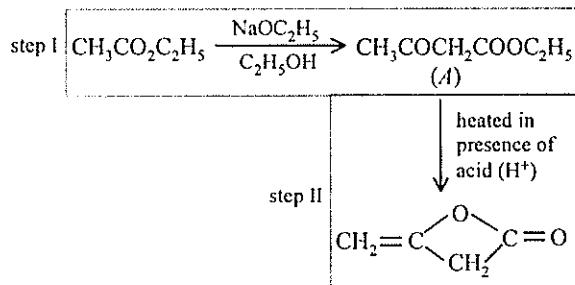


92. (d) : *Trans* configuration is more stable than *cis* configuration because in *cis*-configuration the H groups are thrown closely enough together to cause crowding or repulsion. Again between 1,2-and 1,3-configurations, in 1,3, the OH groups are placed further apart to minimise the repulsion. Hence, more stable is 1,3-configuration.

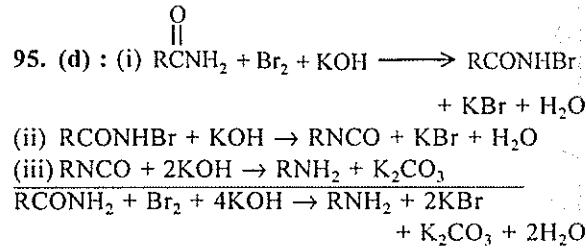
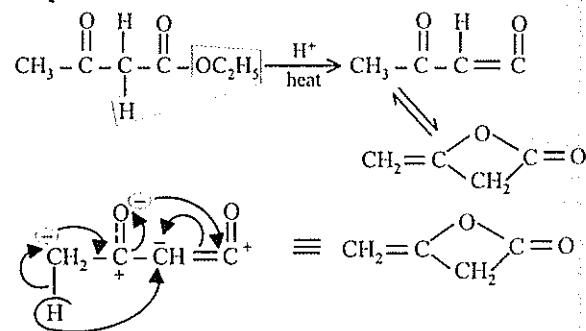
93. (b) : According to Markownikoff's rule, the negative part of the unsymmetrical reagent adds to less hydrogenated (more substituted) carbon atom of the double bond.



94. (c) : *Claisen condensation*

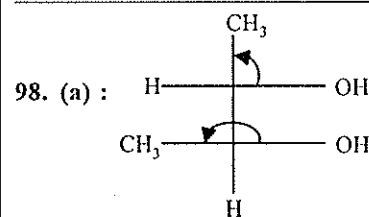


Step II :



96. (d) : Basicity of amines is due to availability of an unshared pair (lone pair) of electrons on nitrogen. This lone pair of electrons is available for the formation of a new bond with a proton or Lewis acid. Pyridine is less basic than triethylamine because lone pair of nitrogen in pyridine is delocalised.

97. (a) : α -Keratin is a water insoluble fibrous protein, serves as the major constituent of hair, nails and skin.

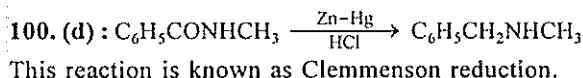


Following the procedure outlined under 'Golden Rule' the absolute configuration is 1S, 2S.

99. (b) : Genetic code shows degeneracy i.e. occurrence of more than 1 codon per amino acid. All the amino acid except methionine and tryptophan are coded by more than 1 codon.

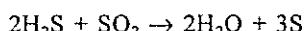
For example, valine is specified by GUU, GUC, GUA, GUG.

This shows that first two bases are common in all the four codons coding for valine. But the third base can be changed.



101. (b) : SO_2 shows both oxidising as well as reducing nature.

The reaction given in assertion is due to oxidising nature of SO_2 .



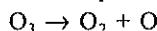
102. (a) : (i) Due to smaller size of F; steric repulsions will be less in SiF_6^{2-} .

(ii) Interaction of F lone pair electrons with Si is stronger than that of chlorine lone pairs.

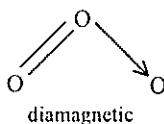
103. (b) : Borax bead test is not suitable for Al(III) because its oxidising as well as reducing flame is colourless in both hot as well as cold.

Alumina is insoluble in water as they exist in hydrated form like $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$, $\text{Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$ etc.

104. (b) : Due to the ease with which it can liberate nascent oxygen, O_3 acts as a powerful oxidising agent.



:O  O:
paramagnetic
(due to presence of
two unpaired electrons)



105. (c) : Ferrocyanide ion

	3d			4s		4p			
$[\text{Fe}(\text{CN})_6]^{4-}$				x	x	x	x	x	x
d ² sp ³ hybridisation									
diamagnetic									
$[\text{Fe}(\text{CN})_6]^{3-}$									
paramagnetic				x	x	x	x	x	x
d ² sp ³ hybridisation									

In ferrocyanide ion, the oxidation state of Fe is +2 however in ferricyanide ion, the oxidation number of Fe is +3.

Generally, the higher the oxidation state of the metal, the greater the crystal field splitting. It means crystal field splitting in ferrocyanide ion is lower than that of ferricyanide ion.

106. (d) : $\text{Ba}(\text{OH})_2$ is soluble in water.

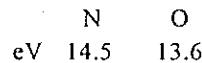
107. (c) : SeCl_4 possess see saw geometry, which can be regarded as a distorted trigonal bipyramidal structure,

having one lone pair (lp) of electrons in the basal position of the trigonal bipyramidal. See-saw geometry of SeCl_4 molecules arises due to the sp^3d hybridisation of the central atom. The distortion in shape is due to the presence of one lone pair of electrons.

108. (a) : Depression in freezing point is a colligative property which depends upon the number of particles. The number of particles are different in case of benzene and water that is why molecular weight of acetic acid determined by depression in freezing point method is also different.

109. (a) : In case of H_2 , compressibility factor increases with the pressure. At 273 K, $Z > 1$ which shows that it is difficult to compress the gas as compared to ideal gas. In this case repulsive forces dominate.

110. (d) : First ionization energy for nitrogen is greater than oxygen.



This is due to stable configuration of nitrogen (half-filled 2p-orbital).

Due to screening effect the valency electron experiences less attraction towards the nucleus. This brings decrease in the nuclear charge (Z) actually present on the nucleus. The reduced nuclear charge is termed effective nuclear charge and its magnitude increases in a period when we move from left to right.

111. (d) : In B_2 , total number of electrons = 10
 $\text{B}_2 \rightarrow \sigma(1s)^2 \sigma^*(1s^2) \sigma(2s)^2 \sigma^*(2s)^2 \sigma(2p_x)^1 \pi(2p_y)^1$
 Presence of unpaired electron shows the paramagnetic nature.

The highest occupied molecular orbital is of π -type.

112. (a) : Hydrolysis of methyl chloride to methanol follows $\text{S}_{\text{N}}2$ reaction. The rates of many $\text{S}_{\text{N}}2$ reactions are affected by the solvent. Protic solvents – those that contain – OH or – NH group are generally the worst solvents for $\text{S}_{\text{N}}2$. Polar protic solvents, (like water, alcohols and carboxylic acids), which have strong dipoles but don't have – OH or – NH groups are the best. In contrast to protic solvents, which decrease the rates of $\text{S}_{\text{N}}2$ reactants by lowering the ground state energy of nucleophile, polar aprotic solvents (DMF) increase the rates of $\text{S}_{\text{N}}2$ reactions by raising the ground state energy of nucleophile.

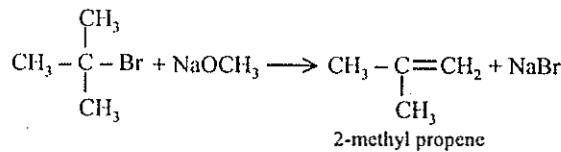
113. (a) : Zinc metal which has a more negative electrode potential than iron will provide electrons in preference to the iron, and therefore corrode first. Only when all the zinc has been oxidised does the iron start to rust.

114. (d) : Extraction of iron metal from iron oxide ore is carried out by heating with coke and flux (calcium carbonate). Flux is a slag forming substance. It converts infusible impurities into fusible slag.

The reaction : $\text{Fe}_2\text{O}_3 \rightarrow \text{Fe} + 3/2 \text{O}_2$ is not a spontaneous process. Fe_2O_3 is converted to FeO at about 400°C . FeO is converted to Fe at about 800°C - 1000°C .

115. (d) : Rates of nitration of benzene and hexadeutero benzene are same because nitration depends upon availability of electrophile.

116. (b) : In Williamson's synthesis, if a tertiary alkyl halide is used, an alkene is the only reaction product and no ether is formed.



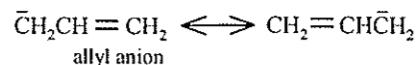
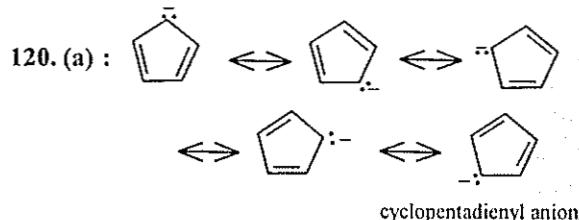
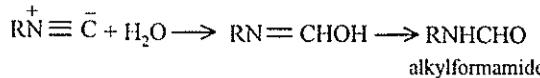
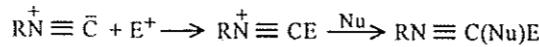
It is because alkoxides are not only nucleophiles but also strong bases as well. They react with alkyl halides leading to elimination reaction.

117. (e) : On hydrolysis one mole of maltose yields two moles of D-glucose. It is a reducing sugar. The two glucose units are linked through α -glucosidic linkage between C - 1 of one unit and the C-4 of another.

118. (d) : The nitro group strongly deactivates the benzene ring towards electrophilic substitution.

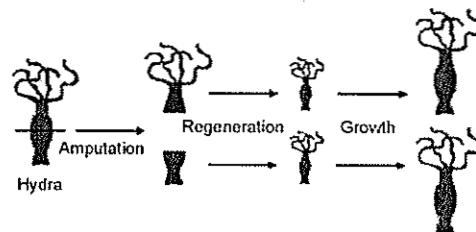
Nitrobenzene does not undergo Friedel-Crafts acylation reaction.

119. (a) : In an isocyanide, first an electrophile and then a nucleophile add at the carbon to form a species which usually undergoes further transformations.



Here the resonance approach is a poor predictor of stability. The Huckel rule, based on molecular orbital theory, is a much better predictor of stability for these aromatic and antiaromatic systems.

121. (a) : Based on cellular mechanisms, regeneration can be divided into two broad categories : morphallaxis and epimorphosis.



Morphallaxis refers to the type of regeneration in which lost body parts are replaced by the remodelling of the remaining tissue. In this type of regeneration, little or no cellular proliferation takes place during the regeneration process. A classic example of an organism that regenerates using this mechanism is the *Hydra*. When a *Hydra* is cut into two pieces, two *Hydra* will be regenerated, both smaller than the parental *Hydra*. Once regeneration is completed, the two *Hydra* can continue to grow and reach the size of their original parent. In contrast to morphallaxis, epimorphosis requires active cellular proliferation prior to the replacement of the lost body part. For example, *Planarian*, which are flatworms, regenerate using a mechanism in which pre-existing stem cells, known as neoblasts, begin to proliferate and migrate to the injured site in response to injury. These cells then form a mass of proliferating cells, known as regeneration blastema, that will later differentiate into the specialized cells that comprise the regenerated structure. Most tissue regeneration in mammals also belongs to the epimorphosis. For example, mammals can regenerate their muscle, bone, epithelia of the skin and gut, blood, and some neurons by activating pre-existing stem cells or progenitor cells.

122. (d) : Gastrin is a polypeptide hormone produced by the enteroendocrine cells of the stomach after exposure to mechanical stimuli or stimulation of vagus nerve and of the duodenum, after the exposure of chyme that contains undigested proteins. It plays an important role in the control of gastric acid secretion. Inhibin hormone is secreted from corpus luteum, placenta and testes. It supplements the effect of excess sex hormones for depressing gonadotrophic activity (FSH, LH, ICSH). The target of inhibin is anterior lobe of pituitary. Duodenal enterokinase converts trypsinogen to activate trypsin which, in turn, activates the other pancreatic enzymes. Atrial natriuretic factor (ANF) is released by walls of the cardiac atrium in response to high sodium concentration, high extracellular fluid volume, or high blood volume. It then acts *via* various mechanisms to excrete Na⁺ and to cause vasodilation in the circulatory system. It dilates the afferent glomerular arteriole, constricts the efferent glomerular arteriole, and relaxes the mesangial cells. This increases the glomerular filtration rate, resulting in greater excretion of Na⁺ and water. It also decreases Na⁺ resorption in the renal distal convoluted tubule and cortical collecting duct. It also inhibits renin secretion.

123. (b) : Cretinism is a type of mental retardation and bodily malformation caused by severe, uncorrected thyroid deficiency in infancy and early childhood. Delta cells are a type of cell in the pancreas (the organ of the digestive system located behind the stomach). Within the pancreas, the delta cells are located in areas called the islets of Langerhans. The delta cells make somatostatin, a hormone that inhibits the release of numerous hormones in the body. Somatostatin has a variety of functions. Taken together, they work to reduce the rate at which food is absorbed from the contents of the intestine. Somatostatin is also secreted by the hypothalamus and by the intestine. Beta cells in the pancreatic islets secrete the hormone insulin in response to a high concentration of glucose in the blood. Parathyroid hormone is a hormone secreted by the parathyroid glands that regulates the metabolism of calcium and phosphate in the body. Parathyroid hormone acts to raise the extracellular calcium concentration, that is, the concentration of calcium ions in the spaces between the cells of the body and in the blood plasma; it promotes the absorption of calcium by the intestine, mobilizes calcium salts from the bones, and increases

the tendency of the kidney to recover calcium from the urine. The hormone also enhances both the excretion of phosphate by the kidneys and its uptake by the cells.

124. (a) : In the given chart the disease is inherited by female child from his father and none of the male child is affected hence it shows that the disease is X linked. Moreover, in the progeny the disease is expressed phenotypically by female child even if it is carrier, so the disease is dominant. Hence the pattern of disease is X linked dominant.

125. (c) : The cross section of the sperm midpiece shows the axial bundle of microtubules or axoneme surrounded by a microtubular sheath in which the mitochondria of the spermatid have become arranged in a helical manner. The microtubular structure provides the ability of the sperm to swim through the reproductive tract of the female. The microtubules are in 9 + 2 arrangement.

126. (c) : Bt in "Bt Cotton" stands for *Bacillus thurengiensis*. This is naturally occurring soil bacterium. Somatic hybridization involves fusion of protoplast of two cells. "Flavr savr" is genetically engineered tomatoes which express delayed softening by insertion of an additional copy of PG endocidin gene. PG is polygalacturonase enzyme which is responsible for the breakdown of cell wall pectin. Transgenic *Brassica napus* seeds are being used to produce the anticoagulant hirudin.

127. (b) : Inflammation is common to almost all diseases that involve microbiologic, chemical, or physical injury to living tissues. Acute inflammation may be defined as the microcirculation response to injury; the cardinal signs are heat, redness, pain, swelling, and loss of function. The accompanying microcirculatory changes comprise arteriolar vasodilation, increased small vein permeability, formation of edema fluid, and WBC migration to the site of injury. Histamine is stored in mast cell granules and basophils and is released by inflammatory and immunologic stimuli. It plays an important role in acute inflammation, exerting a dilator action on arterioles, increasing the permeability of small venules to plasma proteins and causing pain by stimulating nociceptors. However, the generally poor clinical efficacy of antihistamines suggests that their role in nonimmune inflammation is limited. Plasma kinins such as bradykinin are not stored but are released by the action of kininase on plasma α_2 -globulin. Bradykinin is a potent vasodilator, increasing small vein permeability

and causing pain by stimulating peripheral nociceptors, but it has a short half-life.

128. (c) : Eastern Himalayas and Western Ghats are the geographical areas in India which shows the maximum diversity.

129. (a) : Introduction of high yield varieties is the major threat to the genetic diversity in agricultural crops. This would eliminate other crop type/variety from the pool.

130. (c) : *Ex situ* conservation is the preservation of components of biological diversity outside their natural habitats: in zoos, aquaria, botanic gardens and gene banks, for example. Zoos, botanical gardens and arboretums are the most conventional methods of *ex-situ* conservation, all of which house whole, protected specimens for breeding and reintroduction into the wild when necessary and possible. These facilities provide not only housing and care for specimens of endangered species, but also have an educational value.

Rest of the given options are example of *insitu* conservation.

131. (b) : Blue baby syndrome is blood related condition found in babies due to nitrate poisoning (poisoning limits blood's ability to carry oxygen thereby causing baby to look blue); known as methemoglobinemia. This is a serious illness in infants which is caused when nitrate is converted into nitrite in the infant's body. Nitrite interferes with the oxygen carrying capacity of the child's blood (It replaces the oxygen on the red blood cells). This is an acute disease in that symptoms can develop rapidly in infants. However, in most cases, health deteriorates over a period of days. Clearly, expert medical advice should be sought immediately if these symptoms occur.

132. (b) : MRI is a non-invasive technique which uses strong magnetic field for generating resonance and low radio frequency in protons present in body. Most common protons are H nuclei of H₂O molecules. Scapula and canine are osteocytic structures with negligible H₂O content.

133. (d) : Valium (diazepam) is in a class of drugs called benzodiazepines. Valium (diazepam) affects chemicals in the brain that may become unbalanced and cause anxiety, seizures, and muscle spasms. Valium (diazepam) is used to relieve anxiety, nervousness, and tension associated with anxiety disorders. It is also used to treat

certain types of seizure disorders and muscle spasms.

134. (c)

135. (b) : Menstruation is a part of the female reproductive cycle that starts when girls become sexually mature at the time of puberty. The parts of the body involved in the menstrual cycle include the brain, pituitary gland, uterus and cervix, ovaries, fallopian tubes and vagina. The following events given in the options occur in a normal menstrual cycle.

- (i) Release of egg called ovulation usually takes place roughly 14 days after the first day of the start of a period for fertilization.
- (ii) Following menstruation endometrium regenerates about 8 days during the proliferative phase.
- (iii) Implantation occurs after 7 days of fertilization.
- (iv) Progesterone level rises after ovulation which occurs after 14 days.

136. (d) : T₁ plasmid is found extragenomically in *Agrobacterium tumefaciens* which possess T-DNA that is responsible for causing tumor in host plant.

137. (a) : Non-biodegradable pollutant: a pollutant which retains its toxicity for extremely long periods of time. Some lead and mercury compounds, certain chlorinated hydrocarbon pesticides (e.g., DDT) and radioactive substances are nonbiodegradable pollutants. Osteoporosis is a condition that is characterized by a decrease in bone mass and density, causing bones to become fragile. Blackfoot disease (BFD) is a severe form of peripheral vascular disease (PWD), in which the blood vessels in the lower limbs are severely damaged, resulting eventually in progressive gangrene. It has been observed in Taiwan. Itai-itai disease is a chronic cadmium poisoning with renal tubular dysfunction followed by osteomalacia.

138. (a) : Camel excrete a highly concentrated urine to conserve water. They do not sweat till body temperature rises about 55°C-60°C. Camel can also tolerate desiccation upto 40% cellular content.

139. (a) : Cri du chat a rare syndrome (1 in 50,000 live births) caused by a deletion on the short arm of chromosome 5, is a rare genetic disorder due to a missing portion of chromosome 5. It was first described by Lejeune in 1963. The name of this syndrome is French for "cry of the cat," referring to the distinctive cry of children with this disorder. The cry is caused by abnormal

larynx development, which becomes normal within a few weeks of birth. Infants with cri du chat have low birth weight and may have respiratory problems.

140. (a) : Brassica (mustard) belongs to family Brassicaceae. Family brassicaceae is characterised by polypetalous 4 petals, polysepalous 4 sepals, six stamens (which are in tetrodynamic condition i.e. 4 + 2 or in two whorls, 4 inner long and 2 outer short). Gynoecium is bicarpellary, syncarpous unilocular with parietal placentation. Fruit is usually siliqua (Dry dehiscent fruit formed by bicarpellary syncarpous gynoecium with replum) and rarely lomentum.

141. (b) : Polygene results in quantitative inheritance. Quantitative inheritance is characterised by occurrence of intermediate forms between the parental type. There will be 7 (1 : 6 : 15 : 20 : 15 : 6 : 1) phenotypes when three polygene pairs are involved. The total number of progeny would be 64. Out of these sixty four only two will be likely to resemble either parents. Hence their proportion in F_2 generation would be 3.12 i.e. less than five per cent.

142. (c) : Mature cork cells are plant cells that form the protective water resistant tissue in the outer covering of stems and trunks. Cork cells are genetically programmed not to divide, but instead to remain as they are dead cells. Cork cells possess lenticels. A lenticel is produced beneath a former stomata or stoma of the epidermis. They encloses intercellular space for gaseous exchange. Passage cells help in transfer of water from cortex. Quiescent centre is present in root apical meristem.

143. (b): The synapsis, pairing of homologous chromosomes takes place during zygotene. Synapsis results in the formation of bivalents during zygotene. The formation of special proteinaceous structure called synaptonemal complex occur. After zygotene stage cell entered in pachytene stage in which the bivalents become spiralled, shortened and thickened.

144. (b) : Recombination is the natural process of breaking and rejoining DNA strands to produce new combinations of genes and, thus, generate genetic variation. This is the phenomenon occur during meiosis I.

145. (d) : The presence of plastid is a feature of plant cells but animal cells are devoid of them. Even then they function properly and divide mitotically similar to plant cells.

146. (a) : Lysosomes are roughly spherical bodies bounded by a single membrane. They are manufactured by the Golgi apparatus. Lysosomes are small membrane bound vesicles in the cytoplasm of cells which contain toxic enzymes. When a cell dies, these membranes rupture and the enzymes are released. They break down the cells structure, and the debris is removed. The lysosome also contains cytokines which summon inflammatory cells and stimulate inflammation. The contents of lysosomes can be released by macrophages and neutrophils both to kill bacteria and viruses, and to stimulate inflammation.

147. (b) : Glyoxysomes are enzymes which play a critical role in lipid metabolism in seedlings. Hence they are supposed to be present in endosperm of castor as endosperm of wheat will posses starch.

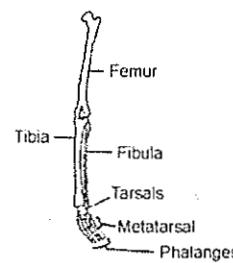
148. (c) : Ecological niche is the term used to describe the status of a plant or animal in its community.

149. (c) : Pyramid of energy is always upright as only 10% energy is transferred from one trophic level to another. Pyramid of number in a grassland is also upright as the producers are always maximum in number than herbivores and carnivores. Pyramid of biomass in a lake shows spindle shaped pyramid.

150. (b)

151. (b) : Nephridia in earthworm, malpighian tubules in cockroach and urinary tubules in rat are all excretory in function.

152. (c) : According to the correct labelling shown the pair fibula and phalanges is wrongly marked.



153. (c) : Electroporation is the process used for the transformation of bacteria or plant protoplasts. Electroporation occurs as a result of the reconcentration of lipid molecules of the bilayer membrane to form hydrophilic pores in the membrane. The distribution of such pores, both in terms of size and number, determine the electrical properties of the cell membrane.

154. (d) : Somatic variations is the term used to

describe the variation seen in plants that have been produced by plant tissue culture. Chromosomal rearrangements are an important source of this variation.

155. (a) : According to the graph the growth of the insect takes place as the amount of the cholesterol increase and at 6 μg cholesterol/g the growth get static. If the growth rate would have been directly proportional to the cholesterol concentration then the graph would have been straight line. (3) is wrong as the optimum level is 6 $\mu\text{g}/\text{g}$ cholesterol concentration.

156. (b) : *Prosopis* are tree found in scrub. *Saccharum* is grass which is cultivated. *Shorea robusta* (Sal) is tree found in moist tropical forest. *Acacia catechu* is tree found in dry deciduous forests.

157. (b) : Reverse transcriptase is an enzyme used by retroviruses to from complementary DNA (cDNA) from their RNA. The resulting DNA is then inserted into the chromosome of the host cell.

158. (b) : Gibberellins induces the hydrolyzing enzymes in the endosperm of germinating seeds. It stimulates the production of digestive enzymes like proteases, amylase, lipase which help to mobilise stored nutrients.

159. (c) : Silverfish, scorpion, dragonfly and prawn all fall in phylum arthropods which have jointed appendages and chitinous exoskeleton as the characteristic feature.

160. (d) : Double fertilization is the characteristic feature of angiosperms. Here one male nucleus fertilizes the egg nucleus and the other male nucleus fertilizes the central cell (polar nuclei). First fertilization result in zygote where as second fertilization results in the formation of endosperm.

161. (a) : Process of ageing is called senescence. Ageing, is cumulative changes in an organism, organ, tissue, or cell leading to a decrease in functional capacity. In humans, aging is associated with degenerative changes in the skin, bones, heart, blood vessels, lungs, nerves, and other organs and tissues.

It is genetically controlled programme regulated by regulatory genes. This view is suggested by the great range of lifespans among different animal species—from a few days in the fruit fly to more than 100 years in some tortoises. Scientists have recently learned how to double the lifespans of such laboratory organisms as roundworms and fruit flies through genetic manipulation, and mutant genes in mice have been observed to have a

comparable effect in postponing ageing.

Genes which have a deleterious effect on individual's fitness are selected against by natural selection. Mutations in these genes which postponed the deleterious effect of the gene to a later time in individual's life history reduce the effect of natural selection to the gene, because the selection has less time to act on it. If the gene doesn't have a negative effect until after the individual has reproduced, the gene may escape natural selection altogether, because when selection starts to affect the gene, it has already propagated to the next generation. In a related fashion, some genes may help to ensure reproduction at the cost of diseases later in life. For instance, our immune system generally helps to keep us healthy during reproductive age, but many adults acquire autoimmune diseases such as rheumatoid arthritis as they age.

162. (a) : In recombinant DNA technology widely used host for replication and amplification of recombinant DNA are prokaryotic *E. coli* and the eukaryotic yeast. They replicate very fast to form a large population which expressed desired gene. Yeast artificial chromosome (YAC) are important cloning tools for the analysis of complex genome such as that of humans. They allow the maintenance, propagation and analysis of such genome in an experimentally tractable system, the yeast.

163. (b) : SPM (Suspended Particulate Matter) is defined as particles floating in the air with a diameter below 10 μm . Studies have shown that high SPM concentrations in the air can have a detrimental impact on respiratory organs. SPM is generated from natural sources (e.g., volcanoes or dust storms) and human activities (vehicles, incinerators and industrial plants).

SPM	Other aerosols
Less than 10 μm	Less than 100 μm
Tend to float longer in air due to small size.	Tend to settle fairly quickly due to comparative heaviness

Catalytic converter is a device designed to reduce the amount of emissions from automobiles. The current (so-called three-way) systems use a heated metal catalyst to reduce the emissions of carbon monoxide (CO), hydrocarbons, and nitric oxide (NO), all of which contribute to the formation of photochemical smog. In an automobile's exhaust system, a catalytic converter provides an environment for a chemical reaction where

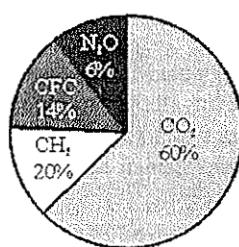
unburnt hydrocarbons completely combust. Hence the combustion process continues but outside the engine combustion chamber where no useful energy is extracted. Toxic car gases such as unburnt hydrocarbon (UHC) and carbon monoxide (CO) would not exist if the fuel to energy conversion in the engine were perfect.

164. (b) : Methane is largely a product of incomplete decomposition and is produced by a group of bacteria called methanogens under anaerobic conditions. The major sources of methane include freshwater wetlands, enteric fermentation in cattle and flooded rice fields. Biomass burning also produces methane. Major gases contributing in greenhouse effect with their percentage contribution are given in the given pie chart.

Efficient engine (for example, multi point fuel injection engine) can reduce the unburnt carbons (like methane etc.) in auto emission.

165. (d) : Interferons are not antibodies. These are natural proteins produced by the cells of the immune systems of most animals in response to challenges by foreign agents such as viruses, bacteria, parasites and tumor cells. Interferons belong to the large class of glycoproteins known as cytokines. In human body there are three types of interferon – α , β and γ . Interferon alpha and beta are produced by many cell types, including T-cells and B-cells and are important component of the antiviral response. They stimulate both macrophages and NK (Natural Killer) cells. They both are also active against tumors. Interferon gamma is involved in the regulation of the immune and inflammatory response. Interferon gamma has had some antiviral and antitumor effect but these are generally weak, however, it potentiates the effect of interferon alpha and interferon beta.

Inflammation is the first response to infection and injury and is critical to body defence. Basically, the inflammatory response is an attempt by the body to restore and maintain homeostasis after injury. Inflammation is the influx of fluid and cells that results in redness, swelling, heat, and pain at the infection site.



The relative contribution of different gases to global warming

166. (a) : An organ transplant is the transplantation of an organ (or part of one) from one body to another, for the purpose of replacing the recipient's damaged or failing organ with a working one from the donor. Organ donors can be living, or cadaveric (dead). Immunosuppressive drug are any of a variety of substances used to prevent production of *antibodies*. They are clinically used to

- prevent rejection by a recipient's body of an organ (e.g. bone marrow, heart, kidney, liver) transplanted from a donor. A transplant is rejected when the recipient's immune system acts against it.

- treatment of autoimmune diseases or diseases that are most likely of autoimmune origin (e.g. rheumatoid arthritis). The *steroids*, such as *cortisone*, which suppress the antibody-forming lymphocyte cells, have been used to prolong human organ transplants. Steroids may also prevent antigens from entering cells and thereby prevent local allergic inflammation reactions. In another immunosuppressive method, human lymphocytes are injected into horses, stimulating the animals to produce antilymphocyte serum. The serum, administered to humans with transplanted organs, in some way inactivates lymphocytic cells. Another group of immunosuppressive drugs act by interfering with the synthesis of *nucleic acids* and are especially effective against proliferating cells such as stimulated lymphocytes. Some of these are analogs of purines and pyrimidines, substances that are nucleic acid subunits; the purine analog azathioprine has been used to suppress rejection of transplanted human kidneys. Most substances that inhibit nucleic acid synthesis, such as nitrogen mustard, cyclophosphamide (*Cytoxan*), chloramphenicol, actinomycin, and colchicine, are not widely used clinically because they are too toxic.

167. (c) : Haemophilia is a blood disorder where the blood does not clot normally. Haemophilia A is the most common form, caused by a deficiency of blood clotting factor VIII. Haemophilia B is due to a deficiency of blood clotting factor IX. Haemophilia is an hereditary disorder. In almost all cases, it is males that suffer the condition, although it is passed on by both females and males carrying the gene. Queen Victoria was a carrier of haemophilia A. It is also known as classical haemophilia and factor VIII deficiency haemophilia. Haemophilia B is also known as Factor IX haemophilia, and Christmas disease after the

first patient diagnosed with it. Prothrombin producing platelets in such persons are not found in very low concentration.

168. (c) : In most animal species, chromosomes can be categorized as two types: autosomes and sex chromosomes. Autosomes are non-sex chromosomes that are the same number and kind between sexes. Sex chromosomes determine if the individual is male or female. Sex chromosomes in the human female are XX; those of the male are XY. Males produce X-containing and Y-containing gametes; therefore males determine the sex of offspring. Besides genes that determine sex, sex chromosomes carry many genes for traits unrelated to sex. X-linked gene is any gene located on X chromosome; used to describe genes on X chromosome that are missing on the Y chromosome.

When the female ovum is fertilized by the male, there is initiated an incredibly complex chain of events which culminate nine months later in the birth of a child. During the very early stages of this gestation period the development of the embryo is predisposed in certain directions by the possession of the sex chromosomes which are composed of two elements, one contributed by the mother and the other by the father. The mother can contribute only what is termed as an X chromosome which predisposes towards the development of female structural, functional and temperamental characteristics, but the father can contribute either an X or a Y chromosome predisposing in the first instance to female, or in the second to male structural and functional and temperamental characteristics. In short, the sex of the child to be born is initially governed by the chromosomal contribution of the father. All chromosomes are paired, and the Y is dominant over the X chromosome when combined with it. A child conceived will therefore be subject during development thereafter to a predisposition towards femaleness if receiving an X chromosome from the mother and an X chromosome from the father (XX), or towards maleness if receiving an X chromosome from the mother but a Y chromosome from the father (XY). Therefore sex in human is a monogenic not polygenic.

Polygenic traits or continuous traits are those traits that are determined by the combined effect of more than one pair of genes. An example of this is human stature. The combined size of all of the body parts from head to foot determines the height of an individual. There is an additive effect. The sizes of all of these body parts

are, in turn, determined by numerous genes. Human skin, hair, and eye colour are also polygenic traits because they are influenced by more than one allele at different loci. The result is the perception of continuous gradation in the expression of these traits.

169. (c) : Mitochondria and chloroplasts both are double membrane organelles. They are semi autonomous as both their structure and functions are partially controlled by nucleus of the cell and partially themselves. Both possess their own DNA and arises from pre-existing cells. Synthesis of many amino acids occurs in mitochondria. The first formed amino acids are glutamic acid and aspartic acid.

Also plastid manufactures some of its own proteins, enzymes and other chemicals because of the presence of 70s ribosomes which can help translate the coded information contained in mRNAs transcribed over chloroplast DNA.

170. (a) : DNA replication is the process of forming carbon copy of DNA. Whereas transcription is the formation of RNA over DNA template.

DNA replication and transcription takes place in nucleus as the required material DNA and RNA are present in the nucleus.

During transcription mRNA take the coded information from DNA to the cytoplasm where translation takes place. Translation is the process of protein synthesis. It is separated from transcription in both space and time. It prevents the intermixing of raw materials, protect DNA from respiratory enzymes and ribosomal machinery from nuclease.

171. (c) : Fungi are considered ubiquitous i.e. they occur in a variety of habitats. Most of them are moisture loving and terrestrial and few (eg. *Monoblepharis*) are aquatic. Fungi may be epiphytic (i.e. live on plants eg. *Armillaria*), saprophytic (i.e. grow in dead organic matter eg. *Mucor*), symbiotic (i.e. live with association with other plants eg. lichen, mycorrhiza) and predacious (eg. *Dactyldela*) and parasitic (eg *Erysiphi*) fungi are achlorophyllus i.e. devoid of chlorophyll hence cannot prepare their own food. They are heterotrophic and show absorptive type of nutrition.

172. (a) : C₄ photosynthetic pathway is more efficient than C₃ pathway as C₄ plants can pick up CO₂ even when it is found in low concentration. PEP enzymes shows high affinity for CO₂. C₄ plants contain two types of chloroplast (Kranz anatomy) : bundle sheath

chloroplast and mesophyll chloroplast. Bundle sheath cells contain Calvin cycle enzymes. Due to high concentration of CO_2 in bundle sheath cells, RuBP carboxylase works only for Calvin cycle and not for photorespiration.

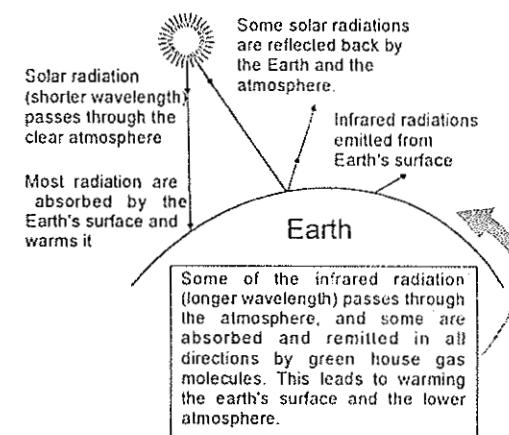
Photorespiration is a wasteful process as it works to undo the act of photosynthesis in C_3 plants. No energy rich compound is produced in this process. When temperature increase more and more photosynthetically fixed carbon is lost by photorespiration thus reducing the efficiency of C_3 plants.

173. (d) : If humans share ancestry with other primates, then we should expect to see remnants of that common ancestry in our genes. For example, tails; this characteristic is still exhibited occasionally in atavism. According to current evolutionary theory, the ancestors of humans lost their tails about 25 million years ago, when apes (tail-less primates) diverged from monkeys (tailed primates). Theory of the continuity of the germplasm was given by Weismann. The German biologist Weismann recognized that animals are made up of: body cells (soma), which contain gamete-producing cells (germplasm). At each generation, the embryo that develops from the zygote not only sets aside some germplasm for the next generation but also produces the cells that will develop into the body, the soma, of the organism. Jean-Baptise Lamarck (1744-1829), presented the first widely discussed theory of Evolution, the idea that organisms are connected through time by ancestor-descendent relationships and that they change through time. Lamarck's theory of evolution had four main components. (1) Spontaneous generation of organisms from inanimate matter occurs continuously throughout Earth history (2) Extinction does not occur. (3) Traits developed by parents are passed on directly to offspring (The Inheritance of Acquired Characteristics). (4) Use or disuse of parts causes them to transformation (i.e., it drove evolutionary change).

174. (b) : The warming up of global atmosphere present day is due to the increase in green house effect.

Green house effect (GHE) describes the roles of water vapour, CO_2 and other trace gases in keeping the Earth's surface warmer than it would be otherwise. These radiatively active gases are relatively transparent to incoming shortwave radiation (visible spectrum), but are relatively opaque to outgoing reradiating (infrared

rays) longwave radiation. The latter radiation, which would otherwise escape to space, is trapped by these gases within the lower levels of the atmosphere. The subsequent reradiation of some of the energy back to the surface maintains surface temperature higher than they would be if the gases were absent (without the green house effect the Earth's average global temperature would be -18 degree celsius rather than the present 15 degree celsius). There is concern that increasing concentration of the green house gases including CO_2 , CH_4 , and man made chlorofluorocarbons (CFCs), may enhance the green house effect and cause global warming.



Ozone layer present in the stratosphere is depleted by the aerosols and chlorofluorocarbons. Ozone protects the earth from high energy ultra violet radiation.

175. (b) : Convincing evidence of common ancestry comes from the similarities in the biochemical composition, reactions and physiological activities of living beings, like metabolic process, enzymes, cytochrome C, insulin, haemoglobin, blood and lymph etc. Genetic code is the sequence of DNA nucleotides that determines the amino acid sequence of the translated protein. The genetic code is read in triplets of bases called codons.

Genetic code is applicable universally i.e. a codon specifies the same amino acid from a virus to a tree or human beings. The mRNA from chick oviduct introduced in *E.coli* produces an ovalbumen in the bacterium exactly similar to one formed in chick.

176. (a) : Darwin finches are an excellent example of the way in which the species gene pools have adapted in order for long term survival via their offspring. Finches

were formed due to divergent evolution (adaptive radiation) to avoid interspecific competition.

The common birds of Galapagos islands, the finches were markedly different from the finches of main land. The closely related species of finches had beak of different shapes and sizes, and adapted for feeding on completely different diets. Darwin also found that fossils of Galapagos islands are most similar to living species of South America. The food supply increases in arithmetic ratio but the population increases in geometric ratio. With the study of this theory it struck to Darwin that there is struggle for existence among plants and animals. This concept of competition among the living beings for their survival offered the basis for the theory of natural selection. Apparently a single ancestral group can give rise to several different varieties of species.

177. (c) : At very low CO_2 concentration photosynthesis is strongly limited by the low CO_2 while respiratory rates are unaffected. As a result there is a negative balance between CO_2 fixed by photosynthesis and CO_2 produced by respiration and a net efflux of CO_2 from the plant.

By increasing the atmospheric concentration of CO_2 at which photosynthesis just compensates for respiration is referred to as CO_2 compensation point.

178. (b) : The most important demographic characteristic of a population is its age sex structure which is also known as population pyramids. Age sex pyramids display the percentage or actual amount of a population broken down by gender and age. Developed countries with stable population gives a steep pyramid.

The population of Sudan and India are increasing at a rapid rate. The population growth rate for Sudan is 2.60% and for India it is 1.40%.

179. (a) : To be a mammal the presence of hair and milk or mammary gland is must, but presence of 7 cervical

vertebrae and 12 pairs of cranial nerves are also additional mammalian characteristics. The monotremes make up by far the smallest subclass of mammals, with just three species, found in Australia, Tasmania, and New Guinea. One of these is the duck-billed platypus, and the remaining two are the echidnas, or spiny anteaters. The duck-billed platypus and the spiny anteater are mammals that lay eggs rather than give live birth to young ones. The platypus has a bill like a duck, fur like a mammal and webbed feet. It lays eggs that look like reptile eggs. Its young feed from the mother's mammary glands. The spiny anteater's covering looks like that of the porcupine. It has a long tongue to catch insects and a bill. It lays several eggs which it keeps in a pouch on its side.

180. (d) : *Agrobacterium tumefaciens* is a gram negative non sporing, motile, rod shaped bacterium, closely related to *Rhizobium*. It is found commonly on and around root surfaces. The region termed rhizosphere where it seems to survive by using nutrients that leak from the root tissues. But it infects only through the wound-site either naturally occurring or caused by transplanting of seedling and nursery stock. It is harmful to plants and useful to scientists for the same reason i.e. it transfers DNA into plant genomes found in soil worldwide. *A. tumefaciens* cause crown gall disease of a wide range of dicot (broccoli leaved) plants especially members of rose family by transferring its own DNA into plant cells. But in laboratory, the ability to move all sorts of genes into plants has made the microbe the standard tool for investigating plant genetics and modifying crops.

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|----------|----------|----------|----------|
| 181. (a) | 182. (d) | 183. (c) | 184. (a) |
| 185. (d) | 186. (a) | 187. (a) | 188. (a) |
| 189. (b) | 190. (a) | 191. (b) | 192. (b) |
| 193. (a) | 194. (c) | 195. (c) | 196. (a) |
| 197. (b) | 198. (b) | 199. (a) | 200. (c) |

