

# SOLVED PAPER

## AIIMS - 2005

Time : 3½ Hours

Max. Marks : 200

### PHYSICS

1. For skywave propagation of a 10 MHz signal, what should be the minimum electron density in ionosphere?  
 (a)  $\sim 1.2 \times 10^{12} \text{ m}^{-3}$  (b)  $\sim 10^6 \text{ m}^{-3}$   
 (c)  $\sim 10^{14} \text{ m}^{-3}$  (d)  $\sim 10^{22} \text{ m}^{-3}$
2. Which of the following logic gates is an universal gate?  
 (a) OR (b) NOT  
 (c) AND (d) NAND.
3. What should be the maximum acceptance angle at the air-core interface of an optical fibre if  $n_1$  and  $n_2$  are the refractive indices of the core and the cladding, respectively?  
 (a)  $\sin^{-1}(n_2/n_1)$  (b)  $\sin^{-1}\sqrt{n_1^2 - n_2^2}$   
 (c)  $\left[ \tan^{-1} \frac{n_2}{n_1} \right]$  (d)  $\left[ \tan^{-1} \frac{n_1}{n_2} \right]$
4. A conducting ring of radius 1 meter is placed in an uniform magnetic field  $B$  of 0.01 tesla oscillating with frequency 100 Hz with its plane at right angle to  $B$ . What will be the induced electric field?  
 (a)  $\pi$  volts/m (b) 2 volts/m  
 (c) 10 volts/m (d) 62 volts/m.
5. Consider an  $n$ - $p$ - $n$  transistor amplifier in common-emitter configuration. The current gain of the transistor is 100. If the collector current changes by 1 mA, what will be the change in emitter current?  
 (a) 1.1 mA (b) 1.01 mA  
 (c) 0.01 mA (d) 10 mA.
6. A telescope has an objective lens of focal length 200 cm and an eye piece with focal length 2 cm. If this telescope is used to see a 50 meter tall building at a distance of 2 km, what is the height of the image of the building formed by the objective lens?  
 (a) 5 cm (b) 10 cm  
 (c) 1 cm (d) 2 cm.
7. The ground state energy of hydrogen atom is -13.6 eV. What is the potential energy of the electron in this state?  
 (a) 0 eV (b) -27.2 eV  
 (c) 1 eV (d) 2 eV.
8. Solid targets of different elements are bombarded by highly energetic electron beams. The frequency ( $f$ ) of the characteristic X-rays emitted from different targets varies with atomic number  $Z$  as  
 (a)  $f \propto \sqrt{Z}$  (b)  $f \propto Z^2$   
 (c)  $f \propto Z$  (d)  $f \propto Z^{3/2}$ .
9. Two infinitely long parallel conducting plates having surface charge densities  $+\sigma$  and  $-\sigma$  respectively, are separated by a small distance. The medium between the plates is vacuum. If  $\epsilon_0$  is the dielectric permittivity of vacuum, then the electric field in the region between the plates is  
 (a) 0 volt/meter (b)  $\sigma/2\epsilon_0$  volt/meter  
 (c)  $\sigma/\epsilon_0$  volt/meter (d)  $2\sigma/\epsilon_0$  volt/meter.
10. In a semiconducting material the mobilities of electrons and holes are  $\mu_e$  and  $\mu_h$  respectively. Which of the following is true?  
 (a)  $\mu_e > \mu_h$  (b)  $\mu_e < \mu_h$   
 (c)  $\mu_e = \mu_h$  (d)  $\mu_e < 0 ; \mu_h > 0$ .
11. The magnetic moment ( $\mu$ ) of a revolving electron around the nucleus varies with principal quantum number  $n$  as  
 (a)  $\mu \propto n$  (b)  $\mu \propto 1/n$   
 (c)  $\mu \propto n^2$  (d)  $\mu \propto 1/n^2$ .
12. A radioactive material has a half-life of 10 days. What fraction of the material would remain after 30 days?  
 (a) 0.5 (b) 0.25  
 (c) 0.125 (d) 0.33

13. According to Hubble's law, the redshift ( $Z$ ) of a receding galaxy and its distance  $r$  from earth are related as

(a)  $Z \propto r$  (b)  $Z \propto 1/r$   
(c)  $Z \propto 1/r^2$  (d)  $Z \propto r^{3/2}$

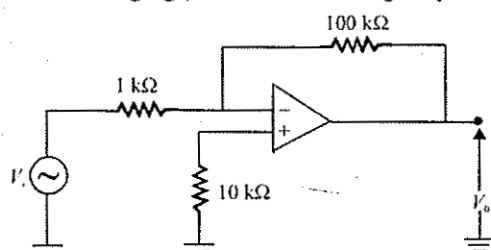
14. When exposed to sunlight, thin films of oil on water often exhibit brilliant colours due to the phenomenon of

(a) interference (b) diffraction  
(c) dispersion (d) polarisation.

15. "Parsec" is the unit of

(a) time (b) distance  
(c) frequency (d) angular acceleration.

16. The voltage gain of the following amplifier is

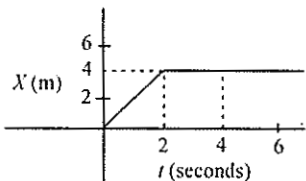


(a) 10 (b) 100  
(c) 1000 (d) 9.9

17. A 50 Hz a.c. source of 20 volts is connected across  $R$  and  $C$  as shown in figure. The voltage across  $R$  is 12 volt. The voltage across  $C$  is

(a) 8 V (b) 16 V  
(c) 10 V (d) not possible to determine unless values of  $R$  and  $C$  are given.

18. In the figure given, the position-time graph of a particle of mass 0.1 kg is shown.



The impulse at  $t = 2$  sec is

(a)  $0.2 \text{ kg m sec}^{-1}$  (b)  $-0.2 \text{ kg m sec}^{-1}$   
(c)  $0.1 \text{ kg m sec}^{-1}$  (d)  $-0.4 \text{ kg m sec}^{-1}$

19. The pressure exerted by an electromagnetic wave of intensity  $I$  (watt/m<sup>2</sup>) on a nonreflecting surface is [ $c$  is the velocity of light]

(a)  $Ic$  (b)  $Ic^2$   
(c)  $I/c$  (d)  $I/c^2$

20. A block of mass 10 kg is moving in  $x$ -direction with a constant speed of 10 m/sec. It is subjected to a retarding force  $F = -0.1x$  joule/meter during its travel from  $x = 20$  meter to  $x = 30$  meter. Its final kinetic energy will be

(a) 475 joule (b) 450 joule  
(c) 275 joule (d) 250 joule.

21. Energy required to break one bond in DNA is approximately

(a)  $\sim 1 \text{ eV}$  (b)  $\sim 0.1 \text{ eV}$   
(c)  $\sim 0.01 \text{ eV}$  (d)  $\sim 2.1 \text{ eV}$

22. The condition for a uniform spherical mass  $m$  of radius  $r$  to be a black hole is [ $G$  = gravitational constant and  $g$  = acceleration due to gravity]

(a)  $\left(\frac{2Gm}{r}\right)^{1/2} \leq c$  (b)  $\left(\frac{2gm}{r}\right)^{1/2} = c$   
(c)  $\left(\frac{2Gm}{r}\right)^{1/2} \geq c$  (d)  $\left(\frac{gm}{r}\right)^{1/2} \geq c$

23. Which of the following is an amorphous solid?

(a) glass (b) diamond  
(c) salt (d) sugar.

24. For a constant hydraulic stress on an object, the fractional change in the object's volume ( $\Delta V/V$ ) and its bulk modulus ( $B$ ) are related as

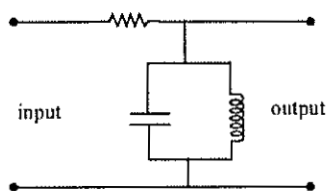
(a)  $\frac{\Delta V}{V} \propto B$  (b)  $\frac{\Delta V}{V} \propto \frac{1}{B}$   
(c)  $\frac{\Delta V}{V} \propto B^2$  (d)  $\frac{\Delta V}{V} \propto B^{-2}$

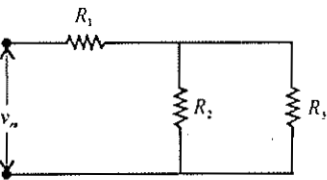
25. Which of the following functions represents a simple harmonic oscillation?

(a)  $\sin \omega t - \cos \omega t$  (b)  $\sin^2 \omega t$   
(c)  $\sin \omega t + \sin 2\omega t$  (d)  $\sin \omega t - \sin 2\omega t$

26. In case of linearly polarised light, the magnitude of the electric field vector

(a) does not change with time  
(b) varies periodically with time  
(c) increases and decreases linearly with time  
(d) is parallel to the direction of propagation.

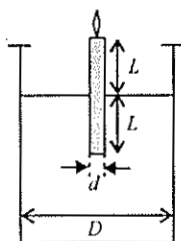
27. The circuit shown below acts as
- 
- (a) tuned filter  
(b) low pass filter  
(c) high pass filter  
(d) rectifier.

28. For ensuring dissipation of same energy in all three resistors ( $R_1$ ,  $R_2$ ,  $R_3$ ) connected as shown in figure, their values must be related as
- 
- (a)  $R_1 = R_2 = R_3$   
(b)  $R_2 = R_3$  and  $R_1 = 4R_2$   
(c)  $R_2 = R_3$  and  $R_1 = 1/4 R_2$   
(d)  $R_1 = R_2 + R_3$ .

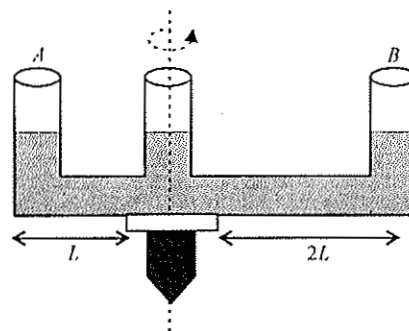
29. The apparent depth of water in cylindrical water tank of diameter  $2R$  cm is reducing at the rate of  $x$  cm/minute when water is being drained out at a constant rate. The amount of water drained in c.c. per minute is ( $n_1$  = refractive index of air,  $n_2$  = refractive index of water).

- (a)  $\frac{x\pi R^2 n_1}{n_2}$   
(b)  $\frac{x\pi R^2 n_2}{n_1}$   
(c)  $\frac{2\pi R n_1}{n_2}$   
(d)  $\pi R^2 x$ .

30. A candle of diameter  $d$  is floating on a liquid in a cylindrical container of diameter  $D$  ( $D \gg d$ ) as shown in figure. If it is burning at the rate of 2 cm/hour then the top of the candle will

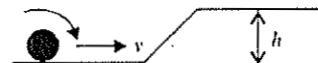


- (a) remain at the same height  
(b) fall at the rate of 1 cm/hour  
(c) fall at the rate of 2 cm/hour  
(d) go up at the rate of 1 cm/hour.
31. A given shaped glass tube having uniform cross section is filled with water and is mounted on a rotatable shaft as shown in figure. If the tube is rotated with a constant angular velocity  $\omega$  when

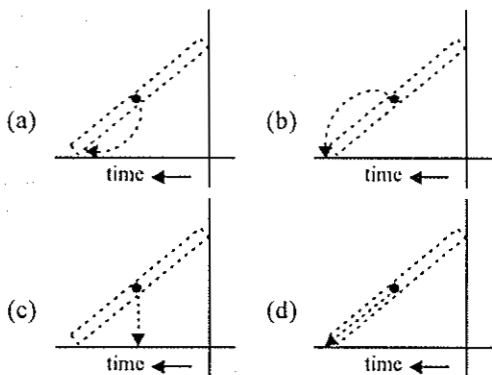


- (a) water levels in both sections A and B go up  
(b) water level in section A goes up and that in B comes down  
(c) water level in section A comes down and that in B it goes up  
(d) water levels remain same in both sections.
32. When a ball is thrown up vertically with velocity  $v_0$ , it reaches a maximum height of  $h$ . If one wishes to triple the maximum height then the ball should be thrown with velocity
- (a)  $\sqrt{3}v_0$   
(b)  $3v_0$   
(c)  $9v_0$   
(d)  $3/2 v_0$ .

33. A solid sphere is rolling on a frictionless surface, shown in figure with a translational velocity  $v$  m/s. If it is to climb the inclined surface then  $v$  should be



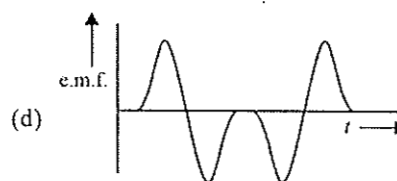
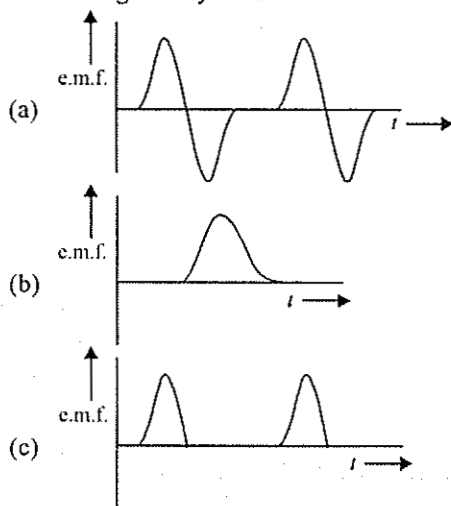
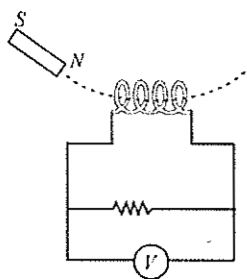
- (a)  $\geq \sqrt{10/7 gh}$   
(b)  $\geq \sqrt{2 gh}$   
(c)  $2gh$   
(d)  $10/7 gh$ .
34. A horizontal platform is rotating with uniform angular velocity around the vertical axis passing through its centre. At some instant of time a viscous fluid of mass  $m$  is dropped at the centre and is allowed to spread out and finally fall. The angular velocity during this period
- (a) decreases continuously  
(b) decreases initially and increases again  
(c) remains unaltered  
(d) increases continuously.
35. A ladder is leaned against a smooth wall and it is allowed to slip on a frictionless floor. Which figure represents trace of its centre of mass.



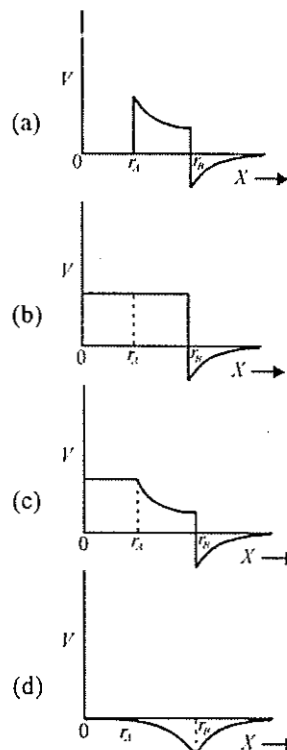
36. A person is standing in an elevator. In which situation he finds his weight less?

- when the elevator moves upward with constant acceleration.
- when the elevator moves downward with constant acceleration.
- when the elevator moves upward with uniform velocity
- when the elevator moves downward with uniform velocity.

37. A magnet is made to oscillate with a particular frequency, passing through a coil as shown in figure. The time variation of the magnitude of e.m.f. generated across the coil during one cycle is



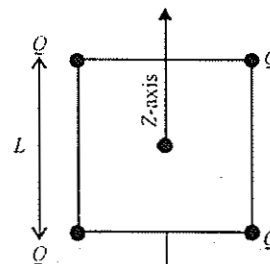
38. Two concentric conducting thin spherical shells  $A$  and  $B$  having radii  $r_A$  and  $r_B$  ( $r_B > r_A$ ) are charged to  $Q_A$  and  $-Q_B$  ( $|Q_B| > |Q_A|$ ). The electrical field along a line, (passing through the centre) is



39. Dimension of electrical resistance is

- $ML^2T^{-3}A^{-1}$
- $ML^2T^{-3}A^{-2}$
- $ML^3T^{-3}A^{-2}$
- $ML^{-1}L^3T^3A^2$

40. Four point +ve charges of same magnitude ( $Q$ ) are placed at four corners of a rigid square frame as shown in figure. The plane of the frame is perpendicular to  $Z$ -axis. If a -ve point



charge is placed at a distance  $z$  away from the above frame ( $z \ll L$ ) then

- (a) -ve charge oscillates along the Z-axis
- (b) it moves away from the frame
- (c) it moves slowly towards the frame and stays in the plane of the frame
- (d) it passes through the frame only once.

**Directions for questions 41–60 :** In each of the following questions, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it. Of the statements, mark the correct answer as

- (a) If both assertion and reason are true and reason is the correct explanation of assertion
- (b) If both assertion and reason are true but reason is not the correct explanation of assertion
- (c) If assertion is true but reason is false
- (d) If both assertion and reason are false.

**41. Assertion :** Specific gravity of a fluid is a dimensionless quantity.

**Reason :** It is the ratio of density of fluid to the density of water.

**42. Assertion :** Frictional forces are conservative forces.

**Reason :** Potential energy can be associated with frictional forces.

**43. Assertion :** By roughening the surface of a glass sheet its transparency can be reduced.

**Reason :** Glass sheet with rough surface absorbs more light.

**44. Assertion :** A diode lasers are used as optical sources in optical communication.

**Reason :** Diode lasers consume less energy.

**45. Assertion :** Diamond glitters brilliantly.

**Reason :** Diamond does not absorb sunlight.

**46. Assertion :** The energy ( $E$ ) and momentum ( $p$ ) of a photon are related by  $p = E/c$ .

**Reason :** The photon behaves like a particle.

**47. Assertion :** The clouds in sky generally appear to be whitish.

**Reason :** Diffraction due to clouds is efficient in equal measure at all wavelengths.

**48. Assertion :** Television signals are received through sky-wave propagation.

**Reason :** The ionosphere reflects electromagnetic waves of frequencies greater than a certain critical frequency.

**49. Assertion :** The logic gate NOT can be built using diode.

**Reason :** The output voltage and the input voltage of the diode have  $180^\circ$  phase difference.

**50. Assertion :** The resolving power of a telescope is more if the diameter of the objective lens is more.

**Reason :** Objective lens of large diameter collects more light.

**51. Assertion :** Reversible systems are difficult to find in real world.

**Reason :** Most processes are dissipative in nature.

**52. Assertion :** For a system of particles under central force field, the total angular momentum is conserved.

**Reason :** The torque acting on such a system is zero.

**53. Assertion :** Air quickly leaking out of a balloon becomes cooler.

**Reason :** The leaking air undergoes adiabatic expansion.

**54. Assertion :** It is not possible to use  $^{35}\text{Cl}$  as the fuel for fusion energy.

**Reason :** The binding energy of  $^{35}\text{Cl}$  is too small.

**55. Assertion :** The number of electrons in a  $p$ -type silicon semiconductor is less than the number of electrons in a pure silicon semiconductor at room temperature.

**Reason :** It is due to law of mass action.

**56. Assertion :** In a common emitter transistor amplifier the input current is much less than the output current.

**Reason :** The common emitter transistor amplifier has very high input impedance.

**57. Assertion :** A body that is a good radiator is also a good absorber of radiation at a given wavelength.

**Reason :** According to Kirchoff's law the absorptivity of a body is equal to its emissivity at a given wavelength.

**58. Assertion :** In pressure-temperature ( $P$ - $T$ ) phase diagram of water, the slope of the melting curve is found to be negative.

**Reason :** Ice contracts on melting to water.

**59. Assertion :** For higher temperatures the peak emission wavelength of a black body shifts to lower wavelengths.

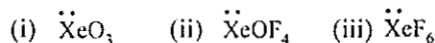
**Reason :** Peak emission wavelengths of a blackbody is proportional to the fourth-power of temperature.

**60. Assertion :** For Reynold number  $R_e > 2000$ , the flow of fluid is turbulent.

**Reason :** Inertial forces are dominant compared to the viscous forces at such high Reynold numbers.

## CHEMISTRY

61. Among the following molecules



Those having same number of lone pairs on Xe are

- (a) (i) and (ii) only  
(b) (i) and (iii) only  
(c) (ii) and (iii) only  
(d) (i), (ii) and (iii).

62. An aqueous solution of  $\text{CoCl}_2$  on addition of excess of concentrated  $\text{HCl}$  turns blue due to formation of

- (a)  $[\text{Co}(\text{H}_2\text{O})_4\text{Cl}_2]$  (b)  $[\text{Co}(\text{H}_2\text{O})_2\text{Cl}_4]^{2-}$   
(c)  $[\text{CoCl}_4]^{2-}$  (d)  $[\text{Co}(\text{H}_2\text{O})_2\text{Cl}_2]$

63. In which of the following pairs both the complex's show optical isomerism?

- (a)  $\text{cis-}[\text{Cr}(\text{C}_2\text{O}_4)_2\text{Cl}_2]^{3-}$ ,  $\text{cis-}[\text{Co}(\text{NH}_3)_4\text{Cl}_2]$   
(b)  $[\text{Co}(\text{en})_3]\text{Cl}_3$ ,  $\text{cis-}[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$   
(c)  $[\text{PtCl}(\text{dien})]\text{Cl}$ ,  $[\text{NiCl}_2\text{Br}_2]^{2-}$   
(d)  $[\text{Co}(\text{NO}_3)_3(\text{NH}_3)_3]$ ,  $\text{cis-}[\text{Pt}(\text{en})_2\text{Cl}_2]$ .

64. The diamagnetic species is

- (a)  $[\text{Ni}(\text{CN})_4]^{2-}$  (b)  $[\text{NiCl}_4]^{2-}$   
(c)  $[\text{CoCl}_4]^{2-}$  (d)  $[\text{CoF}_6]^{2-}$ .

65. In the balanced chemical reaction



$a$ ,  $b$ ,  $c$  and  $d$  respectively corresponds to

- (a) 5, 6, 3, 3 (b) 5, 3, 6, 3  
(c) 3, 5, 3, 6 (d) 5, 6, 5, 5

66. Among the following pairs of ions, the lower oxidation state in aqueous solution is more stable than the other, in

- (a)  $\text{Ti}^+$ ,  $\text{Ti}^{3+}$  (b)  $\text{Cu}^+$ ,  $\text{Cu}^{2+}$   
(c)  $\text{Cr}^{2+}$ ,  $\text{Cr}^{3+}$  (d)  $\text{V}^{2+}$ ,  $\text{VO}^{2+}$ .

67. The number of P – O – P bridges in the structure of phosphorus pentoxide and phosphorus trioxide are respectively

- (a) 6, 6 (b) 5, 5  
(c) 5, 6 (d) 6, 5.

68. In diborane, the two H – B – H angles are nearly

- (a)  $60^\circ$ ,  $120^\circ$  (b)  $95^\circ$ ,  $120^\circ$   
(c)  $95^\circ$ ,  $150^\circ$  (d)  $120^\circ$ ,  $180^\circ$ .

69. Which of the following gives propyne on hydrolysis?

- (a)  $\text{Al}_4\text{C}_3$  (b)  $\text{Mg}_2\text{C}_3$   
(c)  $\text{B}_4\text{C}$  (d)  $\text{La}_4\text{C}_3$ .

70. The pair of amphoteric hydroxides is

- (a)  $\text{Al}(\text{OH})_3$ ,  $\text{LiOH}$   
(b)  $\text{Be}(\text{OH})_2$ ,  $\text{Mg}(\text{OH})_2$   
(c)  $\text{B}(\text{OH})_3$ ,  $\text{Be}(\text{OH})_2$   
(d)  $\text{Be}(\text{OH})_2$ ,  $\text{Zn}(\text{OH})_2$ .

71. Which of the following is a carbonate ore?

- (a) pyrolusite (b) malachite  
(c) diasporite (d) cassiterite.

72.  $^{238}_{92}\text{U}$  emits 8  $\alpha$ -particles and 6  $\beta$ -particles. The neutron/proton ratio in the product nucleus is

- (a) 60/41 (b) 61/40  
(c) 62/41 (d) 61/42.

73. The correct order for the wavelength of absorption in the visible region is

- (a)  $[\text{Ni}(\text{NO}_2)_6]^{4-} < [\text{Ni}(\text{NH}_3)_6]^{2+} < [\text{Ni}(\text{H}_2\text{O})_6]^{2+}$   
(b)  $[\text{Ni}(\text{NO}_2)_6]^{4-} < [\text{Ni}(\text{H}_2\text{O})_6]^{2+} < [\text{Ni}(\text{NH}_3)_6]^{2+}$   
(c)  $[\text{Ni}(\text{H}_2\text{O})_6]^{2+} < [\text{Ni}(\text{NH}_3)_6]^{2+} < [\text{Ni}(\text{NO}_2)_6]^{4-}$   
(d)  $[\text{Ni}(\text{NH}_3)_6]^{2+} < [\text{Ni}(\text{H}_2\text{O})_6]^{2+} < [\text{Ni}(\text{NO}_2)_6]^{4-}$

74.  $\text{F}_2$  formed by reacting  $\text{K}_2\text{MnF}_6$  with

- (a)  $\text{SbF}_5$  (b)  $\text{MnF}_3$   
(c)  $\text{KSbF}_6$  (d)  $\text{MnF}_4$ .

75. The isoelectronic pair is

- (a)  $\text{Cl}_2\text{O}$ ,  $\text{ICl}_2^-$  (b)  $\text{ICl}_2^-$ ,  $\text{ClO}_2$   
(c)  $\text{IF}_2^+$ ,  $\text{I}_3^-$  (d)  $\text{ClO}_2^-$ ,  $\text{ClF}_2^+$ .

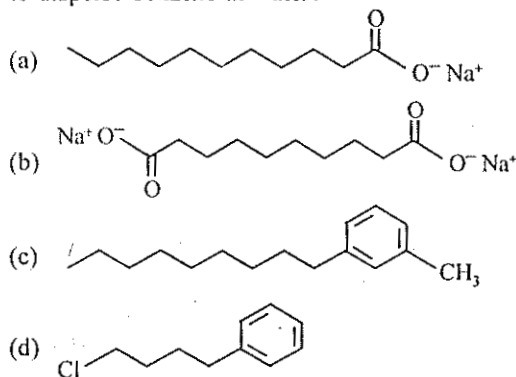
76. Which of the following chemicals are used to manufacture methyl isocyanate that caused "Bhopal Tragedy"?

- (i) methylamine (ii) phosgene  
(iii) phosphine (iv) dimethylamine.  
(a) (i) and (iii) (b) (iii) and (iv)  
(c) (i) and (ii) (d) (ii) and (iv).

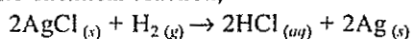
77.  $\alpha$ -Particles can be detected using

- (a) thin aluminium sheet  
(b) barium sulphate  
(c) zinc sulphide screen  
(d) gold foil.

78. Which of the following molecules is most suitable to disperse benzene in water?



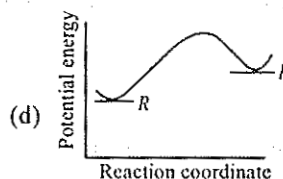
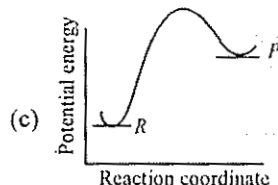
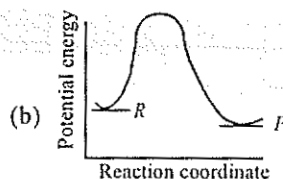
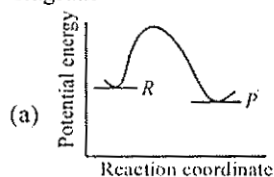
79. The chemical reaction,



taking place in a galvanic cell is represented by the notation

- (a)  $\text{Pt}_{(s)} | \text{H}_{2(g)}, 1 \text{ bar} | 1 \text{M HCl}_{(aq)} | \text{AgCl}_{(s)} | \text{Ag}_{(s)}$   
 (b)  $\text{Pt}_{(s)} | \text{H}_{2(g)}, 1 \text{ bar} | 1 \text{M HCl}_{(aq)} | 1 \text{M Ag}^{+}_{(aq)} | \text{Ag}_{(s)}$   
 (c)  $\text{Pt}_{(s)} | \text{H}_{2(g)}, 1 \text{ bar} | 1 \text{M HCl}_{(aq)} | \text{AgCl}_{(s)} | \text{Ag}_{(s)}$   
 (d)  $\text{Pt}_{(s)} | \text{H}_{2(g)}, 1 \text{ bar} | 1 \text{M HCl}_{(aq)} | \text{Ag}_{(s)} | \text{AgCl}_{(s)}$
80. If  $Z$  is the number of atoms in the unit cell that represents the closest packing sequence ...  $A B C A B C \dots$ , the number of tetrahedral voids in the unit cell is equal to  
 (a)  $Z$  (b)  $2Z$   
 (c)  $Z/2$  (d)  $Z/4$
81.  $\Delta H_f^\circ$  (298 K) of methanol is given by the chemical equation  
 (a)  $\text{CH}_{4(g)} + \frac{1}{2} \text{O}_{2(g)} \rightarrow \text{CH}_3\text{OH}_{(g)}$   
 (b)  $\text{C (graphite)} + \frac{1}{2} \text{O}_{2(g)} + 2\text{H}_{2(g)} \rightarrow \text{CH}_3\text{OH}_{(l)}$   
 (c)  $\text{C (diamond)} + \frac{1}{2} \text{O}_{2(g)} + 2\text{H}_{2(g)} \rightarrow \text{CH}_3\text{OH}_{(l)}$   
 (d)  $\text{CO}_{(g)} + 2\text{H}_{2(g)} \rightarrow \text{CH}_3\text{OH}_{(l)}$

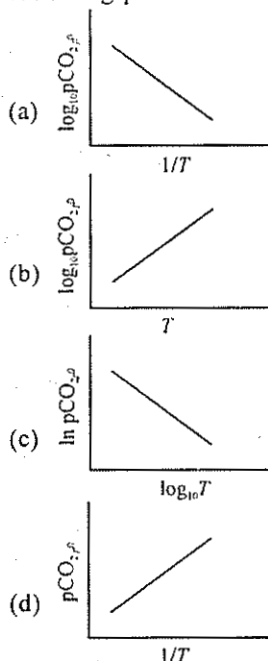
82. An endothermic reaction with high activation energy for the forward reaction is given by the diagram



83. When 10 ml of 0.1 M acetic acid ( $\text{p}K_a = 5.0$ ) is titrated against 10 ml of 0.1 M ammonia solution ( $\text{p}K_b = 5.0$ ), the equivalence point occurs at pH  
 (a) 5.0 (b) 6.0  
 (c) 7.0 (d) 9.0
84. The most probable radius (in pm) for finding the electron in  $\text{He}^+$  is  
 (a) 0.0 (b) 52.9  
 (c) 26.5 (d) 105.8
85. For the reaction of one mole of zinc dust with one mole of sulphuric acid in a bomb calorimeter,  $\Delta U$  and  $w$  corresponds to  
 (a)  $\Delta U < 0, w = 0$  (b)  $\Delta U < 0, w < 0$   
 (c)  $\Delta U > 0, w = 0$  (d)  $\Delta U > 0, w > 0$
86. For reaction  $aA \rightarrow xP$ , when  $[A] = 2.2 \text{ mM}$ , the rate was found to be  $2.4 \text{ mM s}^{-1}$ . On reducing concentration of  $A$  to half, the rate changes to  $0.6 \text{ mM s}^{-1}$ . The order of reaction with respect to  $A$  is  
 (a) 1.5 (b) 2.0  
 (c) 2.5 (d) 3.0
87. For reaction,  $2\text{NOCl}_{(g)} = 2\text{NO}_{(g)} + \text{Cl}_{2(g)}$ ,  $K_c$  at  $427^\circ\text{C}$  is  $3 \times 10^{-6} \text{ L. mol}^{-1}$ . The value of  $K_p$  is nearly  
 (a)  $7.50 \times 10^{-5}$  (b)  $2.50 \times 10^{-5}$   
 (c)  $2.50 \times 10^{-4}$  (d)  $1.75 \times 10^{-4}$

88. For the chemical equilibrium,

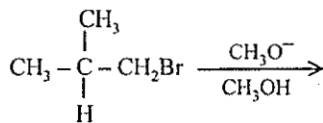
$\text{CaCO}_3(s) \rightleftharpoons \text{CaO}(s) + \text{CO}_2(g)$ ,  
 $\Delta H_r^\circ$  can be determined from which one of the following plots?



89. Among the following the strongest nucleophile is

- (a)  $\text{C}_2\text{H}_5\text{SH}$  (b)  $\text{CH}_3\text{COO}^-$   
 (c)  $\text{CH}_3\text{NH}_2$  (d)  $\text{NCCH}_2^-$

90. The major product formed in the following reaction is



- (a)
- (b)
- (c)
- (d)

91. The major product obtained on treatment of  $\text{CH}_3\text{CH}_2\text{CH}(\text{F})\text{CH}_3$  with  $\text{CH}_3\text{O}^-/\text{CH}_3\text{OH}$  is

- (a)  $\text{CH}_3\text{CH}_2\text{CH}(\text{OCH}_3)\text{CH}_3$   
 (b)  $\text{CH}_3\text{CH}=\text{CHCH}_3$   
 (c)  $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$   
 (d)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OCH}_3$

92. Among the following the most stable compound is

- (a) *cis*-1,2-cyclohexanediol  
 (b) *trans*-1,2-cyclohexanediol  
 (c) *cis*-1,3-cyclohexanediol  
 (d) *trans*-1,3-cyclohexanediol

93. 3-Phenylpropene on reaction with HBr gives (as a major product)

- (a)  $\text{C}_6\text{H}_5\text{CH}_2\text{CH}(\text{Br})\text{CH}_3$   
 (b)  $\text{C}_6\text{H}_5\text{CH}(\text{Br})\text{CH}_2\text{CH}_3$   
 (c)  $\text{C}_6\text{H}_5\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$   
 (d)  $\text{C}_6\text{H}_5\text{CH}(\text{Br})\text{CH}=\text{CH}_2$

94.  $\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$  on reaction with sodium ethoxide in ethanol gives A, which on heating in the presence of acid gives B. Compound B is

- (a)  $\text{CH}_3\text{COCH}_2\text{COOH}$  (b)  $\text{CH}_3\text{COCH}_3$   
 (c) (d)

95. Among the following which one does not act as an intermediate in Hofmann rearrangement?

- (a)  $\text{RNCO}$  (b)  $\text{RCON}^-$   
 (c)  $\text{RCONHBr}$  (d)  $\text{RNC}$

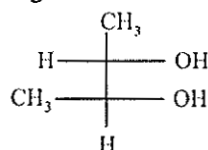
96. Pyridine is less basic than triethylamine because

- (a) pyridine has aromatic character  
 (b) nitrogen in pyridine is  $sp^2$  hybridised  
 (c) pyridine is a cyclic system  
 (d) in pyridine, lone pair of nitrogen is delocalised.

97. Which one of the following biomolecules is insoluble in water?

- (a)  $\alpha$ -keratin (b) haemoglobin  
 (c) ribonuclease (d) adenine.

98. Correct configuration of the following is



- (a) 1S, 2S (b) 1S, 2R  
 (c) 1R, 2S (d) 1R, 2R.

99. Which one of the following statements is true for protein synthesis (translation)?  
 (a) amino acids are directly recognized by *m*-RNA  
 (b) the third base of the codon is less specific  
 (c) only one codon codes for an amino acid  
 (d) every *t*-RNA molecule has more than one amino acid attachment.
100.  $C_6H_5CONHCH_3$  can be converted into  $C_6H_5CH_2NHCH_3$  by  
 (a)  $NaBH_4$  (b)  $H_2 - Pd/C$   
 (c)  $LiAlH_4$  (d)  $Zn-Hg/HCl$ .

**Directions for questions 101-120 :** In each of the following questions, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it. Of the statements, mark the correct answer as

- (a) If both assertion and reason are true and reason is the correct explanation of assertion  
 (b) If both assertion and reason are true but reason is not the correct explanation of assertion  
 (c) If assertion is true but reason is false  
 (d) If both assertion and reason are false.

101. **Assertion :** Reaction of  $SO_2$  and  $H_2S$  in the presence of  $Fe_2O_3$  catalyst gives elemental sulphur.  
**Reason :**  $SO_2$  is a reducing agent.

102. **Assertion :**  $SiF_6^{2-}$  is known but  $SiCl_6^{2-}$  is not.  
**Reason :** Size of fluorine is small and its lone pair of electrons interacts with *d*-orbitals of Si strongly.

103. **Assertion :** Borax bead test is not suitable for  $Al(III)$ .  
**Reason :**  $Al_2O_3$  is insoluble in water.

104. **Assertion :** Ozone is a powerful oxidising agent in comparison to  $O_2$ .  
**Reason :** Ozone is diamagnetic but  $O_2$  is paramagnetic.

105. **Assertion :** Potassium ferrocyanide is diamagnetic whereas potassium ferricyanide is paramagnetic.  
**Reason :** Crystal field splitting in ferrocyanide ion is greater than that of ferricyanide ion.

106. **Assertion :** Addition of  $NH_4OH$  to an aqueous solution of  $BaCl_2$  in the presence of  $NH_4Cl$  (excess) precipitates  $Ba(OH)_2$ .

**Reason :**  $Ba(OH)_2$  is insoluble in water.

107. **Assertion :**  $SeCl_4$  does not have a tetrahedral structure.

**Reason :** Se in  $SeCl_4$  has two lone pairs.

108. **Assertion :** The molecular weight of acetic acid determined by depression in freezing point method in benzene and water was found to be different.

**Reason :** Water is polar and benzene is non-polar.

109. **Assertion :** Compressibility factor for hydrogen varies with pressure with positive slope at all pressures.

**Reason :** Even at low pressures, repulsive forces dominate hydrogen gas.

110. **Assertion :** First ionization energy for nitrogen is lower than oxygen.

**Reason :** Across a period effective nuclear charge decreases.

111. **Assertion :**  $B_2$  molecule is diamagnetic.

**Reason :** The highest occupied molecular orbital is of  $\sigma$  type.

112. **Assertion :** Rate of hydrolysis of methyl chloride to methanol is higher in DMF than in water.

**Reason :** Hydrolysis of methyl chloride follows second order kinetics.

113. **Assertion :** Galvanised iron does not rust.

**Reason :** Zinc has a more negative electrode potential than iron.

114. **Assertion :** Extraction of iron metal from iron oxide ore is carried out by heating with coke.

**Reason :** The reaction  $Fe_2O_3(s) \rightarrow Fe(s) + 3/2 O_2(g)$  is a spontaneous process.

115. **Assertion :** Rates of nitration of benzene and hexadeuterobenzene are different.

**Reason :** C – H bond is stronger than C – D bond.

116. **Assertion :** *t*-Butyl methyl ether is not prepared by the reaction of *t*-butyl bromide with sodium methoxide.

**Reason :** Sodium methoxide is a strong nucleophile.

117. **Assertion :** Maltose is a reducing sugar which gives two moles of D-glucose on hydrolysis.

**Reason :** Maltose has a 1,4- $\beta$ -glycosidic linkage.

**118. Assertion :**  $p\text{-O}_2\text{N} - \text{C}_6\text{H}_5\text{COCH}_3$  is prepared by Friedel Crafts acylation of nitrobenzene.

**Reason :** Nitrobenzene easily undergoes electrophilic substitution reaction.

**119. Assertion :** Alkyl isocyanides in acidified water give alkyl formamides.

**Reason :** In isocyanides, carbon first acts as a nucleophile and then as an electrophile.

**120. Assertion :** Cyclopentadienyl anion is much more stable than allyl anion.

**Reason :** Cyclopentadienyl anion is aromatic in character.

### BIOLOGY

**121.** Based on cellular mechanisms there are two major types of regeneration found in the animals. Which one of the following is the correct example of the type mentioned?

- Morphallaxis – Regeneration of two transversely cut equal pieces of a Hydra into two small Hydrys.
- Epimorphosis - Replacement of old and dead erythrocytes by the new ones.
- Morphallaxis - Healing up of a wound in the skin.
- Epimorphosis - Regeneration of crushed and filtered out pieces of a *Planaria* into as many new Planarians.

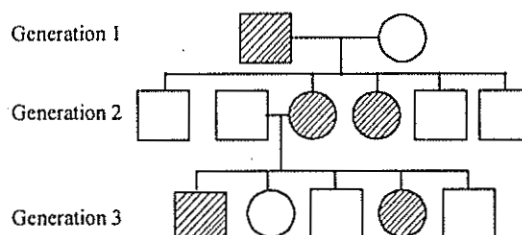
**122.** Which one of the following four secretions is correctly matched with its source, target and nature of action?

|     | Secretion                       | Source                                  | Target                           | Action                                                    |
|-----|---------------------------------|-----------------------------------------|----------------------------------|-----------------------------------------------------------|
| (a) | Gastrin                         | Stomach lining                          | Oxyntic cells                    | Production of HCl                                         |
| (b) | Inhibin                         | Sertoli cells                           | Hypothalamus                     | Inhibition of secretion of gonadotropin releasing hormone |
| (c) | Enterokinase                    | Duodenum                                | Gall bladder                     | Release of bile juice                                     |
| (d) | Atrial Natriuretic Factor (ANF) | Sino atrial node (SAN) M-cells of Atria | Juxta-glomerular apparatus (JGA) | Inhibition of release of renin                            |

**123.** Which one of the following four glands is correctly matched with the accompanying description ?

- Thyroid - hyperactivity in young children causes cretinism
- Thymus - starts undergoing atrophy after puberty
- Parathyroid - secretes parathormone which promotes movement of calcium ions from blood into bones during calcification
- Pancreas - Delta cells of the Islets of Langerhans secrete a hormone which stimulates glycolysis in liver.

**124.** Given below is a pedigree chart showing the inheritance of a certain sex-linked trait in humans.



Key:

- ☐ Unaffected male
- ☒ Affected male
- ☐ Unaffected female
- ☒ Affected female

The trait traced in the above pedigree chart is

- dominant X-linked
- recessive X-linked
- dominant Y-linked
- recessive Y-linked.

**125.** A cross section at the midpoint of the middle piece of a human sperm will show

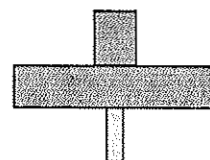
- centriole, mitochondria and 9 + 2 arrangement of microtubules
- centriole and mitochondria
- mitochondria and 9 + 2 arrangement of microtubules
- 9 + 2 arrangement of microtubules only.

**126.** Which one of the following is a correct statement?

- "Bt" in "Bt-cotton" indicates that it is a genetically modified organism produced through biotechnology.

- (b) Somatic hybridization involves fusion of two complete plant cells carrying desired genes.  
(c) The anticoagulant hirudin is being produced from transgenic *Brassica napus* seeds.  
(d) "Flavr Savr" variety of tomato has enhanced the production of ethylene which improves its taste.
127. An insect bite may result in inflammation of that spot. This is triggered by the alarm chemicals such as:  
(a) histamine and dopamine  
(b) histamine and kinins  
(c) interferons and opsonin  
(d) interferons and histones.
128. Which one of the following pairs of geographical areas show maximum biodiversity in our country?  
(a) Sunderbans and Rann of Kutch  
(b) Eastern Ghats and West Bengal  
(c) Eastern Himalaya and Western Ghats  
(d) Kerala and Punjab.
129. Genetic diversity in agricultural crops is threatened by :  
(a) introduction of high yielding varieties  
(b) intensive use of fertilizers  
(c) extensive intercropping  
(d) intensive use of biopesticides.
130. One of the *ex situ* conservation methods for endangered species is  
(a) wildlife sanctuaries  
(b) biosphere reserves  
(c) cryopreservation (d) national parks.
131. Formation of non-functional methaemoglobin causes blue-baby syndrome. This is due to  
(a) excess of arsenic concentration in drinking water  
(b) excess of nitrates in drinking water  
(c) deficiency of iron in food  
(d) increased methane content in the atmosphere.
132. Two of the body parts which do not appear in MRI may be:  
(a) molar teeth and eye lens  
(b) scapula and canines  
(c) ligaments and ribs  
(d) tendons and premolars.
133. A young drug addict used to show symptoms of depressed brain activity, feeling of calmness, relaxation and drowsiness. Possibly he was taking  
(a) amphetamine (b) marijuana  
(c) pethidine (d) valium.
134. Antigen binding site in an antibody is found between  
(a) two light chains  
(b) two heavy chains  
(c) one heavy and one light chain  
(d) either between two light chains or between one heavy and one light chain depending upon the nature of antigen.
135. Which one of the following events is correctly matched with the time period in a normal menstrual cycle?  
(a) release of egg : 5<sup>th</sup> day  
(b) endometrium regenerates : 5 - 10 days  
(c) endometrium secretes nutrients for implantation : 11-18 days  
(d) rise in progesterone level : 1 - 15 days.
136. A tumor inducing plasmid widely used in the production of transgenic plants is that of  
(a) *Escherichia coli*  
(b) *Bacillus thuringiensis*  
(c) *Staphylococcus aureus*  
(d) *Agrobacterium tumefaciens*.
137. Which one of the following statement pertaining to pollutants is correct?  
(a) DDT is a non-biodegradable pollutant  
(b) excess fluoride in drinking water causes osteoporosis  
(c) excess cadmium in drinking water causes black foot disease  
(d) methylmercury in water may cause "Itai Itai" disease.
138. Which one of the following statements is correct with respect to salt water balance inside the body of living organisms?  
(a) when water is not available camels do not produce urine but store urea in tissues  
(b) Salmon fish excretes lot of stored salt through gill membrane when in fresh water.  
(c) *Paramecium* discharges concentrated salt solution by contractile vacuoles

- (d) The body fluids of fresh water animals are generally hypotonic to surrounding water.
139. The "cri-du-chat" syndrome is caused by change in chromosome structure involving  
 (a) deletion (b) duplication  
 (c) inversion (d) translocation.
140. The family containing mustard and its main characters are  
 (a) Brassicaceae – Tetramerous flowers, six stamens, bicarpellary gynoecium, silique type fruit  
 (b) Brassicaceae – Pentamerous flowers, many stamens, pentacarpellary gynoecium, capsule type fruit  
 (c) Solanaceae – Pentamerous flowers, five stamens, bicarpellary gynoecium, berry type fruit  
 (d) Poaceae – Trimerous flowers, three stamens, monocarpellary gynoecium, caryopsis type of fruit.
141. Grain colour in wheat is determined by three pairs of polygenes. Following the cross AABBCC (dark colour)  $\times$  aabbcc (light colour), in  $F_2$  generation what proportion of the progeny is likely to resemble either parent?  
 (a) none (b) less than 5 percent  
 (c) one third (d) half.
142. Which one of the following statements pertaining to plant structure is correct?  
 (a) cork lacks stomata, but lenticels carry out transpiration  
 (b) passage cells help in transfer of food from cortex to phloem  
 (c) sieve tube elements possess cytoplasm but no nuclei  
 (d) the shoot apical meristem has a quiescent centre.
143. When synapsis is complete all along the chromosome, the cell is said to have entered a stage called  
 (a) zygotene (b) pachytene  
 (c) diplotene (d) diakinesis.
144. Primary source of allelic variation is  
 (a) independent assortment  
 (b) recombination
- (c) mutation (d) polyploidy
145. Many cells function properly and divide mitotically even though they do not have  
 (a) plasma membrane (b) cytoskeleton  
 (c) mitochondria (d) plastids.
146. Three of the following statements regarding cell organelles are correct while one is wrong. Which one is wrong?  
 (a) Lysosomes are double membraned vesicles budded off from Golgi apparatus and contain digestive enzymes.  
 (b) Endoplasmic reticulum consists of a network of membranous tubules and helps in transport, synthesis and secretion.  
 (c) Leucoplasts are bound by two membranes, lack pigment but contain their own DNA and protein synthesizing machinery.  
 (d) Sphaerosomes are single membrane bound and are associated with synthesis and storage of lipids.
147. In which one of the following would you expect to find glyoxysomes?  
 (a) endosperm of wheat  
 (b) endosperm of castor  
 (c) palisade cells in leaf  
 (d) root hairs.
148. Which one of the following correctly represents an organism and its ecological niche?  
 (a) *Vallisneria* and pond  
 (b) desert locust (*Scistocerca*) and desert  
 (c) plant lice (aphids) and leaf  
 (d) vultures and dense forest.
149. Given below is one of the types of ecological pyramids.  
 This type represents  
 (a) pyramid of numbers in a grassland  
 (b) pyramid of biomass in a fallow land  
 (c) pyramid of biomass in a lake  
 (d) energy pyramid in a spring.
150. The given graph shows the effect of substrate concentration on the rate of reaction of the enzyme green-gram-phosphatase  
 What does the graph indicate?

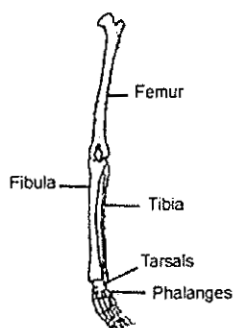


- (a) The rate of enzyme reaction is directly proportional to the substrate concentration
- (b) Presence of an enzyme inhibitor in the reaction mixture
- (c) Formation of an enzyme-substrate complex
- (d) at higher substrate concentration the pH increases.

151. Which one of the following groups of structures/organs have similar function?

- (a) Typhlosole in earthworm, intestinal villi in rat and contractile vacuole in *Amoeba*.
- (b) Nephridia in earthworm, Malpighian tubules in cockroach and urinary tubules in rat.
- (c) Antennae of cockroach, tympanum of frog and clitellum of earthworm.
- (d) Incisors of rat, gizzard (proventriculus) of cockroach and tube feet of starfish.

152. Given diagram shows bone of the left human hindlimb as seen from front. It has certain mistakes in labeling. Two of the wrongly labelled bones are:



- (a) tibia and tarsals
- (b) femur and fibula
- (c) fibula and phalanges
- (d) tarsals and femur.

153. Electroporation procedure involves :

- (a) fast passage of food through sieve pores in phloem elements with the help of electric stimulation
- (b) opening of stomatal pores during night by artificial light
- (c) making transient pores in the cell membrane to introduce gene constructs
- (d) purification of saline water with the help of a membrane system.

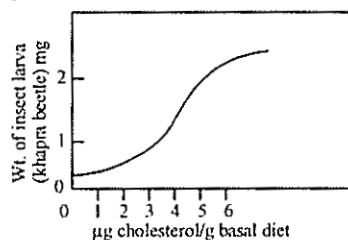
54. Somaclonal variation appears in

- (a) organisms produced through somatic hybridization
- (b) plants growing in highly polluted conditions
- (c) apomictic plants
- (d) tissue culture raised plants.

55. In an experiment freshly hatched larvae of an insect

(Khapra beetle) were reared on a basal diet (complete diet without cholesterol) with increasing amounts of cholesterol. Results obtained are shown in the graph given in the table :

The graph indicates that



- (a) cholesterol is an essential dietary requirement of khapra beetle
- (b) growth of khapra beetle is directly proportional to cholesterol concentration
- (c) cholesterol concentration of 2 µg/g diet is the optimum level
- (d) growth of khapra beetle is inhibited when cholesterol concentration exceeds 5 µg/g diet.

156. Which one of the following is correct matching of a plant, its habit and the forest type where it normally occurs?

- (a) *Prosopis*, tree, scrub
- (b) *Saccharum*, grass, forest
- (c) *Shorea robusta*, herb, tropical rain forest
- (d) *Acacia catechu*, tree, coniferous forest.

157. cDNA probes are copied from the messenger RNA molecules with the help of

- (a) restriction enzymes
- (b) reverse transcriptase
- (c) DNA polymerase
- (d) adenosine deaminase.

158. Gibberellins can promote seed germination because of their influence on

- (a) rate of cell division
- (b) production of hydrolyzing enzymes
- (c) synthesis of abscisic acid
- (d) absorption of water through hard seed coat.

159. Which one of the following features is common in silverfish, scorpion, dragonfly and prawn?

- (a) Three pairs of legs and segmented body
- (b) Chitinous cuticle and two pairs of antennae
- (c) Jointed appendages and chitinous exoskeleton
- (d) Cephalothorax and tracheae.

160. Double fertilization involves
- fertilization of the egg by two male gametes
  - fertilization of two eggs in the same embryo sac by two sperms brought by one pollen tube
  - fertilization of the egg and the central cell by two sperms brought by different pollen tubes
  - fertilization of the egg and the central cell by two sperms brought by the same pollen tube.

In the following questions (161-180), a statement of assertion (A) is followed by a statement of reason (R).

- If both Assertion & Reason are true and the reason is the correct explanation of the assertion, then mark *a*
  - If both Assertion & Reason are true but the reason is not the correct explanation of the assertion, then mark *b*
  - If Assertion is true statement but Reason is false, then mark *c*
  - If both Assertion and Reason are false statements, then mark *d*.
161. **Assertion :** Senescence is the time when age associated defects are manifested.  
**Reason :** Certain genes may be undergoing sequential switching on and off during one's life.
162. **Assertion :** In recombinant DNA technology, human genes are often transferred into bacteria (prokaryotes) or yeast (eukaryote).  
**Reason :** Both bacteria and yeast multiply very fast to form huge populations which express the desired gene.
163. **Assertion :** A suspended particulate matter (SPM) is an important pollutant released by diesel vehicles.  
**Reason :** Catalytic converters greatly reduce pollution caused by automobiles.
164. **Assertion :** Methane component of green house gases contributing to global warming is about 20 percent.  
**Reason :** Introduction of multi-point fuel injection engines in automobiles has decreased methane content in the exhausts.
165. **Assertion :** Interferons are a type of antibodies produced by body cells infected by bacteria.  
**Reason :** Interferons stimulate inflammation at the site of injury.
166. **Assertion :** Organ transplantation patients are given immunosuppressive drugs.  
**Reason :** Transplanted tissue has antigens which stimulate the specific immune response of the recipient.
167. **Assertion :** Persons suffering from haemophilia fail to produce blood clotting factor VIII.  
**Reason :** Prothrombin producing platelets in such persons are found in very low concentration.
168. **Assertion :** In humans, the gamete contributed by the male determines whether the child produced will be male or female.  
**Reason :** Sex in humans is a polygenic trait depending upon a cumulative effect of some genes on X-chromosome and some on Y-chromosome.
169. **Assertion :** Mitochondria and chloroplasts are semi-autonomous organelles.  
**Reason :** They are formed by division of pre-existing organelles as well as contain DNA but lack protein synthesizing machinery.
170. **Assertion :** Replication and transcription occur in the nucleus but translation occurs in the cytoplasm.  
**Reason :** mRNA is transferred from the nucleus into the cytoplasm where ribosomes and amino acids are available for protein synthesis.
171. **Assertion :** The fungi are widespread in distribution and they even live on or inside other plants and animals.  
**Reason :** Fungi are able to grow anywhere on land, water or on other organisms because they have a variety of pigments, including chlorophyll, carotenoids, fucoxanthin and phycoerythrin.
172. **Assertion :**  $C_4$  photosynthetic pathway is more efficient than the  $C_3$  pathway.  
**Reason :** Photorespiration is suppressed in  $C_4$  plants.
173. **Assertion :** Human ancestors never used their tails and so the tail expressing gene has disappeared in them.  
**Reason :** Lamarck's theory of evolution is popularly called theory continuity of germ plasm.

174. *Assertion* : Presently, the global atmosphere is warming up.

*Reason* : The depletion of stratospheric ozone layer has resulted in increase in ultraviolet radiations reaching the earth.

175. *Assertion* : Comparative biochemistry provides a strong evidence in favour of common ancestry of living beings.

*Reason* : Genetic code is universal.

176. *Assertion* : Darwin's finches show a variety of beaks suited for eating large seeds, flying insects and cactus seeds.

*Reason* : Ancestral seed-eating stock of Darwin's finches radiated out from South American mainland to different geographical areas of the Galapagos Islands, where they found competitor-free new habitats.

177. *Assertion* : The atmospheric concentration of  $\text{CO}_2$  at which photosynthesis just compensates for respiration is referred to as  $\text{CO}_2$  compensation point.

*Reason* : The  $\text{CO}_2$  compensation point is reached when the amount of  $\text{CO}_2$  uptake is less than that generated through respiration because the level of  $\text{CO}_2$  in the atmosphere is more than that required for achieving  $\text{CO}_2$  compensation point.

178. *Assertion* : The age-sex structure of human population in countries like France and Germany gives a steep pyramid.

*Reason* : In countries like Sudan and India the population is increasing at a rapid rate.

179. *Assertion* : The duck-billed *Platypus* and the spiny ant-eater, both are egg-laying animals yet they are grouped under mammals.

*Reason* : Both of them have seven cervical vertebrae and 12 pairs of cranial nerves.

180. *Assertion* : *Agrobacterium tumefaciens* is popular in genetic engineering because this bacterium is associated with the roots of all cereal and pulse crops.

*Reason* : A gene incorporated in the bacterial chromosomal genome gets automatically transferred to the crop with which the bacterium is associated.

## GENERAL KNOWLEDGE

181. Metaphysics refers to :

- (a) A branch of philosophy concerned with the rational query of reality.
- (b) A branch of physics concerned with investigation of reality.
- (c) Meta-analysis of physics for the purpose of theory of relativity.
- (d) Analysis of human body at atomic level.

182. Who is called as numismatist?

- (a) an expert on numerology
- (b) a numerator
- (c) an expert on mathematics
- (d) a person who studies coins.

183. Anjali Bhagwat is related to which field:

- (a) Lawn tennis
- (b) Badminton
- (c) Shooting
- (d) Athletics.

184. Who received Stains International award for religion harmony?

- (a) Teesta Setalvad
- (b) Kuldeep Nayar
- (c) Bharatiya Vidya Bhawan
- (d) Pope John Paul.

185. A 'dirty' nuclear bomb means :

- (a) it has small amount of cobalt 60
- (b) it involves low grade fusion reaction
- (c) it involves low grade fission reaction
- (d) it involves small Ce-137.

186. National Inland Navigation Institute (NINI) is situated in:

- (a) Patna
- (b) Kolkata
- (c) Goa
- (d) Gomukh, Uttaranchal.

187. 'Blogs' means:

- (a) On line journals where cyber-diarists unveil their stories.
- (b) Black spots in somebody's life.
- (c) Big logs used to cross the river in hills.
- (d) Big blocks of land used for grazing animals.

188. What is the colour of Black Box, that is found in aircraft?

- (a) Orange
- (b) Red
- (c) Blue
- (d) Black.

189. Which author was a Bengali writer and an Oscar-winning film director?  
(a) Bankimchandra Chatterjee  
(b) Satyajit Ray  
(c) Chhabi Biswas  
(d) Rabindranath Tagore.
190. What is the symbol of Laloo Prasad Yadav's RJD party?  
(a) Lantern (b) Tea Leaves  
(c) Elephant (d) Palm.
191. Where is the Tibetan government-in-exile based?  
(a) Delhi (b) Dharamsala  
(c) Phomphenh (d) London.
192. What is true of Leonardo da Vinci's Mona Lisa?  
(a) he painted without a model  
(b) the model was the wife of a client  
(c) he dreamt her in the night  
(d) the model was an unmarried women.
193. Which is the annual pilgrimage that every Muslim should make once in the lifetime?  
(a) Haj (b) Sharjah  
(c) Jihad (d) Zakat.
194. What is the term used in e-mail and online conversations to convey mood along with the words?  
(a) smiley (b) pictures  
(c) emoticon (d) flames.
195. Whose quote is "I hear and I forget. I see and I remember. I do and I understand"?  
(a) Caskie Stinnet (b) Mickey Mantle  
(c) Confucious  
(d) Arthur Schopenhauer.
196. Whose autobiography is "Sunny Days"?  
(a) Sunil Gavaskar (b) Geofrey Boycott  
(c) Sunny Deol (d) Sunil Shetty.
197. Which age in Indian history is referred to as the "Golden Age"?  
(a) Maurya (b) Gupta  
(c) Mughal (d) Ancient.
198. Which novel of Amitav Ghosh is called *Esteremi Orienti* in its Italian version?  
(a) In An Antique Land  
(b) Dancing in Cambodia  
(c) The Circle of Reason  
(d) The Shadow Lines.
199. Which of the following is President A.P.J. Abdul Kalam's autobiography?  
(a) Wings of Fire (b) Crossroads  
(c) Ignited Minds: Unleashing the Power Within India  
(d) My experiment with truth.
200. Which of the following units of measurement is not named after a person?  
(a) Hertz (b) Curie  
(c) Barleycorn (d) Apgar.

# 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/m<sup>3</sup>.

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

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

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  $B$

$\therefore$  The corresponding frequency is 200 Hz.

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

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

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

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

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,

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

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

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

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

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

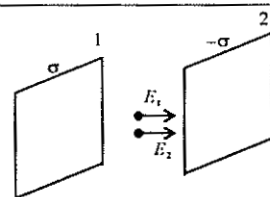
8. (b) : According to Moseley's law

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

Note : The correct answer should have been  $f \propto (Z - \sigma)^2$  where  $\sigma$  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.

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

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

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

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

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

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.

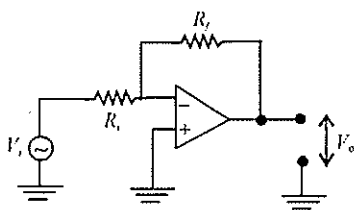
14. (a) : The colour in the oil film is formed due to interference of sunlight where the colour of the film will depend upon the thickness and the angle of inclination.

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.  
 $1 \text{ parsec} = 3.085677 \times 10^{16} \text{ m} = 3.26 \text{ light years}.$

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

$$A = \frac{V_0}{V_i} = \frac{R_f}{R_i}$$

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



17. (b) :  $\nu = 50 \text{ Hz}$ ,  $V = 20 \text{ V}$ ,  $V_R = 12 \text{ V}$

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

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

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) :  $y = \sin \omega t - \cos \omega t$

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

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

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

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

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.

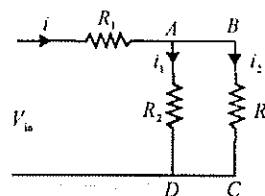
27. (a)

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

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

Also the energy in all resistance is same.

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



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

Thus  $i^2 R_1 t = \frac{i^2}{4} R_2 t$  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

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

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

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

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

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

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

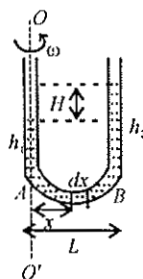
Outside also it has decreased 1 cm as the total decrease is 2 cm. The level of the candle comes down at half the rate of burning.

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

$$dm \omega^2 x = A dx \rho \omega^2 x$$

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

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



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

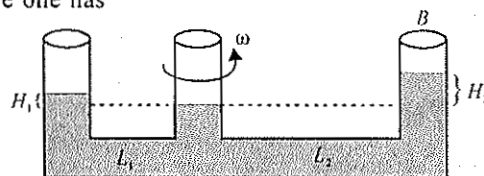
$$\text{Pressure at B due to liquid column on the right hand side} = \text{atmospheric pressure} + h_2 \rho g$$

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  $\omega$  is the same, and  $L_2 > L_1$ ,  $H_2 > H_1$ .

But both will go up.

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

$$\therefore u'^2 \propto s \quad \dots (i)$$

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

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

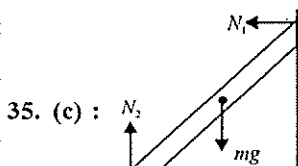
$$mgh = \frac{1}{2} mv^2 + \frac{1}{2} \left(\frac{2}{5}\right) mR^2 \cdot \frac{v^2}{R^2}$$

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

34. (b) : According to law of conservation of momentum,

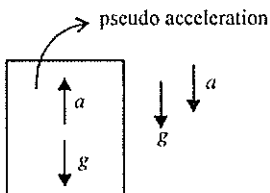
$$I\omega = \text{constant.}$$

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 start 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 as hence positive potential. Beyond  $r_A$ ,  $V_A \propto (1/r)$ , this is  $> V_B$ , one gets the curve  $\propto 1/r$ . 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 =  $\frac{\text{potential difference}}{\text{current}}$

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

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



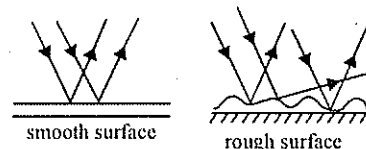
41. (a) : Specific gravity is former name of relative density and relative density is the density of a substance divided by the density of water.

$\therefore$  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

$$p = h/\lambda \quad (\text{by de Broglie hypothesis}) \quad \dots (i)$$

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

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

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  $\lambda$  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.

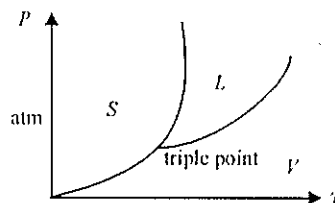
54. (c) : The process of nuclear fusion can be explained with the help of concept of binding energy per nucleon of very light nuclei and the intermediate nuclei. Binding energy per nucleon of very light nuclei is less than that of intermediate nuclei. It means light nuclei are less stable than that of intermediate nuclei. As  $^{35}\text{Cl}$  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.

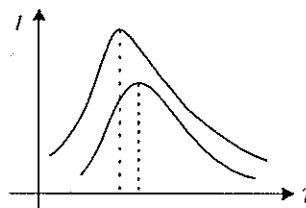
57. (a) : According to Kirchhoff's law,  $a = e$ .  
or the absorptivity of a body equals its emissivity. A good absorber is a good emitter. As a good absorber is poor reflector, emitting (or radiating) ability of body is oppositely related to its ability to reflect. Therefore good emitter (or radiator) 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  $\lambda$  at maximum intensity,  $\lambda_m \cdot T = \text{constant}$ .

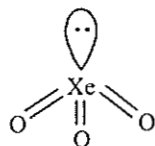
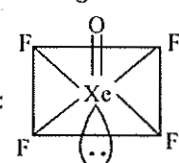
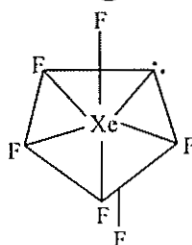


Stefan's law,

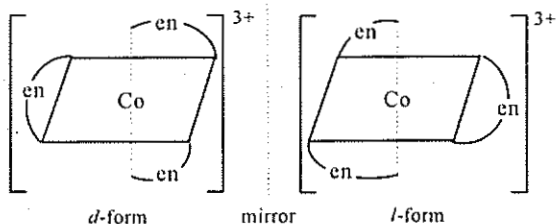
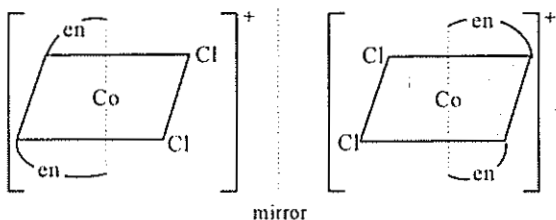
$\sigma T^4$  = intensity of emission of a particular wavelength does not explain the shift of  $\lambda_m$  with absolute temperature.

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

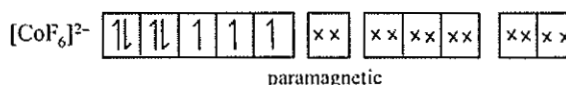
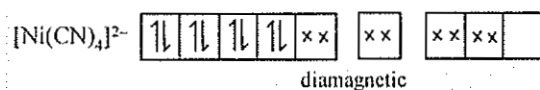
## CHEMISTRY

61. (d) :  $\text{XeO}_3$  : $\text{XeOF}_4$  : $\text{XeF}_6$  :

62. (c) :  $\text{CoCl}_2$  is a weak Lewis acid, reacting with chloride ion to produce salt containing the tetrahedral  $[\text{CoCl}_4]^{2-}$  ion.  $\text{CoCl}_2$  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) :  $[\text{Co}(\text{en})_3]\text{Cl}_3$  $\text{cis-}[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$ 

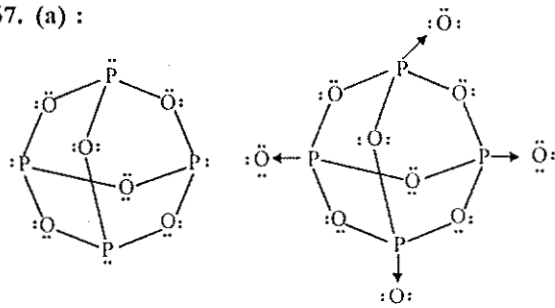
64. (a) :

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 :  $2\text{IO}_3^- + 12\text{H}^+ + 10e^- \rightarrow \text{I}_2 + 6\text{H}_2\text{O}$  $[2\text{I}^- \rightarrow \text{I}_2 + 2e^-] \times 5$ 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,  $a = 5$ ,  $b = 6$ ,  $c = 3$ ,  $d = 3$ .

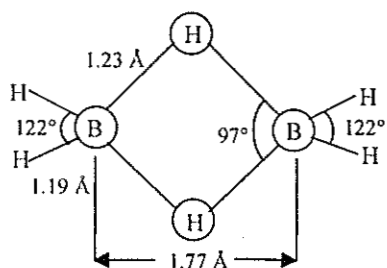
66. (a) :  $\text{Tl}^+$  ions are more stable than  $\text{Tl}^{3+}$  and thus,  $\text{Tl}^{3+}$  ions change to  $\text{Tl}^+$  ions thereby acting as oxidising agents.

$\text{Tl}^{3+}$  compounds +  $2e^- \rightarrow \text{Tl}^+$  compounds  
(less stable oxidising agent) (more stable reducing agent)

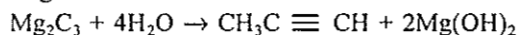
67. (a) :



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.

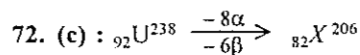


69. (b) : Propyne can be prepared by the hydrolysis of magnesium carbide.



70. (d) : Both  $\text{Be}(\text{OH})_2$  and  $\text{Zn}(\text{OH})_2$  are amphoteric in nature.

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



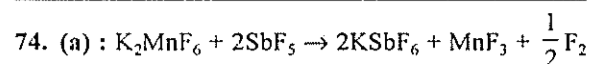
Number of protons = 82

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)



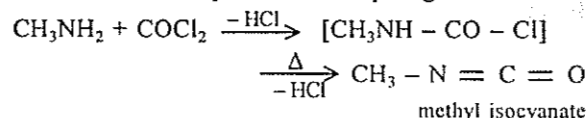
In this reaction, the stronger Lewis acid  $\text{SbF}_5$  displaces the weaker one,  $\text{MnF}_4$  from its salt.  $\text{MnF}_4$  is unstable and readily decomposes to give  $\text{MnF}_3$  and fluorine.

75. (d) : Number of electrons in  $\text{ClO}_2^-$   
 $= 7 + 6 + 6 + 1 = 20$

Number of electrons in  $\text{ClF}_2^+ = 7 + 7 + 7 - 1 = 20$ .

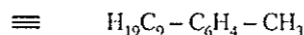
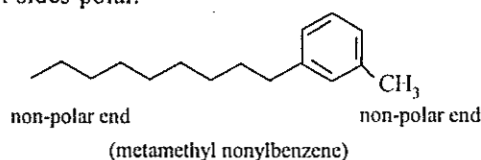
76. (c) : Methyl isocyanate is industrially prepared by

the action of methyl amine with phosgene.



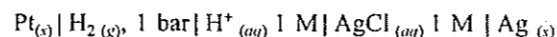
77. (c) : Rutherford first of all used zinc sulphide ( $\text{ZnS}$ ) as phosphor in detection of  $\alpha$ -particles.

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.



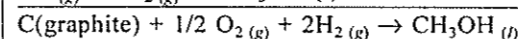
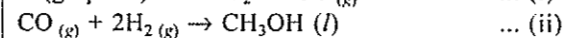
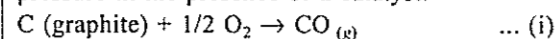
79. (b) :  $2\text{AgCl}_{(s)} + \text{H}_2_{(g)} \rightarrow 2\text{HCl}_{(aq)} + 2\text{Ag}_{(s)}$   
 The activities of solids and liquids are taken as unity and at low concentrations, the activity of a solute is approximated to its molarity.

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) :  $\text{p}K_a = -\log K_a$ ,  $\text{p}K_b = -\log K_b$

$$\begin{aligned} \text{pH} &= -\frac{1}{2}[\log K_a + \log K_w - \log K_b] \\ &= -\frac{1}{2}[-5 + \log(1 \times 10^{-14}) - (-5)] \\ &= -\frac{1}{2}[-5 - 14 + 5] = -\frac{1}{2}(-14) = 7. \end{aligned}$$

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) :  $aA \rightarrow xP$

$$\text{Rate of reaction} = [A]^a$$

$$\text{Order of reaction} = a.$$

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

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

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

$$\text{Rate of reaction} = [A]^2$$

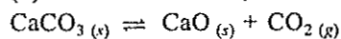
$$\text{Order of reaction} = 2.$$

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

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

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

88. (a) : For the reaction,



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

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

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  $R$ ,  $\Delta H_r^\circ$  can be calculated.

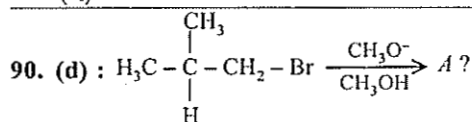
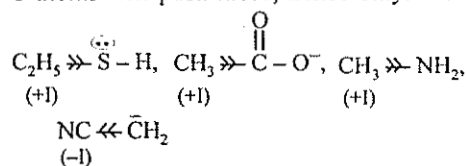
(Equation of straight line :  $Y = mx + C$ . Here,

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

Y                      m                      x                      C)

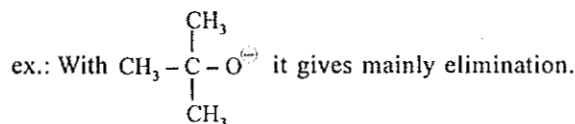
89. (a) : Nucleophiles are those substances which can donate a pair of electrons. These can be neutral or

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.

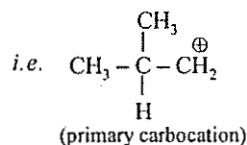


Alkyl halide is  $1^\circ$ .

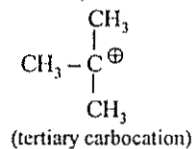
Keep in mind  $1^\circ$  halide give product by  $S_N2/E-2$  mechanism and  $1^\circ$  halide always gives substitution reaction except when strongly hindered base is used.



The reaction involves carbocation intermediate.



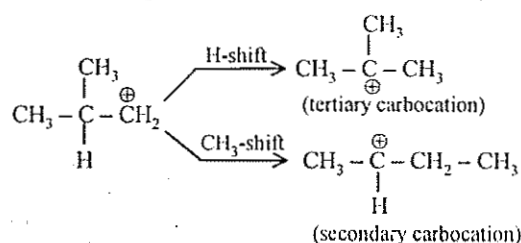
but as it is a primary carbocation it will rearrange to give a tertiary carbocation, which completes the reaction



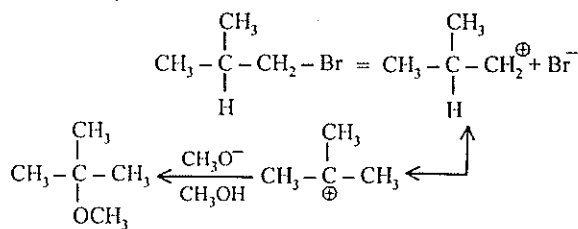
Stability of carbocation :  $3^\circ > 2^\circ > 1^\circ > \text{CH}_3^+$

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.

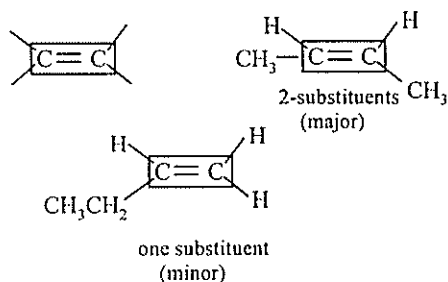
N.B. - Rearrangement can be done in two ways.



Therefore,

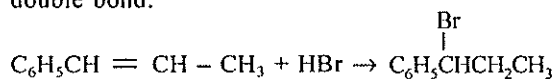


91. (b) : According to Saytzeff's rule, the major product will be that one which contains more number of substituents around the double bond.

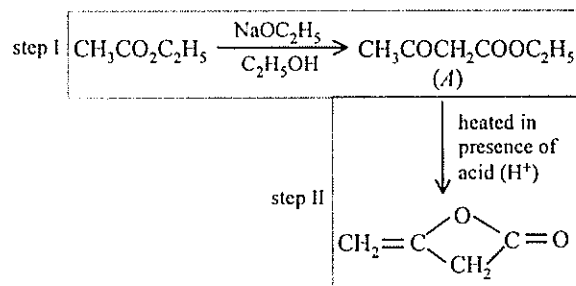


92. (d) : *Trans* configuration is more stable than *cis* configuration because in *cis*-configuration the H groups are thrown closely enough together to cause crowding or repulsion. Again between 1,2-and 1,3-configurations, in 1-3, the OH groups are placed further apart to minimise the repulsion. Hence,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

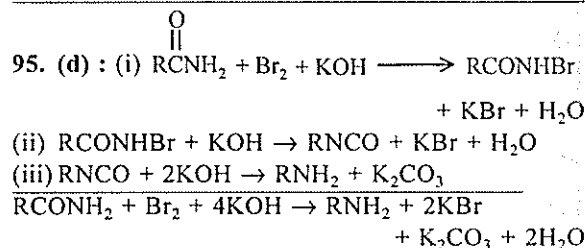
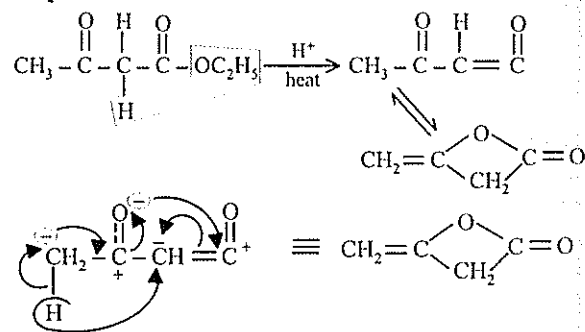
93. (b) : According to Markownikoff's rule, the negative part of the unsymmetrical reagent adds to less hydrogenated (more substituted) carbon atom of the double bond.



94. (c) : *Claisen condensation*

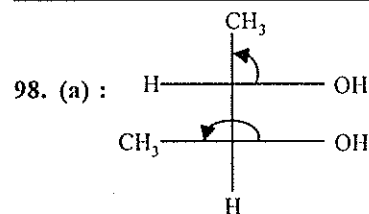


Step II :



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) :  $\alpha$ -Keratin is a water insoluble fibrous protein, serves as the major constituent of hair, nails and skin.

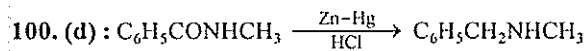


Following the procedure outlined under 'Golden Rule' the absolute configuration is 1S, 2S.

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.

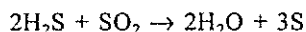
This shows that first two bases are common in all the four codons coding for valine. But the third base can be changed.



This reaction is known as Clemmenson reduction.

101. (b) :  $\text{SO}_2$  shows both oxidising as well as reducing nature.

The reaction given in assertion is due to oxidising nature of  $\text{SO}_2$ .



102. (a) : (i) Due to smaller size of F; steric repulsions will be less in  $\text{SiF}_6^{2-}$ .

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

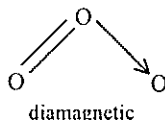
103. (b) : Borax bead test is not suitable for Al(III) because its oxidising as well as reducing flame is colourless in both hot as well as cold.

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.

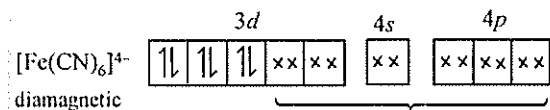
104. (b) : Due to the ease with which it can liberate nascent oxygen,  $\text{O}_3$  acts as a powerful oxidising agent.



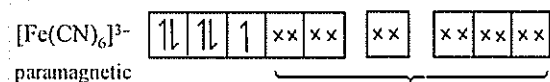
$\text{:O} \cdot \cdot \cdot \cdot \text{O} \cdot$   
paramagnetic  
(due to presence of  
two unpaired electrons)



105. (c) : Ferrocyanide ion



$d^2sp^3$  hybridisation



$d^2sp^3$  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) :  $\text{Ba(OH)}_2$  is soluble in water.

107. (c) :  $\text{SeCl}_4$  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  $\text{SeCl}_4$  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  $\text{H}_2$ , 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.

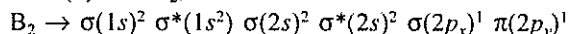
110. (d) : First ionization energy for nitrogen is greater than oxygen.

|    |      |      |
|----|------|------|
|    | N    | O    |
| eV | 14.5 | 13.6 |

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  $\text{B}_2$ , total number of electrons = 10



Presence of unpaired electron shows the paramagnetic nature.

The highest occupied molecular orbital is of  $\pi$ -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.

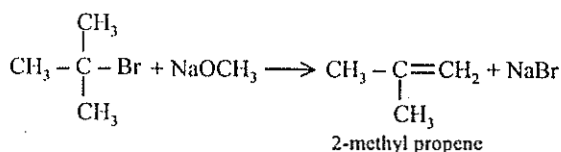
113. (a) : Zinc metal which has a more negative electrode potential than iron will provide electrons in preference to the iron, and therefore corrode first. Only when all the zinc has been oxidised does the iron start to rust.

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 :  $\text{Fe}_2\text{O}_3(s) \rightarrow \text{Fe}(s) + 3/2 \text{O}_2(g)$  is not a spontaneous process.  $\text{Fe}_2\text{O}_3$  is converted to  $\text{FeO}$  at about  $400^\circ\text{C}$ .  $\text{FeO}$  is converted to  $\text{Fe}$  at about  $800^\circ\text{C}$ - $1000^\circ\text{C}$ .

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.

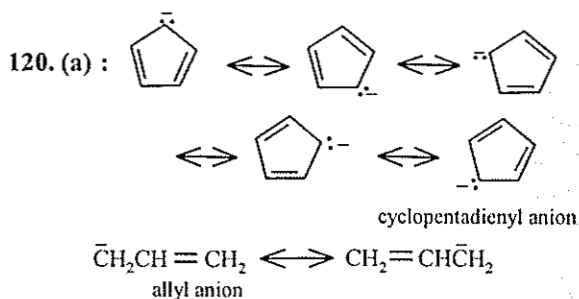
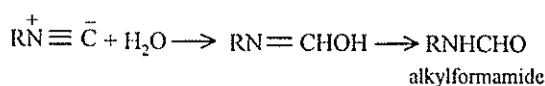
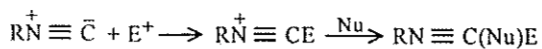


It is because alkoxides are not only nucleophiles but also strong bases as well. They react with alkyl halides leading to elimination reaction.

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

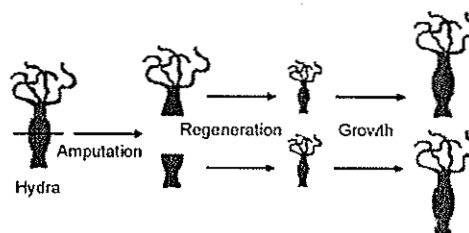
118. (d) : The nitro group strongly deactivates the benzene ring towards electrophilic substitution. Nitrobenzene does not undergo Friedel-Craft acylation reaction.

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 system.

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 require active cellular proliferation prior to the replacement of the lost body part. For eg. *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. The increases the glomerular filtration rate, resulting in greater excretion of Na<sup>+</sup> 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 is 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 provide 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 endocoding gene. PG is poly galacturonase 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 kininogenase on plasma  $\alpha_2$ -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 *in situ* 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  $H_2O$  molecules. Scapula and canine are osteocytic structures with negligible  $H_2O$  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) :**  $T_1$  plasmid is found extragenomically in *Agarobacterium 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 (PVD), 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  $55^{\circ}\text{C}$ - $60^{\circ}\text{C}$ . 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 tetradynamous 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 silique (Dry dehiscent fruit formed by bicarpellary syncarpous gynoecium with replum) and rarely lomontum.

**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 enclose 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 possess starch.

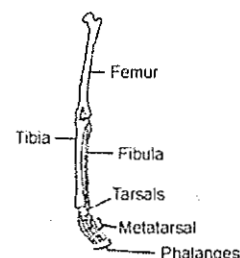
**148. (c) :** Ecological niche is the term used to describe the status of a plant or animal in its community.

**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) :** Somaclonal 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  $\mu\text{g}$  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  $\mu\text{g/g}$  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  $\mu\text{m}$ . 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).

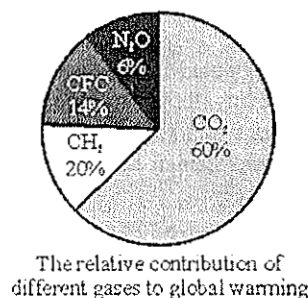
| SPM                                            | Other aerosols                                             |
|------------------------------------------------|------------------------------------------------------------|
| Less than 10 $\mu\text{m}$                     | Less than 100 $\mu\text{m}$                                |
| 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 –  $\alpha$ ,  $\beta$  and  $\gamma$ . 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.

**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 lymphocyte 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 (Cytosan), 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. *Erysipi*) fungi are achlorophyllous i.e. devoid of chlorophyll hence cannot prepare their own food. They are heterotrophic and show absorptive type of nutrition.

**172. (a) :**  $C_4$  photosynthetic pathway is more efficient than  $C_3$  pathway as  $C_4$  plants can pick up  $CO_2$  even when it is found in low concentration. PEP enzymes shows high affinity for  $CO_2$ .  $C_4$  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  $\text{CO}_2$  in bundle sheath cells, RuBP carboxylase works only for Calvin cycle and not for photorespiration.

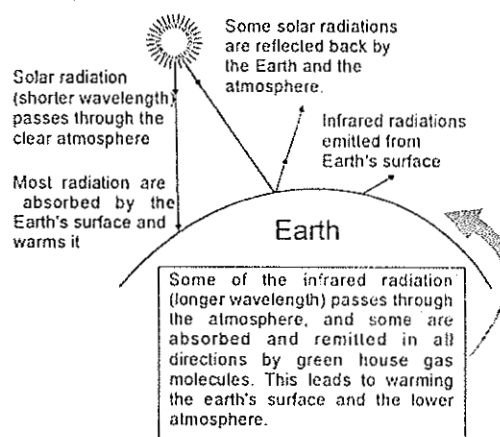
Photorespiration is a wasteful process as it works to undo the act of photosynthesis in  $\text{C}_3$  plants. No energy rich compound is produced in this process. When temperature increase more and more photosynthetically fixed carbon is lost by photorespiration thus reducing the efficiency of  $\text{C}_3$  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 (somatoplasm), 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-Baptiste 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) describe the roles of water vapour,  $\text{CO}_2$  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  $\text{CO}_2$ ,  $\text{CH}_4$ , 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 ovalbumin 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  $\text{CO}_2$  concentration photosynthesis is strongly limited by the low  $\text{CO}_2$  while respiratory rates are unaffected. As a result there is a negative balance between  $\text{CO}_2$  fixed by photosynthesis and  $\text{CO}_2$  produced by respiration and a net efflux of  $\text{CO}_2$  from the plant.

By increasing the atmospheric concentration of  $\text{CO}_2$  at which photosynthesis just compensate for respiration is referred to as  $\text{CO}_2$  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 (broad 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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| <b>181. (a)</b> | <b>182. (d)</b> | <b>183. (c)</b> | <b>184. (a)</b> |
| <b>185. (d)</b> | <b>186. (a)</b> | <b>187. (a)</b> | <b>188. (a)</b> |
| <b>189. (b)</b> | <b>190. (a)</b> | <b>191. (b)</b> | <b>192. (b)</b> |
| <b>193. (a)</b> | <b>194. (c)</b> | <b>195. (c)</b> | <b>196. (a)</b> |
| <b>197. (b)</b> | <b>198. (b)</b> | <b>199. (a)</b> | <b>200. (c)</b> |