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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION

Paper Code: UN 415

Solutions for Class : 12 (PCB)

Biology

1. (A) If microspore mother cell has 12 bivalents (means) 12 pairs of chromosomes or 24 chromosomes), the spores (pollens) which are haploid will have only 12 chromosomes ($n = 12$).
2. (B) Gonads are derived from the mesodermal germinal ridges of the embryo which contain mesodermal epithelium and large spherical primitive germ cells.
3. (D) Omnis cellula a cellula (every cell from a cell) – Rudolf Virchow (1858); Omne vivum e vivo (every living from the living).
4. (D) The process of mitogenesis, the notochord formation, takes place immediately after gastrulation.
5. (B) Nematodes are characterized by constancy in number of cells in each organ, hence growth occurs by increase in size of cells.
6. (A) Mendel studied the inheritance of traits located on the chromosome pairs 1, 4, 5 and 7.
7. (D) UGG codes for the amino acid tryptophan.
8. (C) Structural gene determines the primary structure of a protein by genetic transcription and translation.
9. (B) The facial features of Down syndrome resemble to mongol, an Asian ethnic group.
10. (C) Because the amino acids are organic monomers.
11. (D) Wings of birds and insects are analogous organs.
12. (B) Von Baer's law was reinterpreted in the light of evolutionary theory by Muller and Haeckel (1864) and named as 'Bio-genetic law'
13. (A) The sequence of the three ages of human cultural evolution are palaeolithic, mesolithic and neolithic.
14. (C) Ivory is the dentine, especially the hard white substance composing the tusks of the elephant, walrus, hippopotamus.
15. (B) The Human Leucocyte Antigen System (HLA) is the name of the Major Histocompatibility Complex (MHC) in humans.
16. (B) Best biofertilizer for paddy fields is Azolla and blue-green algae.
17. (C) Rotenone is a natural insecticide which is obtained from roots of Derris and Lonchocarpus. It is used for controlling wide range of insects harming the crop plants. Its application in crop fields is harmless for the crops and is biodegradable.
18. (B) Multiple sclerosis is an auto-immune disease in which the immune system attacks the central nervous system, leading to demyelination. Disease onset usually occurs in young adults, and it is more common in females. It was first described in 1868 by Jean-Martin Charcot.
19. (D) HIV attaches to CD4 receptor site of helper T-cells by the help of GP120 on the protein coat of the virus.
20. (A) Coconut milk contains nutrients along with natural hormones like cytokinin. When it is added in culture medium, the growth of callus is enhanced considerably. Coconut milk is in fact free nuclear endosperm and thus it is a very rich and nutritive drink.
21. (C) Syphilis - Treponema pallidum.
22. (D) Rheumatic fever is an autoimmune disorder, primarily affecting women 40 to 60 years old, causing chronic inflammation

of the joints.

23. (A) DDT is widely used in India under Malaria Eradication Programme in spite of knowing its non-biodegradable nature and highly persistent character. It enters into plants and animals through various food-chains. In human body, it accumulates in fatty tissue and remain persistent even upto 40-50 years. It affects vital organs and often becomes dangerous to human life.
24. (C) Browning of cauliflower is a physiological symptom which develops due to deficiency of Boron.
25. (D) Jatropha has recently been found as a good source of biodiesel produces. Its fruits yield diesel like fluids containing long chain hydrocarbons and thus the fluid can directly be used to generator set as fuel. The plant can be grown as a crop plant and biodiesel can be obtained at low cost after one year of cultivation.
26. (A) Inbreeding is possible between the two members of a species. However, hybrids can be produced using plants of two different species (interspecific hybrids) or of two different genera (intergeneric hybrids). Through somatic hybridization, now it is possible to hybridize cells of two different groups (algae and higher plants, or animal and plant cells, etc).
27. (B) Five major classes of immunoglobulins are IgA, IgD, IgE, IgG and IgM.
28. (D) Bronchitis: An acute or chronic inflammation of the mucous membranes of the tracheobronchial tree.
- Emphysema: Over-inflation and destructive changes of alveolar walls, resulting in the loss of lung elasticity and decreased gases.
29. (A) Diphtheria is characterized by the production of a systemic toxin and a false membrane lining of the mucous membrane of the throat.
30. (C) Bombyx mori belongs to the Class insecta, Order Lepidoptera.
31. (A) Wolffian duct (also called as mesonephric duct) gives rise to epididymis.
32. (A) Genetic clock theory was proposed by Pal (1975). It is also known as genetic time table theory. Every organism has ageing genes and thus, Its maximum life-span.
33. (D) Crossing over or recombination of genes results in variations.
34. (C) Mendel's law of inheritance (1866).
Chromosome theory of inheritance (1902).

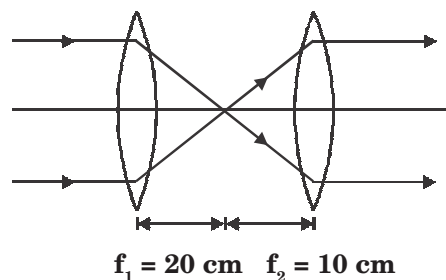
DNA, hereditary material experiments (1944, 52)

35. (B) A mitotic metaphase chromosome consists of two chromatids whereas meiotic metaphase chromosome is a bivalent (tetrad) with four chromatids.
36. (B) Cytosine, thymine and uracil are pyrimidines.
37. (C) Plasmalemma is made mainly of proteins and lipids.
38. (C) The geologist J. Hutton (1726-1797) proposed the uniformitarian concept. The steady uniform action of the forces of nature could account for the earth's features.
39. (D) New World monkey refers to spider monkey.
40. (B) Livestock refers to domestic animals especially horses, cattle, sheep and pigs.

Physics

41. (A) Here, $B = 2.52 \times 10^{-3} \text{ T}$;
 $\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
Length of the solenoid, $l = 0.5 \text{ m}$; Total number of turns in the solenoid, $N = 500$
Therefore, number of turns per unit length of the solenoid,
$$n = \frac{N}{l} = \frac{500}{0.5} = 1000 \text{ m}^{-1}$$

If I is the current through the solenoid, then
 $B = \mu_0 n I$
or $I = \frac{B}{\mu_0 n} = \frac{2.52 \times 10^{-3}}{4\pi \times 10^{-7} \times 1000} = 2.0 \text{ A}$
42. (D) Here, $r = 3.2 \times 10^{-15} \text{ m}$; charge on α - particles, $q_1 = q_2 = 2 \times 1.6 \times 10^{-19} \text{ C}$
Now, $F = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1 q_2}{r^2}$
$$= 9 \times 10^9 \times \frac{(2 \times 1.6 \times 10^{-19})^2}{(3.2 \times 10^{-15})^2} = 90 \text{ N}$$
43. (B) As shown in the figure the distance between the lenses should be 30 cm.

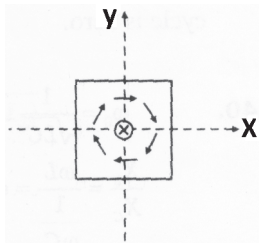


44. (B) For meter bridge,

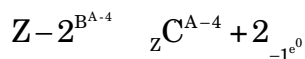
$$\text{Unknown resistance, } R = \frac{l_2}{l_1} \times X$$

$$= \frac{3}{2} \times 5 = 7.5 \Omega$$

45. (D) Magnetic lines are tangential to the coil as shown below. Thus, net magnetic flux passing through the coil is always zero or the induced current will be zero.



46. (A) $Z^A \rightarrow Z - 2^{B^{A-4}} + {}_2\text{He}^4$



Thus, A and C have same atomic number, so these are isotopes.

47. (D) Finger prints on a piece of paper can be detected by sprinkling fluorescent powder on the paper and then looking it into ultra-violet light.

48. (A) $F = 6 \times 10^{-6} \text{ N}$

$$n = \frac{F}{3 \times 10^{-10}} = \frac{6 \times 10^{-6}}{3 \times 10^{-10}} = 2 \times 10^4$$

49. (C) Magnetic field due to a long current carrying conductor

$$B = \frac{\mu_0 I}{2 \pi r} \text{ i.e., } B \propto \frac{1}{r}$$

So, correct graph will be (c).

50. (D) Here, $\nu_0 = 2 \times 10^{14} \text{ Hz}$

$$\omega = h\nu_0 = 6.62 \times 10^{-34} \times 2 \times 10^{14}$$

$$= 1.324 \times 10^{-19} \text{ J}$$

$$= \frac{1.324 \times 10^{-19}}{1.6 \times 10^{-19}} = 0.8275 \text{ eV}$$

51. (A) By Ohm's law $R = \frac{V}{I}$

The resistance of the heater is constant.

$$R = \frac{V_1}{I_1} = \frac{V_2}{I_2}$$

$$\text{or } I_2 = V_2 \frac{I_1}{V_1} = \frac{120 \times 8}{240} = 4 \text{ A}$$

52. (C) Fringe width, $\beta \propto \lambda$

$$\therefore \frac{\beta_1}{\beta_2} = \frac{\lambda_1}{\lambda_2}$$

$$\text{or } \frac{\beta_1}{\beta_2} = \frac{\lambda_1}{\lambda_1 / \mu}$$

$$\therefore \beta_2 = \frac{\beta_1}{\mu} = \frac{0.6}{1.5}$$

$$= 0.4 \text{ mm}$$

53. (B) Here, rate of production of energy at the atomic power house,

$$P = 400 \text{ MW} = 400 \times 10^6 \text{ J s}^{-1}$$

Therefore, total energy produced in a day i.e., $24 \times 60 \times 60$ s,

$$E = P \times 24 \times 60 \times 60 = 400 \times 10^6 \times 24 \times 60 \times 60 = 3.456 \times 10^{13} \text{ J}$$

If mass of U^{235} consumed per day is m (in kg) so as to produce the required amount of energy, then

$$E = m c^2$$

$$\text{or } 3.456 \times 10^{13} = m c^2$$

$$\text{or } m = \frac{3.456 \times 10^{13}}{c^2} = \frac{3.456 \times 10^{13}}{(3 \times 10^8)^2}$$

$$= 0.384 \times 10^{-3} \text{ kg} = 0.384 \text{ g}$$

54. (D) Here, wavelength $\lambda = 5.5 \times 10^{-5} \text{ cm}$

$$= 5.5 \times 10^{-7} \text{ m}$$

$$\text{Velocity of light} = 3 \times 10^8 \text{ m s}^{-1}$$

If ν is the frequency, then

$$\nu = \frac{c}{\lambda} = \frac{3 \times 10^8}{5.5 \times 10^{-7}} = 5.45 \times 10^{14} \text{ Hz}$$

$$= 5.45 \times 10^8 \text{ MHz}$$

55. (A) Incident wavelength

$$= \lambda = 1000 \text{ \AA} = 1000 \times 10^{-10} \text{ m}$$

$$= 10^{-7} \text{ m}$$

$$h\nu = W + \frac{1}{2} m v^2 \text{ Given, Work function, } W = 0$$

$$\text{Kinetic energy of photoelectrons} = \frac{1}{2} m v^2$$

$$= h\nu = \frac{hc}{\lambda} = \frac{6.62 \times 10^{-34} \times 3 \times 10^8}{10^{-7}}$$

$$= 19.86 \times 10^{-19} \text{ J} = \frac{19.86 \times 10^{-19}}{1.6 \times 10^{-19}}$$

$$= 12.41 \text{ eV}$$

56. (B) Polarity of emf will be opposite in the two cases while entering and while leaving the coil. Only in option (B) polarity is changing.

57. (B) In case of transistors, constant α is current gain in common-base configuration and constant β is current gain in common-emitter configuration. Also α is always less than 1 while β is always greater than 1.

58. (B) Let B_1 , B_2 and B_3 be the magnetic fields produced at the point O by the straight part AB, circular part BC and straight part CD of the current carrying conductor ABCD. Since the point O lies on the straight parts AB and CD,

$$B_1 = B_3 = 0$$

Further, as the circular segment BC subtends an angle θ at the point O,

$$B_2 = \frac{\mu_0}{4\pi} \cdot \frac{2\pi I}{r} \times \frac{\theta}{2\pi} = \frac{\mu_0}{4\pi} \cdot \frac{I\theta}{r}$$

$$= \frac{10^{-7} \times 6 \times \pi / 3}{0.1} = 6.28 \times 10^{-6} \text{ T}$$

Hence,
total magnetic field at the point O,

$$B = B_1 + B_2 + B_3 = 0 + 6.28 \times 10^{-6} + 0$$

$$= 6.28 \times 10^{-6} \text{ T}$$

59. (D) The work function of lithium is 2.5 eV. The threshold wavelength is

$$\lambda = hc / \phi.$$

$$= \frac{(4.14 \times 10^{-15} \text{ eV} \cdot \text{s}) \times (3 \times 10^8 \text{ m/s})}{2 \times 5 \text{ eV}}$$

$$= \frac{1242 \text{ eV} \cdot \text{nm}}{2.5 \text{ eV}} = 497 \text{ nm}.$$

This is the required maximum wavelength.

60. (C) The capacitance C of a capacitor depends only on the geometrical configuration (shape, size, separation) of the system of two conductors.

61. (B) When x-rays fall on a neutral metallic block, then they eject electrons from it, so block becomes positively charged.

62. (B) Energy released

$$= (E_A + E_B) - E_x$$

$$= (110 \times 8.2 + 90 \times 8.2) - 200 \times 7.4$$

$$= 1640 - 1480$$

$$= 160 \text{ MeV}$$

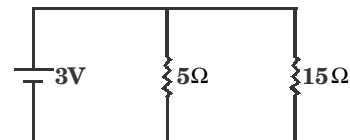
63. (B) $P_R = i_{\text{rms}}^2 R$ or $P_R \propto i_{\text{rms}}^2$

Impedance of the circuit will increase.

Therefore, i_{rms} in the circuit will decrease or average power absorbed by the resistance will decrease.

64. (B) Equivalent resistance in series is sum of individual resistances.

In the given figure 3 resistors of 5Ω are connected in series.



$$\therefore R' = 5 + 5 + 5 = 15 \Omega$$

This 15Ω resistor is connected with the 5Ω resistor in parallel hence, equivalent resistance now is

$$\frac{1}{R''} = \frac{1}{15} + \frac{1}{5}$$

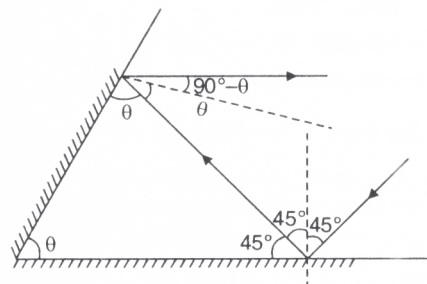
$$\frac{1}{R''} = \frac{5 + 15}{5 \times 15}$$

$$\Rightarrow R'' = 3.75 \Omega$$

From Ohm's law, $V = IR$

$$\therefore I = \frac{V}{R} = \frac{3}{3.75} = 0.8 \text{ A}$$

65. (C) The situation is shown in the figure.



$$\therefore \theta + \theta + 45^\circ = 180^\circ$$

$$\text{or } 2\theta = 180^\circ - 45^\circ$$

$$\text{or } 2\theta = 135^\circ$$

$$\therefore \theta = \frac{135}{2}$$

$$= 67.5^\circ$$

$$= 67^\circ 30'$$

Chemistry

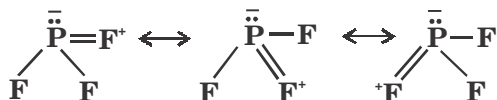
66. (C) Rutile (magnetic) is separated from chlorapatite (non-magnetic) by magnetic separation method.

67. (B) Geometrical isomerism is shown by square planar and octahedral complexes.

68. (C) Ketones are less reactive than aldehydes.
The aromatic aldehydes and ketones are less reactive than the aliphatic aldehydes and ketones. So



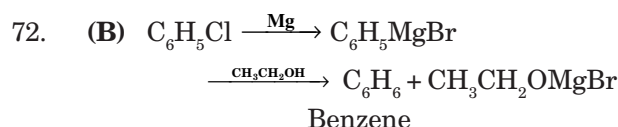
69. (C) The molecule PF_3 is expected to acquire partial double bond character due to back donation of a pair of electrons from F to P which results in the formation of a $\text{p}\pi - \text{d}\pi$ bond. Due to the resonance forms



the bond pair-bond pair repulsion increases to give a higher bond angle.

70. (C) Doping of Si with P gives extra electrons while doping with Al gives rise to holes.

71. (D) Only 1° amides undergo Hofmann bromamide reaction. Since $\text{CH}_3\text{CONHCH}_3$ is a 2° amide, therefore, it does not undergo Hofmann bromamide reaction.



73. (C) The sequence of ribonucleotides in mRNA molecule called codon is a group of three nucleotides.

74. (A) To lower the freezing point of water.

75. (D) Ionisation energies of d-block elements vary slightly from one another because when we move from left to right, the nuclear charge increases but at the same time screening effect also goes up. These two factors tend to neutralise the effect of each other.

76. (C) Vapour pressure of pure, $P_A^\circ = 40$ mm Hg

Vapour pressure of A in solution, $P_A = 32$ mm Hg

According to the Raoult's law,

$$P_A = P_A^\circ X_A$$

$$\text{Then, } X_A = \frac{P_A}{P_A^\circ} = \frac{32 \text{ mm Hg}}{40 \text{ mm Hg}} = 0.8$$

77. (B) Blasting of TNT is done by mixing it with NH_4NO_3 . This mixture of 1 : 5 ratio is called amatol.

78. (B) Decomposition of NH_3 on the surface of finely divided platinum is zero order at high concentration but first order at low concentration.

79. (C) $\text{C}_3\text{H}_8 \xrightarrow[-2\text{Cl}]{+2\text{H}} \text{C}_3\text{H}_6\text{Cl}_2$. The following four structural isomers are possible $\text{CH}_3\text{CH}_2\text{CHCl}_2$ (I), $\text{CH}_3\text{CCl}_2\text{CH}_3$ (II), $\text{ClCH}_2\text{CH}_2\text{Cl}$ (III), $\text{CH}_3-\text{CHCl}-\text{CH}_2\text{Cl}$ (IV). Since (IV) has a chiral carbon, therefore, it has two optical isomers. Therefore, in all, five isomers are possible.

80. (D) Bragg's equation

$$n\lambda = 2d \sin \theta$$

$$2 \times 1 = 2 \times d \times \sin 60^\circ$$

$$2 \times 1 = 2 \times d \times \frac{\sqrt{3}}{2}$$

$$d = \frac{2}{\sqrt{3}} = \frac{2}{1.7} = 1.17 \text{ \AA}$$

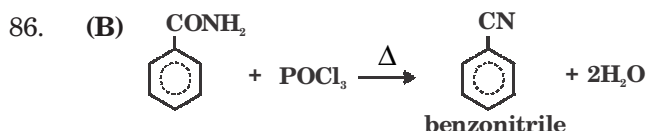
81. (B) HCOOH reduces HgCl_2 to Hg_2Cl_2 but CH_3COOH does not.

82. (C) $\text{PH}_3(\text{g}) + 4\text{Cl}_2(\text{g}) \rightarrow \text{PCl}_5 + 3\text{HCl}(\text{g})$
Phosphine

83. (D) Alcohols show extensive association due to intermolecular hydrogen bonding. Ethers do not show intermolecular hydrogen bonding.

84. (D) Zeigler-Natta catalyst used for polymerisation of ethylene is a mixture of TiCl_4 + trialkyl aluminium.

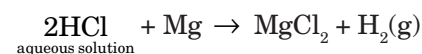
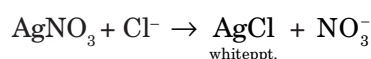
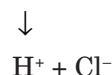
85. (D) CN^- ion is at the extreme right but before CO in the spectrochemical series. So it can cause maximum splitting of d-orbitals.



87. (A) Heating steel to 825—875 K in presence of NH_3 is called nitriding.

88. (A) NaCl being a salt of strong acid and strong base does not hydrolyse, therefore it will remain as such in the mixture.

89. (C) $\text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{HCl} + \text{HClO}$



90. (C) Cell potential

$$= E_{\text{Red}}^\circ (\text{RHS}) - E_{\text{Red}}^\circ (\text{LHS})$$

$$= 0.34 - (-0.76) = +1.10 \text{ V}$$