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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION

Paper Code: UN426

Solutions for Class : 12 (PCB)

Biology

1. **(B)** 2-celled pollen grains of angiosperm represent a partially developed male gametophyte.
2. **(C)** Graafian follicle, named after the Dutch physician Reijnier de Graaf, is a matured mammalian ovarian follicle.
3. **(C)** All birds are oviparous.
4. **(B)** Anterior pituitary promotes growth through the secretion of hormone STH or GH.
5. **(B)** Being dioecious, a dog cannot be self-fertilized.
6. **(A)** In the given figure part labelled W is fallopian tube. Fertilisation takes place in fallopian tube and implantation takes place in part labelled Y (uterus)
7. **(B)** In honeybee, males (drones) are haploid developed by parthenogenesis and females are diploid.
8. **(B)** Dysentery (bacterial), plague and tuberculosis are bacterial diseases, not linked genetically.
9. **(C)** In the given flow chart box labelled R represents teritiary animals. Teritiary animals receive least amount of energy.
10. **(C)** Escherichia coli is an important food borne disease organism. It can cause diarrhoea and haemorrhagic colitis. The infection is associated with poor hygienic practices.
11. **(A)** Warm-blooded animals typically have to expend a lot more energy to keep themselves warm. Thus, they usually need a higher intake of food, which is used to drive metabolism and thus generate heat.
12. **(D)** It is known as plica semilunaris in man.
13. **(A)** Aspirin is chemically acetyli \salicyclic acid. It works by reducing substances in the body that cause pain, fever and inflammation. Aspirin is used to treat mild to moderate pain, and also to reduce fever or inflammation. It is sometimes used to treat or prevent heart attacks, strokes, and angina. Aspirin should be used for cardiovascular conditions only under the supervision of a doctor.
14. **(C)** Hemophilia is due to the deficiency of prothrombin, fibrinogen & thrombokinase.
15. **(A)** Micropropagation is now used for producing numerous plants from a small piece of tissue (may be a root tip or a shoot tip or even protoplasts) with the help of suitable culture medium, it is based on the concept of cellular totipotency indicating that each and every cell of an organism has the potentiality of producing complete plant when allowed to grow on suitable culture medium. Clones are obtained using micropropagation technique. The seeds of orchids have every poor viability and thus do not grow under normal conditions. The shoot tip or root tip of a particular variety of orchids can produce clones within a very short duration (2-3 months), using micropropagation technique.
16. **(D)** Gram +ve bacteria differ from Gram –ve forms in having excess of peptidoglycan in their cell wall which retains Gram staining even after through washing with alcohol. Gram –ve forms are often found associated with diseases (they are pathogenic in nature).
17. **(B)** Most extensively studied bacterium in Escherichia coli (E coli) which commonly found in intestine of man and cattles as endosymbiont. Rarely it becomes pathogenic and cause Urinary Tract Infection. E.coli has been used extensively in molecular biology and biotechnology. Semiconservative type DNA replication was first demonstrated in E.coli. restriction endonuclease 'Eco R-I and Eco R-II' have been isolated from the cells of E. coli. Plasmids of E.coli have been used in recombinant DNA technology. First gene cloning has been successfully carried out using E.coli. First human insulin and human growth hormone somatotropin were synthesized with the help of E. coli.

18. **(A)** Pheromones are sex hormones produced by insects to attract insects of opposite sex for mating. Female pheromones attract male insects and male pheromones, the female insects. If insect trap is pasted with a particular type of pheromones, the insects of opposite sex are attracted in insect trap and killed thus reducing the chance of their over production through frequent mating.

19. **(A)** Mammal-like reptiles (therapsids) lived during the early Triassic period. These were the reptiles that took the road leading to themammals and some of them approached very closely to the mammalian stage of organization, e.g., Cynognathus and Dicynodon.

20. **(D)** Mast cells in areolar connective tissue secrete histamine.

21. **(B)** Auxotrophs are mutants of bacterial strains lacking one or more essential genes required to synthesize amino acids during protein synthesis. They are, therefore incapable of growing on the basal medium and need special media supplemented with desired amino acid/s. Mutants can be converted to normal strains (prototrophs) either through genetic recombination with another mutants or through reverse mutation. Sexuality in E.coli has been studiedusing its auxotrophs of different deficiencies.

22. **(C)** Nitrifying bacteria. Nitrosomonas and Nitrobacter, are capable of oxidizing ammonia to produce nitrites and then nitrates. They are chemoautotrophs and they derive energy through oxidation reactions for synthesizing their own food. Since they are utilizing inorganic raw materials (carbon dioxide and H_2S) in their photosynthesis, they are placed under chemolithotrophs.

23. **(B)** Peripatus resembles an arthropod in having haemocoel, dorsal heart with ostia, tracheal respiration and the pattern of development.

24. **(D)** Myasthenia gravis is an autoimmune disease characterized by the chronic fatiguability and weakness of muscles, especially in the face and throat, as a result of defect in the conduction of nerve impulses at the myoneural junction.

25. **(A)** In India DDT has been used for killing mosquitos to eradicate malaria. It is a peristent insecticide which has residual effect even upto 40-50 years. It is non-biodegradable and thus non-ecofriendly. It pollutes soil and water-bodies both and persists in the body of producers as well as consumers for several years. It is stored in fatty tissues of fishes and human beings.

26. **(A)** Anthers mature and release pollen. Wind transfers pollen to stigma. Pollen tube grows through tissue of stigma. Generative nucleus divides to produce two male gametes. Male gamete fuses with ovum.

27. **(D)** PMNL stands for polymorphonuclear leucocyte, commonly termed as neutrophils.

28. **(A)** Totipotency of cell was first demonstrated by Steward et al. (1964) using the phloem cells of carrot roots and allowing them to grow on Whites medium. A cell, while growing on culture medium, developed callus, then plantlet and ultimately a complete plant showing, thereby, that each and every cell (only theliving cells) has the ability to produce complete plant if proper environment is provided.

29. **(C)** The given figure represents photosynthesis in plants.

30. **(D)** Measles, smallpox and rabies are viral diseases.

31. **(A)** Pachytene is a substage of prophase I of meiosis.

32. **(B)** Colchicine is an alkaloid that inhibits spindle formation during cell division.

33. **(A)** Ovum or sperm of human beings contains equal number of autosomes, 22 each.

34. **(C)** In the double helical model of DNA proposed by Watson and Crick, the nitrogenous bases attached to the pentose sugar backbone are perpendicular to the axis and parallel to each other.

35. **(C)** Because m-RNA carries the triplet codons responsible for sequence of amino acids in protein.

36. **(D)** Protein synthesis takes place in RER.

37. **(B)** Each delivery is an independent event, probability of male or female child will be 50 - 50%.

38. **(D)** Ongole is a place in Andhra Pradesh.

39. **(A)** Silkmoth is a beneficial insect used for the commercial production of silk.

40. **(D)** The proteins are made of amino acids have carbon, hydrogen, oxygen and nitrogen.

Physics

41. **(B)** Using Ampere's circuital law over a circular loop of any radius less than the radius of the pipe, we can see that net current inside the loop is zero. Hence, magnetic field at every point inside the loop will be zero.

42. **(C)** Electric field strength, $E = \frac{V}{d}$

$$= \frac{10}{0.10 \sin 30^\circ} = \frac{10}{0.10 \times \frac{1}{2}} = 200 \text{ V/m}$$

Perpendicular to line of force, i.e., at 120° with X-axis.

43. **(A)** Magnifying power of compound microscope $M = m_o \times m_e$

For objective, $\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$

$$\frac{1}{1/4} = \frac{1}{v_o} - \frac{1}{-1/3.8}$$

$$4 = \frac{1}{v_o} + 3.8 \Rightarrow v_o = 5 \text{ cm}$$

$$\therefore \ m_o = \frac{v_o}{u_o} = \frac{5}{1/3.8} = 19$$

Hence, $m_e = \frac{m}{m_o} = \frac{95}{19} = 5$

44. **(C)** $l_1 : l_2 = 1 : 3$, $r_1 : r_2 = 3 : 1$,
Area $A = \pi r^2$

$A_1 : A_2 = r_1^2 : r_2^2 = 9 : 1$

They are made of the same material. So, the resistivity ρ is the same.

$$\rho = \frac{R A}{l}, \ \frac{R_1 A_1}{l_1} = \frac{R_2 A_2}{l_2}$$

$$\frac{R_1}{R_2} = \frac{l_1}{l_2} \times \frac{A_2}{A_1} = \frac{1}{3} \times \frac{9}{1} = \frac{3}{1}$$

$R_1 : R_2 = 3 : 1$

45. **(D)** Here, $\frac{dI}{dt} = 4 \text{ A s}^{-1}$;

$e = 20 \text{ mV} = 20 \times 10^{-3} \text{ V}$

Now, $e = L\frac{dI}{dt}$ (in magnitude)

$$L = \frac{e}{dI/dt} = \frac{20 \times 10^{-3}}{4} = 5 \times 10^{-3} \text{ H}$$

46. **(A)** Velocity of electron in the nth orbit = $\frac{1}{137} \times \frac{c}{n}$.

Time taken to travel the first orbit = $\frac{\text{Distance}}{\text{Velocity}} = \frac{2\pi r}{V}$

$$= \frac{2\pi r \times 137 \times n}{c}$$

$$= \frac{2 \times 3.14 \times 5.29 \times 10^{-11} \times 137 \times 1}{3 \times 10^8}$$

$= 1.517 \times 10^{-16}$ s.

47. **(D)** There will be no force on electron due to magnetic field (because of parallel motion), but due to force applied by electric field, velocity of electron will decrease.

48. **(C)** Forces applied on the charge at the centre due to charges at A and C will cancel each other, so net force will be along diagonal BD.

49. **(A)** In a non-uniform magnetic field, the magnetic needle will experience both a force and a torque.

50. **(C)** Power P = 10 watt = 10 J/s.

Let n be the number of photons emitted per second

$$P = nhv = \frac{nhv}{\lambda} = 10$$

$$n = \frac{10\lambda}{hc} = \frac{10 \times 6000 \times 10^{-10}}{6.62 \times 10^{-34} \times 3 \times 10^8}$$

$= 3.02 \times 10^{10}$ per sec.

51. **(B)** Heat produced = $I^2 Rt$

or $mc \ \Delta\theta = I^2 Rt$

$\therefore$ Rise in temperature $\Delta\theta \propto I^2$

$$\therefore \ \frac{\Delta\theta_1}{\Delta\theta_2} = \left(\frac{I_1}{I_2}\right)^2$$

$$\frac{3}{\Delta\theta_2} = \left(\frac{I}{2I}\right)^2$$

$\therefore \ \Delta\theta_2 = 4 \times 3 = 12^\circ \text{C}$

52. **(D)** $\omega = \frac{\lambda D}{d}$

d is halved and D is doubled

$\therefore$ Fringe width ω will become four times.

53. **(B)** Initial amount of radioactive element

$= X + Y = 1 + 7 = 8$

Now, $N = N_0 \left(\frac{1}{2}\right)^n$

$\therefore \quad 1 = 8\left(\frac{1}{2}\right)^n \Rightarrow \left(\frac{1}{2}\right)^3 = \left(\frac{1}{2}\right)^n$

or $n = 3$

Hence, required time period

$t = n\, T_{1/2} = 3 \times 2 = 6$ h

54. **(B)** Infrared spectrum lies between microwave and visible region.

55. **(C)** Here, $h = 6.6 \times 10^{-34}$ J s ;
$m = 9.1 \times 10^{-31}$ kg ;

1 e V $= 1.6 \times 10^{-19}$ J

$E = 400$ eV $= 400 \times 1.6 \times 10^{-19}$
$= 6.4 \times 10^{-17}$ J

If λ is de-Broglie wavelength of electron, then

$$\lambda = \frac{h}{\sqrt{2\, m\, E}}$$

$$= \frac{6.6 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 6.4 \times 10^{-17}}}$$

$$= \frac{6.6 \times 10^{-34}}{10.8 \times 10^{-14}} = 0.61 \times 10^{-10} \text{ m}$$

$= 0.61$ Å

56. **(A)** Here, $R = 10\ \Omega$; $E_v = 220$ V ; $f = 50$ Hz ;
$I_v = 2.0$ A ;

If Z is impedance of the CR-circuit, then

$$Z = \frac{E_v}{I_v} = \frac{220}{2.0} = 110\ \Omega$$

But $Z = \sqrt{R^2 + X_C{}^2}$

or $X_C = \sqrt{Z^2 - R^2} = \sqrt{110^2 - 10^2}$

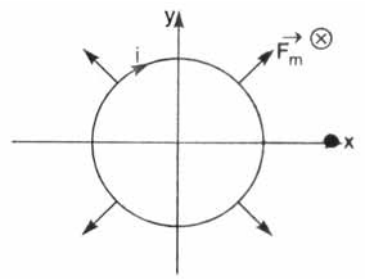
$= \sqrt{120 \times 100} = 109.54\ \Omega$

57. **(A)** A junction diode conducts during alternate half cycles of a.c. input supply. During a half cycle of conduction, the capacitor will charge itself to peak value of the supply voltage. Therefore, voltage across the capacitor,

$V = E_0 = E_{r.m.s.} \times \sqrt{2} = 220 \times \sqrt{2}$

$= 311.1$ V

58. **(B)** Net force on a current carrying loop in uniform magnetic field is zero. Hence, the loop cannot translate. So, options (C) and (D) are wrong. From Fleming's left hand rule we can see that if magnetic field is perpendicular to paper inwards and current in the loop is clockwise (as shown) the magnetic force $\vec{F}_m$ on each element of the loop is radially outwards, or the loops will have a tendency to expand.



59. **(B)** Threshold wavelength

$= \lambda_0 = 6800$ Å $= 6800 \times 10^{-10}$ m.

Work function,

$$W = \frac{hc}{\lambda_0} = \frac{6.62 \times 10^{-34} \times 3 \times 10^8}{6800 \times 10^{-10}}$$

$= 2.92 \times 10^{-19}$ J

$$= \frac{2.92 \times 10^{-19}}{1.6 \times 10^{-19}} = 1.825 \text{ eV.}$$

60. **(C)** Here, mass of the copper penny,
$m = 3.11$ g

$Z = 29$; $A = 63.5$ and $N = 6.02 \times 10^{23}$

Number of atoms in the copper penny,

$$n = \frac{N}{A} \times m$$

$$= \frac{6.02 \times 10^{23} \times 3.11}{63.5} = 2.95 \times 10^{22}$$

Number of protons or electrons in the copper penny

$= n \times Z$

$= 2.95 \times 10^{22} \times 29$

Therefore, total positive or negative charge on the copper penny,

$q = 2.95 \times 10^{22} \times 29 \times 1.6 \times 10^{-19}$

$= 1.37 \times 10^5$ C

61. **(D)** Speed of X-rays does not depend on the applied voltage. It is same as speed of light i.e., 3×10^8 m/s.

62. **(B)** Number of atoms in 1 g of U^{235}

$$= \frac{\text{Avogadro number}}{\text{Atomic weight}} = \frac{6.023 \times 10^{23}}{235}$$

Energy released per fission = 200 MeV

Therefore, energy released on fission of 1 g of U^{235}

$$= \frac{6.023 \times 10^{23} \times 200}{235} = 5.126 \times 10^{23} \text{ MeV}$$

$$= 5.126 \times 10^{23} \times 1.6 \times 10^{-13} \text{ J}$$

$$= 8.2 \times 10^{10} \text{ W s} \qquad (\because 1 \text{ J} = 1 \text{ W s})$$

$$= \frac{8.2 \times 10^{10}}{1000} = 8.2 \times 10^{7} \text{ kWs}$$

$$= \frac{8.2 \times 10^{7}}{3600} = 2.278 \times 10^{4} \text{ kWh}$$

63. **(C)** Here, $X_L = 160\ \Omega$; f= 50 Hz

Now, $X_L = 2\pi fL$ or $L = \frac{X_L}{2\pi f}$

$$= \frac{160}{2\pi \times 50} = 0.51 \text{ H}$$

64. **(D)** $R_0 = 10\ \Omega$, $R = 20\ \Omega$, $t = 273^\circ C$

Temp. coefficient

$$= \alpha = \frac{R - R_0}{R_0 \times t} = \frac{20 - 10}{10 \times 273} = 0.00366/^\circ C$$

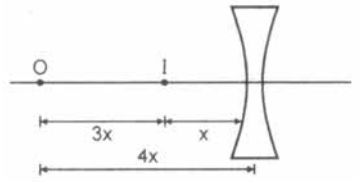
65. **(D)** Concave lens forms the virtual image of a real object. So let

$u = -4x$ and $v = -x$ then $3x = 10$ cm

or $x = \frac{10}{3}$ cm

$\therefore\ u = -\frac{40}{3}$ cm

and $v = -\frac{10}{3}$ cm



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

We get $\frac{1}{f} = \frac{-3}{10} + \frac{3}{40}$

or $f = \frac{-40}{9}$

or $f = -4.4$ cm

Chemistry

66. **(B)** Double salt of $Cu(CH_3COO)_2$ and copper arsenite $Cu_3(AsO_3)_2$ is called Paris green.

67. **(D)** Ferrocyanide ion is a complex ion. Hence, it is a complex salt.

68. **(D)** Aldehydes give silver mirror with ammoniacal $AgNO_3$ but ketones do not.

69. **(D)** $(NH_4)_2Cr_2O_7 \xrightarrow{\text{heat}} Cr_2O_3 + 4H_2O + N_2(g)$

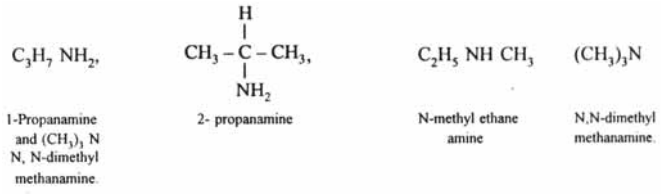
70. **(A)** Amount of NaCl = $\frac{1.00 \text{ g}}{58.5 \text{ g/mol}}$

No. of unit cells in 1.0 g of NaCl

$$= \frac{6.02 \times 10^{23} \text{ mol}^{-1}}{4} \times \frac{1.00}{58.5 \text{ g mol}^{-1}}$$

$$= 2.57 \times 10^{21}$$

71. **(C)** There are 4 possible isomeric amines of C_3H_9N. shown below.



72. **(B)** Benzyl chloride and ethyl bromide both have labile halogen and hence are easily hydrolysed. Since a white ppt. soluble in NH_4OH is obtained, therefore, the compound X is benzyl chloride.

73. **(C)** Heterocyclic base at C_1' and carbohydrate unity at C_5'.

74. **(B)** $CH_3 - CH_2 - CH_2Br \xrightarrow[20^\circ C, \text{ - HBr}]{\text{NaOH (alc.)}} CH_3 - CH = CH_2 \xrightarrow[20^\circ C]{\text{HBr/acetic acid}}$

$$CH_3 - \underset{\displaystyle Br}{\underset{|}{CH}} - CH_3$$

75. **(B)** $3\ d^5$ configuration has five unpaired electrons. Hence highest magnetic moment is shown by the transition metal having this configuration.

76. **(C)** Their molar concentrations will be

$$\text{Glucose} = \frac{10}{180} \times m = 0.05\ M,$$

$$\text{Sucrose} = \frac{10}{342} \times M = 0.02\ M$$

$$NaCl = \frac{10}{58.5} \times 2\ M = 0.34\ M$$

$$CaCl_2 = \frac{10}{111} \times 3\ M = 0.27\ M$$

Thus, concentration of particles in NaCl is highest.

77. **(A)** Normality of oxalic acid solution

$$= \frac{6.3\ g \times 4}{63\ g} = 0.4$$

So, $0.4 \times 10\ mL = 0.1 \times V_{NaOH}$

So, $V_{NaOH} = \frac{0.4 \times 10\ mL}{0.1}$

$= 40\ mL$

78. **(D)** For a first order reaction, Rate = k [Reactant]

So, $k = \frac{\text{Rate}}{[\text{Reactant}]}$

$$= \frac{1.5 \times 10^{-2}\ mol\ L^{-1}\ min^{-1}}{0.5\ mol\ L^{-1}}$$

$= 3 \times 10^{-2}\ min^{-1}$

and $t_{1/2} = \frac{0.693}{k} = \frac{0.693}{3 \times 10^{-2}\ min^{-1}}$

$= 23.1\ min$

79. **(D)** Since C—I bond is the weakest and I^- is a better leaving group than Br^-, Cl^- and F^- ions, therefore, C_2H_5I is the most reactive alkyl halide.

80. **(A)** As in NaCl, Cl^- ions are arranged in ccp and Na^+ ions occupy octahedral voids and radius of octahedral void = 0.414 R, i.e.,

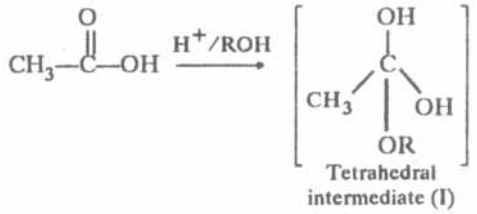
$r_{A+} = 0.414 \times r_{B-}$

or $r_{B-} = \frac{100}{0.414} = 241\ pm$

81. **(B)** Ketones on reduction with Zn + HCl give the corresponding hydrocarbon.

82. **(A)** He—O_2 (80% : 20%) mixture is used by deep sea divers for artificial respiration. Because of low intermolecular forces in He, it is much less soluble in aqueous solutions (as compared to N_2) such as blood and does not cause "caisson sickness" or "bends" by bubbling out of blood when the worker moves from high pressure (while in deep sea) to atmospheric pressure.

83. **(A)** As the size of the hydrocarbon part (R) of the alcohol increases, the tetrahedral intermediate (I) formed during esterificaiton becomes more and more crowded and hence the rate of esterification decreases accordingly. Thus, the smallest alcohol, i.e., CH_3OH reacts at the fastest rate.



84. **(C)** Lyophobic means solvent-hating. Metallic dipersions are lyophobic in nature.

85. **(C)** Wilkinson's catalyst is used for the hydrogenation of alkenes.

86. **(D)** Aromatic 1° amines give coupling reactions but aliphatic 1° amines do not.

87. **(A)** $Fe^{2+} + 6\ CN^- \rightarrow [Fe(CN)_6]^{4-}$.

88. **(C)** During acetylation, one H-atom (at. mass = 1 a.m.u.) of the NH_2 group is replaced by an acetyl group, i.e., 43 (mol. mass = 43 a.m.u.)

$-NH_2 + CH_3COCl \rightarrow -NH-COCH_3 + HCl$

In other words, acetylation of each NH_2 group increases the mass by 43—1 = 42 a.m.u. Now the mol. mass of the compound is 180 while that of the acetylated compound is 390, therefore, the number of NH_2 groups in the compound

$$= \frac{390 - 180}{42} = 5$$

89. **(C)** Halogens are coloured because their molecules absorb visible light causing the excitation of outer electrons to higher energy levels.

90. **(A)** $\Lambda^\circ_{(NaBr)} = \Lambda^\circ_{NaCl} + \Lambda^\circ_{KBr} - \Lambda^\circ_{KCl}$

$= (126 + 152 - 150)\ S\ cm^2\ mol^{-1}$

$= 128\ S\ cm^2\ mol^{-1}$

91. **(B)** 92. **(C)** 93. **(A)** 94. **(B)** 95. **(D)**

96. **(C)** 97. **(A)** 98. **(A)** 99. **(B)** 100. **(B)**