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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION

Paper Code: UN436 (UPDATED)

Solutions for Class : 11-PCB

BIOLOGY

1. **(A)** Susruta studied anatomy by surgical work. He described some 121 different surgical instruments and gave an account of most of surgical operations known before modern times.

2. **(A)** Sanger sequencing, also called as dideoxy sequencing, was developed by British scientist F. Sanger. This is commonly used in DNA sequence analysis. (Nobel Prize 1980)

3. **(C)** The biomacromolecules are formed from smaller molecules by a dehydration synthesis reaction.

4. **(A)** Gibbs change in free energy (ΔG) is that portion of the total energy change in a system that is available for doing work, i.e., free energy is the useful energy in a system.

5. **(C)** The genetic material of a virus can get mutated.

6. **(A)** HFR means High Frequency of Recombination. In some strains of E. coli, fertility factor(F) occurs on plasmid DNA. They are considered as sterile male. In some strains, F-factor occurs on nuclear genome and they are regarded as HFR strains or fertile males. They act as donor during conjugation. F-negative strains act as recipient cells or female.

7. **(B)** Trinomial nomenclature of gorilla is Gorilla gorilla gorilla.

8. **(B)** Seed habit has originated from heterospory. All seed plants are strictly heterosporous.

9. **(B)** Plants which are highly restricted in their distribution and found confined to certain localities are endemic plants, such as Ginkgo biloba or Crocus sativus. Most of the Indian Himalayan flora are endemic in nature due to presence of geographical barriers (due to presence of hills and foot-hills of Himalayas) which do not allow their wide spread distribution.

10. **(A)** In Bentham and Hooker's system, the Polypetalae has been sub-divided into 3 series, viz, Thalamiflorae, Calyciflorae and Disciflorae including 6, 4, and 5 orders respectively.

11. **(B)** Purple non-sulphur bacteria use propionic acid or malic acid as raw material in their photosynthesis, thus they are classified as photoorganotrophs or photoheterotrophs.

12. **(B)** Arboviruses are arthropod-borne viruses that cause infections like encephalitis, dengue fever and yellow fever.

13. **(A)** In prokaryotic cells, only one double stranded and circular DNA occurs which represent their genome or chromosome. Since the number of chromosome in them is only one, the linkage group will also be only one.

14. **(C)** Chloroplasts of diatoms and Chrysophycean algae do not possess well defined grana and stroma. Their chloroplasts are better called chromatophores. They possess only parallel thylakoids.

15. **(D)** Xylaria grows exclusively on decaying timber and thus it is a classical example of lignophilous fungus (wood-loving fungus).

16. **(A)** Nannandrous species of Oedogonium produces two types of filaments, viz., normal sized female filament bearing oogonia and dwarf sized male filaments (called nannandria) bearing antheridia. The female filaments provide place for growth of nannandria and thus nannandria are epiphytically growing near the oogonia of female filament. These species are dioecious and dimorphic.

17. **(D)** Although the ferns produce coiled and multiflagellated antherozoids but in lower pteridophytes like Lycopodium or Selaginella, bryophytes like biflagellated antherozoids are produced. In Marsilea, the antherozoids are cork screw like coiled and multiflagellate.

18. **(A)** Deuterostomia includes Echinodermata. Chordata and a number of minor phyla. The mouth is derived away from the blastopore and endomesoderm is enterocoelous.

19. **(D)** Enteron is the gut or alimentary canal enclosed within the endoderm.

20. **(B)** A sexual reproductive bodies called gemmules are formed by endogenous budding in all freshwater sponges and some marine sponges.

21. **(A)** Tentaculocyst of a jellyfish contains statolith which controls the equilibrium of medusa during swimming.

22. **(C)** Mitochondrial DNA provides one important piece of evidence in Anthozoa as in other metazoa the mitochondrial DNA is circular. But linear mitochondrial DNA is reported is 25 hydrozoans and 5 scyphozoans.

23. **(D)** In protostomiates (hydra) spiral cleavage is observed.

24. **(D)** Taenia is found attached to the intestinal wall of the host with the help of suckers and hooks present on the scolex. It does not possess any locomotory organs.

25. **(B)** Out of four moultings during the life history of Ascaris, the first one takes place outside the body of the host, i.e., in the soil.

26. **(B)** Several species of Polynoe, commonly called the 'scaleworm' are bioluminescent. Their elytra are brilliantly illuminated.

27. **(B)** Pharyngeal or salivary gland of earthworm consists of a group of small, whitish unicellular glands of chromophil cells.

28. **(B)** Scorpions have one pair of coxal glands situated near the bases of third pair of walking legs.

29. **(B)** The shell of the mollusc, when present, is secreted by the mantle and is lined by it.

30. **(B)** Deuterostomia refers to the animals in which blastopore of gastrula develops into the anus.

31. **(A)** Adult is degenerated in Herdmania owing to retrogressive metamorphosis.

32. **(C)** The electric organs of Torpedo are built up of disc-like, multinucleated cells called electrocytes. When all cells are discharged simultaneously, a high amperage current flows into the surrounding water to stun prey or discourage predators.

33. **(C)** Fishes, amphibians and reptiles are oviparous.

34. **(A)** The oily secretion of preen gland is used for lubricating or dressing the feathers.

35. **(A)** Sirenia is an order of herbivorous aquatic mammals without ear pinna.

36. **(A)** Procambium gives rise to vascular bundle forming stelar tissues, i.e., xylem, phloem and pericycle.

37. **(C)** Pseudostem (false stem) develops in banana by sheathing leaf bases. Its real stem is underground and rhizomatous.

38. **(A)** Gall flowers of hypanthodium inflorescence are neuter and they are used as source of food for the gall wasps which are specific pollinators of hypanthodium inflorescence.

39. **(D)** Brown fat has a multilocular appearance. It is brown due to many mitochondria present. Brown fat is specially involved in heat production. The electron transport system is uncoupled from oxidative phosphorylation, which results in the production of heat instead of ATP.

40. **(B)** Renal portal of frog drains blood from hindlimbs and posterior part of the trunk and supplies to the kidneys.

PHYSICS

41. **(C)** A metal ball and a rubber ball of the same mass are dropped from the same height. After hitting the floor, the rubber ball rises higher than the metal ball. There is a greater change in momentum in case of the rubber ball.

42. **(B)** During uniform rotatory motion along a circular path magnitude of acceleration is constant.

43. **(B)** $y = 12x - \frac{3}{4}x^2$.

Therefore, $\frac{dy}{dt} = 12\frac{dx}{dt} - \frac{3}{2}x\frac{dx}{dt}$.

At x = 0, we find $\frac{dy}{dt} = 12\frac{dx}{dt}$. If θ be the angle of projection, then (dy/dx)/(dx/dt)=12 = tan θ. (slope)

Also if u = initial velocity, then u cos θ =3. Therefore, (tan θ)(u cos θ) = 36, or u sin θ = 36.

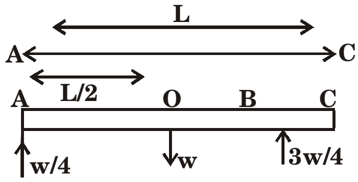
And range R = $\frac{u^2 \sin 2\theta}{g} = \frac{2u^2 \sin\theta\cos\theta}{g}$

$= \frac{2(u\sin\theta)(u\cos\theta)}{10} = \frac{2\times 36\times 3}{10} = 21.6\,\text{m}$.

44. **(C)** v_x = 2ct and v_y = 2bt. Speed after one second will be

$\left[(2b)^2 + (2c)^2\right]^{1/2} = 2\left(b^2 + c^2\right)^{1/2}$.

45. **(A)**



Here AC is the bar. Sunil is holding the bar at A and the Anil is holding it at B. The load on Sunil is w/4 where W is weight of the bar. Then load on M_2 is 3W/4. The weight is acting at point 'O'. Taking moments about A, we find :

$W \times \frac{L}{2} = \frac{3w}{4} \times AB$. Hence, AB = $\frac{2L}{3}$.

46. **(B)** v_{es} = $\sqrt{2}\, v_0$. Kinetic energy in orbit is $\frac{Mv_o^2}{2} = E$

Kinetic energy to escape is Mv_{es}^2 /2

$= \frac{M\left(\sqrt{2}V_o\right)^2}{2}$ = 2E

47. **(B)** The inclination of the string is $\tan^{-1}$ (a/g) opposite to the direction of motion.

48. **(A)** Viscous force is temperature dependent and velocity dependent.

49. **(B)** If the force of cohesion is greater than adhesion, then the liquid will not wet the solid.

50. **(B)** Moment of inertia of a thin circular disc $MR^2/4$. So, the moment of inertia is minimum through the centre parallel to the surface.

51. **(C)** Volume of raft V = $\frac{M}{\rho} = \left(\frac{30}{750}\right)m^3$

= 0.04 m^3

Maximum water the raft can displace

= V × 1000 kg = 0.04 × 1000 = 40 kg

So, we can place 40 – 30 = 10 kg mass on the raft.

52. **(C)** Maximum possible strain = $\frac{0.4}{100}$

$\therefore A = \frac{F}{Y\times \text{strain}} = \frac{2\times10^4\times100}{7\times10^9\times0.4}$

= 7.15 $\times 10^{-4}$ m^2

$\approx$ 7.1 $\times 10^{-4}$ m^2

53. **(A)** For a liquid - solid interface, if the angle of contact is acute, then

(i) the liquid will wet the solid.

(ii) the liquid will rise in the capillary tube made of such a solid and

(iii) Meniscus of the liquid will be concave.

54. **(B)** Velocity at the top is $\sqrt{gr}$ and that at the bottom is $\sqrt{5}$ gr.

Difference in kinetic energy

$$= \frac{1}{2} M (5gr - gr)$$

$$= 2 M gr$$

$$= 2 \times 1 \times 10 \times 1$$

$$= 20 J$$

55. **(D)** The centre of mass of system of particles depends upon the :

(i) masses of the particles

(ii) position of the particles

(iii) relative separation between the particles.

56. **(A)** $V_{rms} = \sqrt{\frac{3RT}{M}}$

Given V_{rms} of argon at T_1 = V_{rms} of He at T_2

$$\sqrt{\frac{3RT_1}{M_a}} = \sqrt{\frac{3RT_2}{M_h}}; T_2 = -20 + 273 = 253 K$$

Squaring, $\frac{3RT_1}{M_a} = \frac{3RT_2}{M_h}; T_1 = \frac{M_a}{M_h} \times T_2$

$$= \frac{39.9 \times 253}{4} = 2523.7 K$$

57. **(C)** $\eta = \frac{P_0}{P_1} \Rightarrow P_1 = \frac{P_0}{\eta}$

(Power) $P_1 = \frac{100}{60} \times \frac{mgh}{t} = \frac{5}{3} \times \frac{100 \times 10 \times 10}{5}$

$= 3.3 \times 10^3$ W = 3.3 kW

58. **(B)** Acceleration due to gravity, g = electric intensity = rate of change of potential

$$= \frac{10}{100} = \frac{1}{10} \text{ m s}^{-2}$$

The work done in moving a body of 5 kg upwards through 40 m will be = mgh

$= 5 \times (1/10) \times 40 = 20$ J

59. **(A)** $K = \frac{r_1^2 + r_2^2 + ...}{n}$, radius of gyration depends on the distribution of mass about the axis of rotation and it is independent of the mass of the body.

60. **(A)** Here m = 8000 kg, u = 800 m s^{-1}

g = 10 m s^{-2}, $\frac{dm}{dt}$ = ?

To overcome the weight of the rocket,

$$F = mg = u\frac{dm}{dt}$$

$$8000 \times 10 = 800\frac{dm}{dt}$$

$$\frac{dm}{dt} = \frac{8000 \times 10}{800} = 100 \text{ kg s}^{-1}$$

61. **(B)** Mean diameter =

$$\frac{0.39 + 0.38 + 0.39 + 0.41 + 0.38 + 0.37 + 0.40 + 0.39}{8}$$

$\bar{d} = 0.38875$ mm

= 0.39 mm (rounded off to two significant figures)

Absolute error in the first reading =

0.39 – 0.39 = 0.00 mm

Similarly finding the absolute error in the other seven readings and taking the mean;

Mean absolute error = $\overline{\Delta d}$ =

$$\frac{0.00 + 0.01 + 0.00 + 0.02 + 0.01 + 0.02 + 0.01 + 0.00}{8}$$

= 0.00875 = 0.01 mm

Relative error = $\frac{\overline{\Delta d}}{d} = \frac{0.01}{0.39} = 0.0256$

62. **(B)** A raw egg behaves like a spherical shell and a half boiled egg behaves like a solid sphere.

$$\therefore \frac{I_r}{I_s} = \frac{2/3\, MR^2}{2/5\, MR^2} = \frac{5}{3} > 1$$

63. **(D)** $\frac{4S}{r_1} - \frac{4S}{r_2} = \frac{4S}{r}$

or $\frac{1}{r} = \frac{1}{r_1} - \frac{1}{r_2} = \frac{1}{4} - \frac{1}{5} = \frac{1}{20}$ or r = 20 cm

64. **(B)** $C_m = \frac{3}{2}R,\ C_{di} = \frac{5}{2}R$.

If change in temperature is ΔT, then

$$1 \times \frac{3}{2} R \Delta T + 1 \times \frac{5}{2} R \Delta T = 2 \times C_v \times \Delta T$$

This gives C_v = 2 R

65. **(B)** Here $dx_1 = dx_2$, $A_1 = A_2$, $\frac{K_1}{K_2} = \frac{2}{3}$

Let θ be the temp. of the junction.

As $\frac{dQ_1}{dt} = \frac{dQ_2}{dt}$

$\therefore K_1A_1\frac{dT_1}{dx_1} = K_2A_2\frac{dT_2}{dx_2}$

$K_1 = (100 - \theta) = K_2(\theta - 0)$

or $\frac{K_1}{K_2} = \frac{\theta}{100-\theta} = \frac{2}{3}$

$3\theta = 200 - 2\theta$; $5\theta = 200$; $\theta = 40\ °C$

CHEMISTRY

66. **(B)** HCl, a strong acid, decreases the sulphide ion concentration by common ion effect. Secondly, dil. HCl is used to keep the sulphide on concentration at a minimum level. Thus, products of their respective sulphides precipitate out.

67. **(D)** Wave mechanical model of the atom depends on:

(i) Heisenberg's uncertainity principle

(ii) De Broglie concept of dual nature of electron.

(iii) Schrondinger wave equation.

68. **(D)** M + X O $\rightarrow$ MO + X + Q

$$M + \cancel{\tfrac{1}{2}O_2} \rightarrow MO + 351.4\ kJ$$

$$XO \rightarrow \cancel{\tfrac{1}{2}O_2}\ -90.8\ kJ$$

$$\overline{M + XO \rightarrow MO + X}$$

$\Delta H = +260.61$ kJ

69. **(D)** Both alkenes and alkynes decolourise alkaline $KMnO_4$ but alkanes do not react with ammoniacal cuprous chloride.

70. **(D)** For an ideal gas, PV = $\frac{1}{3}mNu^2$

Average Kinetic Energy (E_k) = $\frac{1}{2}mNu^2$

Thus, PV = $\frac{2}{3}N\left(\frac{1}{2}mu^2\right) = \frac{2}{3}NE_k$

For 1 mol of a gas, V = V_m and N = N_A

Hence $PV_m = \frac{2}{3}N_AE_K$.

71. **(D)** Solubility of carbonates and bicarbonates of alkali metals increases as one goes down the group. In the Solvay process sodium bicarbonate precipitate out. $KHCO_3$ is relatively more soluble than $NaHCO_3$ but is slightly soluble in water.

72. **(B)** Writing oxidation numbers of all atoms,

$$\overset{0}{Cl_2} + \underset{+5-2}{IO_3^-} + \underset{-2+1}{OH^-} \rightarrow \underset{+7-2}{IO_4^-} + \underset{-1}{Cl^-} + \underset{+1-2}{H_2O}$$

Oxidation numbers of Cl and I have changed.

$\overset{0}{Cl_2} \rightarrow 2\overset{-}{Cl}$ ...... (i)

$\overset{+5}{IO_3^-} \rightarrow \overset{+7}{IO_4^-}$ ...... (ii)

Decrease in oxidation no. of C*l* = 2 units per Cl_2 molecule.

Increase oxidation numer of I = 2 units per IO_3^- molecule

$$Cl_2 + IO_3^- \rightarrow IO_4^- + 2Cl^-$$

To balance oxygen $2OH^-$ ions be added on L.H.S. and one H_2O molecule on R.H.S. Hence, the balanced equation is:

$$Cl_2 + IO_3^- + 2OH^- \rightarrow IO_4^- + 2Cl^- + H_2O$$

73. **(D)** Pauli's principle cannot conclude about the number of unpaired electrons in a subshell.

74. **(C)** In option (A) No violation of any rule

In option (B) Violation of Aufbau principle

In option (C) Violation of both Aufbau principle & Hund's rule.

In option (D) Violation of Aufbau principle.

75. **(D)** When cement is mixed with water, it absorbs water to form a gelatinous mass sets to a hard mass. This is called setting of cement. The setting of cement involves a series of hydration and hydrolysis reactions leading to the formation of colloidal gels. These gels soon begin to harden due to the formation of interlocking crystals of hydrated silicated gels. The process of hydration and hydrolysis are exothermic. Water is sprinkled over it to keep it cool also.

76. **(C)** Half filled or completely filled orbitals are found to be more stable. Therefore, the ionisation enthalpy is higher when an electron is to be removed from a fully filled or half filled orbitals.

77. **(C)** $P_1V_1 = P_2 V_2 = P_3 V_3 = P_4 V_4$

P_2 = 125 Torr ; P_3 = 200 Torr ;

V_2 = 64 m*l* ; V_3 = ?

$P_2V_2 = P_3V_3$

or $V_3 = \frac{P_2V_2}{P_3} = \frac{125 \times 64}{200} = 40\,ml$

78. **(B)**

$$2H_2\overset{-2}{S}(g) + \underset{+4}{SO_2}(g) \rightarrow 3\underset{0}{S}(s) + 2H_2O(g)$$

Oxidation

reduction

In H_2S : $H_2 S^{-2} \rightarrow \overset{0}{S}$

The oxidation number of S (in H_2S) is –2 and it changes to 0 in the reaction. Thus, H_2S gets oxidised to S.

In SO_2 : $SO_2^{+4} \rightarrow \overset{0}{S}$

The oxidation number of S(in SO_2) is + 4 and it changes to 0 in the reaction. Thus, SO_2 gets reduced to S.

79. **(B)** BeH_2 cannot be prepared by direct action of H_2 on Be. BeH_2 is prepared by the action of $LiAlH_4$ on $BeCl_2$

$2\ BeCl_2 + LiAlH_4 \rightarrow 2BeH_2 + LiCl + AlCl_3$.

80. **(B)** 780 mm of Hg = $\frac{780}{760}$ atm

w = 22 g; M = 44 g mol^{1}

T = 27°C = 27 + 273 = 300 K

Volume occupied

$= \frac{w}{M}, \frac{RT}{P} = \frac{22}{44} \times \frac{0.0821 \times 300 \times 760}{780}$

= 12 *l*.

81. **(C)** Mass of the organic compound taken = 0.244 g

Mass of CO_2 formed = 0.616 g

Mass of H_2O formed = 0.108 g

(i) Mass of C in the CO_2 formed

$= \frac{0.616 \times 12}{44}$ g

Percentage of C in the compound

$= \frac{0.616 \times 12}{44} \times \frac{100}{0.244} = 68.85$

(ii) Mass of H in the H_2O formed

$= \frac{0.108 \times 2}{18}$ g

Percentage of H in the compound

$= \frac{0.108 \times 2 \times 100}{18 \times 0.244} = 4.92$

(iii) Percentage of O in the compound = 100 – (68.85 + 4.92) = 26.23

The percentage composition of the compound is, C = 68.85, H = 4.92 and O = 26.23.

82. **(B)** Wavelength, λ = 580 nm = 580 × 10^{-9} m

Velocity of light, c = 3 × 10^8 m s^{-1}

Then,

Frequency, $\nu = \frac{c}{\lambda} = \frac{3 \times 10^8\ m\ s^{-1}}{580 \times 10^{-9}\ m}$

$= 5.17 \times 10^{14}\ s^{-1}$

$= 5.17 \times 10^{14}$ Hz

Wavenumber, $\bar{\nu} = \frac{1}{\lambda} = \frac{1}{580 \times 10^{-9}\ m}$

$= 1.72 \times 10^6\ m^{-1}$

83. **(D)** Addition of helium gas to an equilibrium mixture at constant volume does not disturb the chemical equilibrium. As such there is no effect on the relative amount of SO_3, O_2 and SO_2 gases respectively.

84. **(A)** Zeolite used for softening of hard water is $Na_2O \cdot Al_2O_3 \cdot 2SiO_2 \cdot xH_2O$, which is hydrated sodium aluminium silicate.

85. **(A)** Mass of the substance taken = 0.316 g

Mass of $BaSO_4$ formed = 0.466 g

From stoichiometry, $BaSO_4$ = S

233 32

(molecular mass of $BaSO_4$

= 137 + 32 + 64 = 233)

Then, mass of S in 0.466 g of $BaSO_4$

$= \frac{0.466 \times 32}{233}$ g

Percentage of S in the compound

$= \frac{0.466 \times 32}{233} \times \frac{100}{0.316} = 20.25\ \%$

86. **(D)** All the alkali metals and their salts impart colour to bunsen flame. The colours imparted by different alkali metals are as follows.

Element	Li	Na	K	Rb	Cs
Colour	Crimson red	Golden yellow	Pale violet	Red violet	Bluish

When heat energy is supplied to alkali metal atom or ion in salt, the electronic excitation occurs in which electron jumps to higher energy level. When this excited electron de-excites to ground state, the energy is emitted in the form of electromagnetic radiation which lies in visible region thereby imparting colour to the flame. The colour of flame depends upon the wavelength of radiation emitted e.g., yellow D-line of Na-spectra arises from $3s^1 \rightarrow 3p^1$ transition.

87. **(A)** $$C:H = \frac{12\times100}{13\times12} = \frac{1\times100}{13\times1} = 1:1$$

$\therefore$ E.F. = CH

Since, P decolourises Br_2–H_2O, but Q does not, therefore, P = C_2H_2 (acetylene) and Q = C_6H_6 (benzene).

88. **(D)** (a) It is exact neutralisation. Hence, pH = 7.

(b) After neutralisation, $\frac{M}{10}$ HC*l* left = 10 m*l*.

Total volume = 100 m*l*

Dilution = 10 times.

$\therefore$ $[H^+] = 10^{-2}$

or pH = 2

(c) After neutralisition, $\frac{M}{10}$ NaOH left = 80 m*l*.

Total volume = 100 m*l*. pH > 7.

(d) After neutralisation, $\frac{M}{5}$ HC*l* left = 50 m*l*.

Total volume = 100 m*l*

Dilution = 2 times

$\therefore$ $[H^+] = \frac{1}{10} = 10^{-1}$ M or pH = 1

89. **(B)** Due to the poor shielding (screening) effect of d-electrons in case of Ga, the valence electrons are attracted more strongly and hence, the size is not increased.

90. **(C)** The sum of mass % is 99.8. Hence, there is no oxygen in the given compound.

Element	Mass %	Atomic mass	Atomic ratio	Simplest ratio	Simplest whole number ratio
C	64.4	12	64.4 / 12 = 5.37	5.37 / 0.53 = 10.1	10
H	5.5	1	5.5 / 1 = 5.5	5.5 / 0.53 = 10.4	10
Fe	29.9	56	29.9 / 56 = 0.53	0.53 / 0.53 = 1	1

Thus,the empirical formula of the compound is $C_{10}H_{10}Fe$.

GENERAL AWARENESS

91. **(B)** 92. **(C)** 93. **(A)** 94. **(A)** 95. **(A)** 96. **(A)** 97. **(B)** 98. **(B)** 99. **(C)** 100. **(B)**

The End