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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION - 2015 (UPDATED)

Paper Code: UN412

Solutions for Class : 12 (PCB)

Biology

1. **(B)** For 40 embryos, 40 male and 40 female gametes will be required. In males for the formation of 40 gametes 10 meiotic divisions are required whereas in females for formation of 40 gametes, 40 meiotic divisions will be required as one megaspore mother cell forms 4 megaspores after one meiotic division but 3 of them degenerate and only one continues to form the embryo sac in which there is only one ovum/female gamete. Hence 10 + 40 = 50 meiotic division in all.

2. **(D)** Producers do not produce energy. Energy cannot be produced. It can be transformed from its one form to the other. Producers are converting radiant energy to chemical bond energy through photosynthesis.

3. **(D)** Best material for micropropagation is the root or shoot tips.

4. **(A)** Prof R. Mishra is considered as Father of Ecology in India.

5. **(C)** Viruses are obligate parasites which grow on the living host body only and thus cannot grow as primary colonizer on barren sites.

6. **(A,D)** Grazers feed over the leaves, whereas, the browsers not only feed delicate leaves but also the young and delicate shoots, as can be seen in case of feeding behaviour of elephants, camels and goats.

7. **(D)** Wings of birds and insects are analogous organs.

8. **(A)** Under appropriate conditions of temperature, ionic composition and pH concentrated mixtures of macromolecules tend to give rise to complex units called coacervates. The coacervates had a tendency to absorb and incorporate various organic substances of the ocean and became anaerobic chemoheterotrophs. The coacervates may have first evolved in the direction of life on Earth.

9. **(D)** Anaximander (611-547 BC), thought that life arouse from a mixture of water and earth. The land forms arose from aquatic types, particularly under the influence of the Sun's heat.

10. **(B)** Haemophilia is a genetically linked disease.

11. **(B)** The spermatids are formed after the completion of maturation division during spermatogenesis, hence contain n number of chromosomes, i.e., 23.

12. **(D)** Golgi complex – acrosome, DNA synthesis – Okazaki fragments.

13. **(D)** UGG codes for the amino acid tryptophan.

14. **(A)** Retroviruses are exception to the central dogma.

15. **(C)** Atlas, patella and cochlea are vestigial structures of man.

16. **(C)** RNA is synthesized from DNA as single stranded, linear molecules. Since it is not double stranded, the concentration of different bases in RNA is variable.

17. **(D)** Restriction endonuclease cuts DNA at specific DNA sequence.

18. **(D)** Because synergid is a haploid cell.

19. **(B)** Two types of gametes produced are AbC and abC.

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

21. **(A)** Haemophilia is due to the lack of anti haemophilic globulin.

22. **(Del)**

23. **(C)** The chromosomal mutation given below is due to inversion.

24. **(C)** Mendel's laws of inheritance (1866), Chromosome theory of inheritance (1902),

DNA, hereditary material experiments (1944, 52).

25. **(B)** A single archaeocyte is capable to give rise to an entire sponge.

26. **(C)** A sigmoidal growth cruve is also applicable for the growth of population.

27. **(C)** Adult frog performs pulmonary respiration with the help of lungs.

28. **(C)** All birds are oviparous.

29. **(C)** In the given figure part labelled as III is infundibulum IV, Fimbrae and V cervix are correct.

30. **(C)** Unfertilized ovary produces seedless fruits, whereas fertilized ovary produces fruits with seeds.

31. **(D)** Eczema is a superficial dermatitis. Utricaria is a skin eruption characterized by transient wheals of varying shapes and sizes.

32. **(A)** Male honeybees, called drones, are developed from unfertilized eggs by parthenogenesis.

33. **(D)** The process notogenesis, the notochordformation, takes place immediately after gastrulation.

34. **(B)** Old age is due to the deterioration of the structure and function of body cells, tissues and organs of an animal.

35. **(A)** Mendel studied the inheritance of traits located on the chromosome pairs 1, 4, 5 and 7.

36. **(B)** Cytosine, thymine and uracil are pyrimidines.

37. **(D)** Limulus, sphenedon and coelacanth are living fossils.

38. **(C)** Anticodon is transfer RNA is complementary to the codon of messenger RNA.

39. **(B)** DNase breaks DNA into nucleotides.

40. **(A)** Prophase I is the most important phases of meiosis I because crossing over occurs, resulting in mutual exchange of sections of homologous chromatids.

Physics

41. **(A)** $B = \mu_0 \, n \, I = \mu_0 \frac{N}{l} I = 4\pi \times 10^{-7} \times \frac{120}{0.2} \times 2.5$

$= 1.885 \times 10^{-3}$ T

42. **(B)** As the image formed is erect and hence virtual, the magnification produced by the lens is positive i.e. m = + 4.

Also, f = + 20 cm

Now, $m = \frac{f}{u+f}$

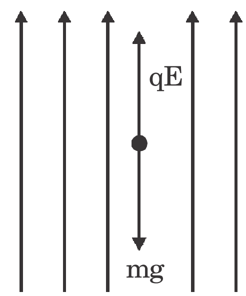
$\therefore\ 4 = \frac{20}{u+20}$ or u + 20 = 5

or u = –15 cm

Again, $m = \frac{f-v}{f}$ $\therefore\ 4 = \frac{20-v}{20}$

or v = 20 – 80 = – 60 cm

43. **(B)** For the equilibrium of the proton as per the figure shown below.



qE = mg

$E = \frac{mg}{q}$

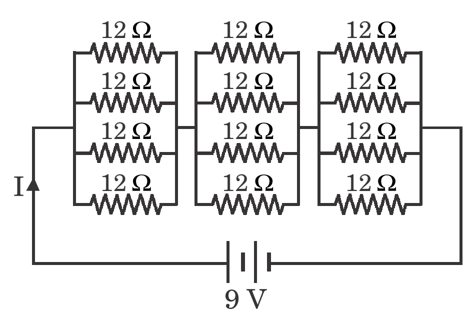
$= \frac{1.67 \times 10^{-27} \times 9.8}{1.6 \times 10^{-19}}$

$= 1.02 \times 10^{-7}$ N C^{-1}

The electric field is directed vertically upwards.

44. **(A)** The network of resistors connected to the battery of e.m.f. 9 V is shown below. Let I be the total current in the circuit. If R' is the effective resistance of the four resistors of 12 Ω each connected in parallel, then

$\frac{1}{R'} = \frac{1}{12} + \frac{1}{12} + \frac{1}{12} + \frac{1}{12} = \frac{4}{12}$ or $R' = 3\ \Omega$



9 V

Therefore, the effective resistance of the network of resistors,

R = R' + R' + R' = 3 + 3 + 3 = 9 Ω

The current in the circuit

$I = \frac{E}{R} = \frac{9}{9} = 1$ A

Since all the four resistors are of the same resistance, same current will pass through the each resistor, Therefore,

the current through each resistor =

$$\frac{1}{4}I = \frac{1}{4}\times 1 = 0.25\,A$$

45. **(C)** $e\,B\times\pi\,r^2\times v = \frac{1}{2}\,B\,r^2\,\omega$

Here, r = 200 cm = 2 m; B = 0.05 Wb m^{-2}

and ω = 60 rad s^{-1}

$$\therefore\ e = \frac{1}{2}\times 0.05\times(2)^2\times 60 = 6\ V$$

46. **(A)** The average atomic mass of neon,

$$A = \frac{90.51\times 19.99 + 0.27\times 20.99 + 9.22\times 21.99}{100}$$

= 20.18 a.m.u.

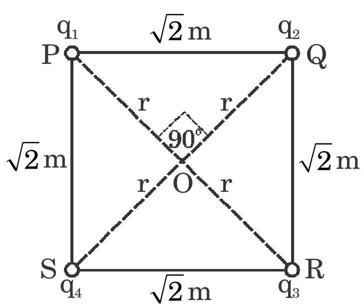
47. **(B)** A 0.1 m long bird will require frequency,

$$v = \frac{c}{\lambda} = \frac{3\times 10^8}{0.1} = 3000\ MHz$$

It is very close to the popular radar frequency. Indeed, radars occasionally detect birds.

48. **(A)** Four charges q_1, q_2, q_3 and q_4 are placed at the four corners of the square PQRS as shown below.

Here,



$q_1 = 2\,\mu C = 2\times 10^{-6}$ C;

$q_2 = -2\,\mu C = -2\times 10^{-6}$ C;

$q_3 = -3\,\mu C = -3\times 10^{-6}$ C;

$q_4 = 6\,\mu C = 6\times 10^{-6}$ C;

and PQ = QR = RS = PS = $\sqrt{2}$ m

Let r be the distance of each charge from the centre O of the square.

Then, $\sqrt{r^2 + r^2} = \sqrt{2}$ or r = 1 m

Potential at point O due to charges at the four corners,

$$V = \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1}{r} + \frac{q_2}{r} + \frac{q_3}{r} + \frac{q_4}{r}\right)$$

$$\frac{1}{4\pi\varepsilon_0}\cdot\frac{1}{r}(q_1 + q_2 + q_3 + q_4)$$

$$\frac{9\times 10^9}{1}\left(2\times 10^{-6} + \left(-2\times 10^{-6}\right) + \left(-3\times 10^{-6}\right) + 6\times 10^{-6}\right)$$

= 2.7×10^4 V

49. **(B)** Here, I = 10 A ; n= 100;

A = 40 cm × 20 cm = 800 cm^2

= 8×10^{-2} m^2 ; B = 5 T ;

$\alpha = 60^o$ (angle between field and plane of coil)

Now, $\tau = n\,B\,I\,A\cos\alpha$

= $100\times 5\times 10\times 8\times 10^{-2}\times\cos 60^o$

= 200 N m

50. **(C)** Statements (A), (B) and (D) are true of photons. Photons are electrically neutral as they are not deflected by electric and magnetic fields.

51. **(B)** When cells are joined in series,

net e.m.f. of cells,

E = 2.0 + 1.8 + 1.5 = 5.3 V

The total internal resistance of the cells in series,

r = 0.5 + 0.7 + 1 = 2.2 Ω

$$\therefore I = \frac{E}{R+r} = \frac{5.3}{4+2.2} = \frac{5.3}{6.2} = 0.854\ A$$

52. **(C)** Here, d = 0.02 cm ; D = 80 cm ;

$\lambda = 6000\times 10^{-8}$ cm = 6×10^{-5} cm ;

For nth bright fringe, $y_n = \frac{nD\lambda}{d}$

For fifth maximum, n = 5

$$y_5 = \frac{5\times 80\times 6\times 10^{-5}}{0.02} = 1.2\ cm$$

53. **(A)** Half-life = T = 12.5 years

Let the initial amount be N_0. This will be reduced to $\frac{N_0}{2}$ after 12.5 years. After 25 years it will be reduced to $\frac{N_0}{4}$. So, the fraction left undecayed is $\frac{1}{4}$.

54. **(B)** In descending order of wavelengths, the sequence of electromagnetic waves is; radio waves, microwaves, infrared radiation, visible light, ultraviolet rays, X-rays, gamma rays. Ultraviolet waves come after visible light.

55. **(D)** Here, h = 6.62×10^{-34} J s

de-Broglie wavelength of electron :

Here, $m_e = 9.1 \times 10^{-31}$ kg ; $v_e = 10^5$ m s^{-1}

$$\therefore \quad \lambda_e = \frac{h}{m_e v_e} = \frac{6.62\times10^{-34}}{9.1\times10^{-31}\times10^{5}}$$

$= 7.27 \times 10^{-9}$ m

56. **(B)** Here, L = 1.0 H ; E_v = 110 V ; f = 70 Hz

Now $X_L = \omega L = 2\pi f L$

$$= 2\times\frac{22}{7}\times70\times1.0 = 440\ \Omega$$

57. **(A)** De Broglie proposed that the wave length λ associated with a particle of momentum p is given as

$$\lambda = \frac{h}{p} = \frac{h}{m\upsilon}$$

where m is the mass of the particle and v its speed is known as the de Broglie relation and the wavelength λ of the matter wave is called de Broglie wave length.

58. **(C)** When the amplifiers are connected in series, the net voltage gain (A_v) is equal to the product of the gain of the individual amplifiers i.e.

$$A_v = A_v' \times A_v'' \qquad ...... \text{(i)}$$

$$\text{Also, } A_v = \frac{V_{out}}{V_{in}} \qquad ...... \text{(ii)}$$

From the equations (i) and (ii), we have

$$\frac{V_{out}}{V_{in}} = A_v' \times A_v''$$

$$\text{or} \quad V_{out} = V_{in} \times A_v' \times A_v''$$

$= 0.01 \times 10 \times 30 = 3$ V

59. **(C)** R = 0.4 m, f = 10 MHz, K.E. = ? m = 10 $\times 10^6$ kg

Maximum K.E. = $2\pi^2 f^2 R^2 m$ =

$2 \times (3.14)^2 \times (10^7)^2 \times (0.4)^2 \times 1.67 \times 10^{-27}$

$= 5.263 \times 10^{-13}$ J

60. **(B)** $$\frac{1}{v} + \frac{1}{9} = \frac{1}{10}$$

i.e., v = – 90 cm

Magnitude of magnification =

$$\frac{90}{9} = 10 \text{ cm}$$

61. **(C)** Here, A = 90 cm^2 = 90×10^{-4} m^2 ;

d = 2.5 mm = 2.5×10^{-3} m ; V = 400 volt

$$\text{Now, } C = \frac{\varepsilon_0 A}{d} = \frac{8.854\times10^{-12}\times90\times10^{-4}}{2.5\times10^{-3}}$$

$= 3.187 \times 10^{-11}$ F

Now,

$$W = \frac{1}{2}CV^2 = \frac{1}{2}\times3.187\times10^{-11}\times(400)^2$$

$= 2.55 \times 10^{-6}$ J

62. **(C)** $$\lambda_{vacuum} = \frac{c}{v} = \frac{3\times10^8}{5\times10^{14}} = 6\times10^{-7}\text{ m}$$

63. **(D)** $$\text{K.E.} = \frac{e^4 m}{8\varepsilon_0^2 n^2 h^2} = 13.6 \text{ eV},$$

$$\text{P.E.} = \frac{-Ze^2}{8\pi\varepsilon_0 r} = -2 \times \text{K.E.} = -27.2 \text{ eV}$$

64. **(C)** Here, R = 10 Ω ; L = 2 H ; C = 25 μF

$= 25 \times 10^{-6}$ F;

E_v = 200 V

When the frequency of the a.c. supply equals the natural frequency of the circuit,

$X_L = X_C$ i.e. Z = R

$\therefore P_{av} = E_v I_v$

$$= E_v \times \frac{E_v}{R} = \frac{200\times200}{10} = 4000 \text{ W}$$

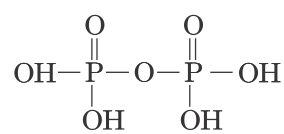
65. **(C)** Let E be the e.m.f of the battery. The charging current I is opposed by the e.m.f. of the battery. According to Ohm's law.

V – E = I r

or E = V – I r = 12.5 – 0.5 × 1 = 12 V

Chemistry

66. **(D)** Pyrophosphoric acid ($H_4P_2O_7$)



contains four P–OH groups and hence, it is a tetrabasic acid.

67. **(C)** $Al^{3+} + 3e^- \rightarrow Al$

$Cu^{2+} + 2e^- \rightarrow Cu$

$Na^+ + e^- \rightarrow Na$

Thus, 1 F will deposit $\frac{1}{3}$ mol, Al, $\frac{1}{2}$ mol, Cu and 1 mol Na, i.e., moles deposited are in the ratio

$\frac{1}{3} : \frac{1}{2} : 1$ i.e., 2 : 3 : 6 or 1 : 1.5 : 3.

68. **(A)** It is a disubstituted complex and will show geometrical isomerism.

69. **(D)** When o- or p-phenolsulphonic acid is treated with HNO_3, nitration occurs at o, p-positions with simultaneous replacement of SO_3H group by NO_2 group to give ultimately 2, 4 6-trinitrophenol.

70. **(D)** Aldehydes which do not have an α-hydrogen atom (e.g., HCHO and C_6H_5CHO) undergo self-oxidation and reduction reaction on treatment with concentrated alkali solution. One of the molecules gets reduced to alcohol and the other gets oxidised to the acid.

$$2C_6H_5CHO \xrightarrow{NaOH} C_6H_5CH_2OH + C_6H_5COO^-Na^+$$

71. **(D)** The reagent reacts with H_2O

$$RMgX + H_2O \rightarrow RH + Mg(OH)X$$

72. **(B)** 100 mol NaC*l* is doped with $SrCl_2$ $= 2 \times 10^{-3}$ mol

$\therefore$ 1 mol NaC*l* is doped with $SrCl_2$ $= 2 \times 10^{-5}$ mol

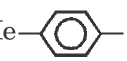
As each Sr^{2+} ion creates one cation vacancy, therefore cation vacancies $= 2 \times 10^{-5}$ mol/mol of NaC*l*

$= 2 \times 10^{-5} \times 6.02 \times 10^{23}\ mol^{-1}$

$= 12.04 \times 10^{18}\ mol^{-1}$

73. **(D)** Order may or may not be equal to molecularity.

74. **(A)** ClF_3 where C*l* is sp^3d hybridised has a T-shape structure with two lone pairs of electrons on C*l* atom.

75. **(B)** Only 1° amines (i.e., Me––NH_2 in the present case) gives positive carbylamine reaction.

76. **(C)** Since, the compound is optically active and does not rotate the plane of polarized light, therefore, the compound must be a racemic mixture.

77. **(B)** Xanthoproteic test involves heating of a protein with conc. HNO_3 when yellow colour is obtained.

78. **(C)** Aldehydes are easily oxidised to the corresponding acids by Tollens' reagent while all others are strong oxidising agents and hence, cleave the molecule at the site of the double bond yielding a mixture of products.

$$CH_3CH = CHCHO \xrightarrow{\text{Tollens' reagent}} CH_3CH = CHCOOH$$

79. **(B)** In the smelting process, the ore copper pyrites is converted into FeO which then combines with silica to give $FeSiO_3$ as a slag.

$$FeO + SiO_2 \rightarrow FeSiO_3$$

80. **(A)** Reactions I and II give 2-propanol, i.e.,

I. $CH_3CH = CH_2 + H_2O \xrightarrow[\text{Mark.add.}]{H^+} CH_3CHOHCH_3$
2-Propanol

II. $CH_3CHO \xrightarrow[\text{(ii) } H^+/H_2O]{\text{(i) } CH_3MgI} CH_3\text{–}CHOH\text{–}CH_3$
2-Propanol

In contrast, reaction III gives 1-propanol and IV gives 1, 2-propanediol.

III. $CH_2O \xrightarrow[\text{(ii) } H^+/H_2O]{\text{(i) } C_2H_5MgI} C_2H_5CH_2OH$
1-Propanol

IV. $CH_2 = CHCH_3 \xrightarrow[KMnO_4]{\text{Neutral}} \underset{OH}{\underset{|}{CH_2}} - \underset{OH}{\underset{|}{CH}} - CH_3$
1, 2 -Propanediol

81. **(D)** Bredig's arc method cannot be used for the preparation of colloidal sol of Na as it reacts with water vigorously.

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)** For a bcc unit cell

$$r = \frac{\sqrt{3}}{4}a = \frac{1.732}{4} \times 4.28\ \mathring{A} = 1.86\ \mathring{A}$$

84. **(A)** Van-Arkel method involves converting the metal to a volatile stable compound.

$\underset{\text{Impure}}{Ti} + 2\,I_2 \xrightarrow{500\ K} TiI_4$ (volatile stable) ;

$TiI_4 \xrightarrow{1700\ K} \underset{\text{Pure}}{Ti} + 2\,I_2$

85. **(B)** Magnetic moment, $\mu_{eff} = 3.87$ B.M. corresponds to the number of unpaired electrons n = 3 by applying the formula

$\mu_{eff} = \sqrt{n(n+2)}$ B.M.

For n = 1, μ = 1.73 B.M.; for n = 2, μ = 2.83 B.M. ; for n = 3, μ = 3.87 B.M. and so on.

86. **(D)** Copper ferrocyanide ppt. acts as a semipermeable membrane.

87. **(C)** Reducing character of hydrides increases down the group.

88. **(C)** $C_6H_5N_2Cl + KCN \xrightarrow{\Delta} C_6H_5CN + N_2 + KCl$

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

90. **(A)** $HCOOH \xrightarrow{P_2O_5} CO + H_2O$