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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION

Paper Code: UN426 (UPDATED)

Solutions for Class : 11 (PCB)

Biology

1. **(D)** The Hippocratic writing are the earliest of the Greek medical works dating from the fourth century B.C.

2. **(D)** In the given flower 'X' is the pollen tube, Mitosis occurs to allow growing of the pollen tube tissue towards the ovary.

   Y - In the anther meiosis occurs to generate the haploid vegetative and generative nucleus.

   In the Z, meiosis occurs to generate the haploid ovum.

3. **(A)** The enzyme lysozyme is found associated with the tail of the bacteriophage. After attachment, lysozyme drills a hole in the mucopeptide layer of the host cell wall.

4. **(A)** A.L. Takhtajan (1967) made this statement is his book 'A system of Phylogeny of Flowering Plants'.

5. **(B)** Spermatophyta includes gymnosperms (Ginkgo) and (Pisum) angiosperms (i.e., all seed producing plants).

6. **(A)** Volvax globator and V.aureus are colonial flagellates found in freshwater. Their plant-like characters include cellulosic cell wall and reserve food in the form of starch.

7. **(B)** In case of fungal infection on susceptable host, the host cells or tissue synthesize some chemical substances to counteract infection. These substances are antifungal in nature and they help in preventing infection. They are called phytoalexins.

8. **(B)** The wood of Cycas is soft and manoxylic whereas of Pinus, is hard, massive and pycnoxylic type.

9. **(A)** Osculum controls the exit of water.

10. **(D)** Tapeworm, leech and mosquito are parasites.

11. **(C)** The food of Hydra consists of small crustaceans like Cyclops, small annelids and insect larva.

12. **(D)** Bipinnaria is a larval stage of starfish (Echinodermata).

13. **(C)** In the given figure P is the synapse. It is a gap between two neurons.

14. **(C)** Annelids like oligochactes exhibit concentric "tube-within-a-tube" body plan with multicellularity and bilateral symmetry.

15. **(B)** The number of segments in a leech are 34.

16. **(B)** Polychaeta is a class of phylum Annelida.

17. **(C)** Pedicellariae are small pineer-like processes found on the body surface of certain echinoderms.

18. **(B)** Shark is a fish, hence cold-blooded.

19. **(A)** Amphibians are amniotes, they require an aquatic medium for reproduction.

20. **(D)** Iguana is a large herbivorous arboreal lizard found in tropical South and Central America.

21. **(B)** Outermost layer of bark is the layer of cork of phellem produced by phellogen or cork cambium to protect vital tissues from drought and desiccation.

22. **(D)** Definitive host of hook worm is man and there is no intermediate host.

23. **(D)** Macrophages are motile cells, derived from blood monocytes, that secrete and respond to cytokines.

24. **(D)** Tonoplast is the membrane that bounds the vacuole of a plant cell.

25. **(A)** For phosphorylation of ATP formation, N and P are used.

26. **(D)** All these are the substages of meiosis I.

27. **(C)** The absorption of water takes place in the large intestine and kidneys.

28. **(A)** Autolysis is the breakdown of the cell tissue by organism's own lysosomal enzymes.

29. **(D)** The actin-tropomyosin interactions are similar in smooth and skeletal muscles; however, troponin is absent in smooth muscle.

30. **(B)** Heterophylly occurs in attached emergent hydrophytes such as Limnophilla heterophylla, Ranunculus aquatilis or Sagittaria sagittifolia. they produce two types of leaves, those submerged in water are deeply lobed but those produced above the level of water are well developed with entire of serrate margins.

31. **(D)** Elie Metchnikoff won the Nobel Prize 1908 in Physiology and Medicine for the concept of phagocytosis.

32. **(A)** Taenia, commonly known as tapeworm is not a protist, it belongs to phylum Platyhelminthes (Kingdom Animalia).

33. **(D)** Proterospongia is a free-living choanoflagellate with collar cells, resembling sponges.

34. **(B)** X - Oxygen and Y - water.

35. **(B)** In gymnosperms, vessels are absent in xylem and companion cells in phloem except the three genera of Gnetopsida (Gnetum, Ephedra and Welwitschia). The vessels produced in these three genera are not the true vessels from their origin point of view but they are modified tracheids, externally looking like vessels.

36. **(B)** Dicot stem is characterized by having vascular bundles arranged in a ring. In some dicots, scattered vascular bundles are seen in medulla (medullary vascular bundles, as seen in Achyranthus, Amaranthus, Boerhaavia, Baugainvellia, Mirabilis, etc). In peperomia, (–a dicot plant) vascular bundles are scattered (abnormal nature) in stem.

37. **(B)** The part labelled P is coronary artery.

38. **(D)** Metagenesis is the alternation of generations, polypoid and medusoid, as found in cnidarians like Obelia.

39. **(B)** Metabolism occurs in all living organisms.

40. **(C)** Mandibles are totally absent in the housefly (Musca).

Physics

41. **(B)** As each car travels one circle in the same time; and $\omega = \frac{2\pi}{T}$, therefore, their angular velocities must be same, i.e., $\omega_1 : \omega_2 = 1 : 1$.

42. **(B)** Maximum stress = Young's modulus × maximum strain

$= 2\times 10^{11}\times 10^{-3} = 2\times 10^{8}\ \text{Nm}^{-2}$

$\therefore$ Maximum force (F) = maximum stress × area

$= 2\times 10^{8}\times 3\times 10^{-6} = 600\ \text{N}$

$$\text{Maximum mass} = \frac{F}{g} = \frac{600}{10} = 60\ \text{kg}$$

43. **(A)** Here mass of the α-particle may be written as 4.

Hence, applying the conservation of momentum we find :

$(A - 4)\,V - 4\,v = 0$

Hence, $V = 4\,v/(A - 4)$

44. **(A)** (i) $\sqrt{\text{Energy / mass}} = \sqrt{ML^2T^{-2} / M}$

$= [L^1T^{-1}]$

(ii) $\sqrt{\text{Pressure / density}}$

$= \sqrt{ML^{-1}\,T^{-2} / ML^{-3}}$

$= [L^1T^{-1}]$

(iii) $\sqrt{\text{Force / linear density}}$

$= \sqrt{ML\,T^{-2} / ML^{-1}}$

$= [L^1T^{-1}]$

45. **(C)** $\frac{G\times 100}{x^2} = \frac{G\times 10{,}000}{(1-x)^2}$

This gives $\frac{10}{x} = \frac{100}{1-x}$

That is $x = \frac{1}{11}$ m.

46. **(B)** Radius of semi-circular path = r = l

As P.E = K.E.

$\therefore\ mgr = \frac{1}{2}\,m\,v^2$

$r = \frac{v^2}{2g} = \frac{7\times 7}{2\times 9.8} = 2.5\ \text{m}$

47. **(A)** A vector has both magnitude and direction whereas a scalar has only magnitude but no direction.

48. **(C)** Lateral pressure exerted by water on the face of the door in contact with water is

$P_w = h\rho_w g = 4\times 1000\times 10$
$= 4\times 10^4\ Nm^{-2}$

Lateral pressure exerted by acid on the face of the door in contact with acid is (ρ_a
$= 1.5\times 1000 = 1500\ kg\ m^{-3}$)

$P_a = h\rho_w g = 4\times 1500\times 10 = 6\times 10^4\ N$

$\therefore$ Net pressure on the door

$= P_a - P_w = 2\times 10^4\ N.$

Now, the face area of the door = 20 cm^2

$= 20\times 10^{-4}\ m^2.$

$\therefore$ Force on the door = pressure $\times$ area

$= 2\times 10^4\times 20\times 10^{-4} = 40\ N$

Hence, a force of 40 N must be applied on the door in order to counterbalance the force due to the two liquids.

49. **(C)** In this case net pulling force

$= m_A g \sin 60^\circ + m_B g \sin 60^\circ - m_C g \sin 30^\circ$

$$= (1)(10)\frac{\sqrt{3}}{2} + (3)(10)\left(\frac{\sqrt{3}}{2}\right) - (2)(10)\left(\frac{1}{2}\right)$$

$= 24.64\ N$

Total mass being pulled

$= 1 + 3 + 2 = 6\ kg$

$\therefore$ Acceleration of the system $a = \dfrac{24.64}{6}$

$= 4.1\ m\ s^{-2}$

50. **(D)** The bursting of tyre is very fast. So the gas fails to gain or lose heat. Hence, the process is an adiabatic process.

51. **(B)** Here only the potential gradient has non zero dimensions. Others are dimensionless.

52. **(C)** Gravitational field is a gravitational force experienced by unit mass and depends on the value of g which decreases with height and depth.

53. **(B)** Here, v = 20 m/s, r = 10 m,
$a_t = 30\ m/s^2$, a = ?

$$a_r = \frac{v^2}{r} = \frac{20\times 20}{10} = 40\ m/s^2$$

$$a = \sqrt{a_r^2 + a_t^2} = \sqrt{40^2 + 30^2} = 50\ m/s^2$$

54. **(B)** $x = (20.15 \pm 0.05)$ g; $\Delta x = \pm 0.05$ g

$y = (20.17 \pm 0.02)$ g; $\Delta y = \pm 0.02$ g

Difference = $z = y - x$

$= (20.17 - 20.15) = 0.02$ g

$\Delta z = \pm(\Delta y + \Delta x) = \pm(0.02 + 0.05)$

$= \pm 0.07$ g

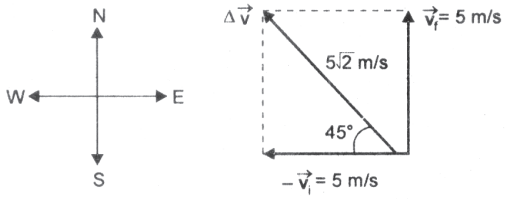
$\therefore z = (0.02 \pm 0.07)$ g

55. **(C)** Both the spring balances will show the actual weight, 4 kg each.

56. **(A)** $p = mv,\ v = \dfrac{p}{m} = \dfrac{500}{5} = 100\ m\ s^{-1}$

$$K.E. = \frac{1}{2}mv^2 = \frac{1}{2}\times 5\times 100^2$$
$= 2.5\times 10^4\ J$

57. **(C)** $\vec{a}_{av} = \dfrac{\Delta\vec{v}}{\Delta t} = \dfrac{\vec{v}_f - \vec{v}_i}{\Delta t}$



$\Delta\vec{v} = 5\sqrt{2}$ m/s in north-west direction.

$\vec{a}_{av} = \dfrac{5\sqrt{2}}{10} = \dfrac{1}{\sqrt{2}}$ m/s² (in north-west direction)

58. **(B)** When a body is orbiting around a heavier body in elliptical orbit, its angular momentum is conserved.

59. **(B)** As $\eta = 1 - \dfrac{T_2}{T_1} = \dfrac{W}{Q_1}$

$$\therefore 1 - \frac{300}{600} = \frac{800}{Q_1}$$

$Q_1 = 1600\ J$

60. **(C)** True value = Measured value $\pm$ Error.

61. **(C)** Weight of sphere = weight of mercury displaced + weight of oil displaced

or $V\rho g = \dfrac{V}{2}\times 13.6\times g + \dfrac{V}{2}\times 0.8\times g$

or $\rho = \dfrac{13.6 + 0.8}{2} = 7.2\ g\ cm^{-3}$

62. **(B)** F = 500 N,

Total mass = m = 10 + 20 = 30 kg;

$$a = \frac{F}{m} = \frac{500}{30} = 16.66 \text{ m s}^{-1}$$

(i) When the pull is applied on 20 kg mass, T_1 is the tension in the string. Thus, 10 kg is acted upon by T_1 and its acceleration is 16.66 m s^{-1}.

$\therefore T_1 = 10a = 10 \times 16.66 = 166.6$ N

(ii) When the pull is applied on 10 kg mass, $T_2 = 20\ a = 20 \times 16.66 = 333.2$ N. Thus, tension depends on the end where pull is applied.

63. **(B)** Three vectors of unequal magnitude, which can be represented by the three sides of a triangle taken in order, produce zero resultant.

64. **(A)** The effective weight inside a satellite is given by :

$$W' = mg' = m(g - a) \text{ ———(1)}$$

Because the frame of reference attached to the satellite is an accelerated frame whose acceleration towards centre of earth is provided by gravitation pull of earth over the satellite.

$$\text{Hence, } a_c = \frac{v^2}{r} \quad G\frac{Me}{r^2} = g$$

$$\left(\text{from, } F_c = F_g \Rightarrow \frac{mv^2}{r} = G\frac{M_e\, m}{r^2}\right)$$

Therefore, eqn. (1) becomes $W' = 0$

65. **(A)** I (ring) = MR^2, I (sphere) = $\frac{2}{5}MR^2$,

I (disc) = $MR^2/2$.

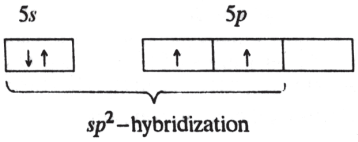
Chemistry

66. **(A)** Due to high ionization enthalpy and weak metallic bonding, mercury is a liquid at room temperature.

67. **(D)** CCl_4 under the name pyrene is incombustible and is used as a fire extinguisher.

68. **(A)** Calorific value is the heat of combustion per gram C.V. for H_2 = –285/2, for CO = –284/28, for CH_4 = –890/16.

69. **(D)** In $SnCl_2$, Sn is sp^2 hybridized. As such it has two bond pairs and one lone pair of electrons.



70. **(B)** The reaction is

$$4\ NH_3\ (g) + 5O_2\ (g) \rightarrow 4\ NO\ (g) + 6\ H_2O\ (g)$$

4 ×17 g	5 ×32 g	4 ×(14 + 16) g
68 g	160 g	120 g
10.0 g	20.0 g	?

Based on of the given data, it shows that in the given reaction, oxygen is the limiting reagent.

Therefore,

Maximum mass of nitric oxide formed

$$= \frac{120\text{g} \times 20\text{g}}{160\text{g}} = 15\text{g}$$

71. **(D)** X and Y are different atoms if they have different number of electrons, protons and /or neutrons. If X and Y have the same total number of nucleons but yet are different, they must have a different number of protons and neutrons, and hence, cannot belong to the same element.

72. **(D)** To convert covalent compounds into ionic compounds (NaCN, Na_2S, NaX)

73. **(C)** Using the relationship,

$$p = \rho\frac{RT}{M}$$

For the given data, if M is the molar mass of the gaseous oxide, we can write

$$2 \text{ bar} = \rho.\frac{RT}{M}$$

and for nitrogen,

$$5 \text{ bar} = \rho.\frac{RT}{28\text{ g/mol}}$$

From these equations, one can write

$$\frac{5\text{ bar}}{2\text{bar}} = \frac{M}{28\text{ g/mol}}$$

This gives,

$$M = \frac{5\text{ bar}}{2\text{bar}} \times 28\text{ g mol}^{-1} = 70\text{ g mol}^{-1}$$

74. **(C)** No. of atoms in different flasks depends upon atomicity of gases present in flasks. The ratio is 2 : 1 : 2 : 3.

75. **(B)** Water molecule can form two hydrogen bonds through its two hydrogen atoms and another two with two lone pairs of electrons on the O atom.

76. **(B)** Li is least reactive due to high ionization enthalpy.

77. **(D)** According to the reaction stoichiometry,

$$I_2\,(g) \rightleftharpoons 2I\,(g)$$

Then $P_{I(g)} = P_{total} \times$ Fraction of I atoms

$= 10^5\ Pa \times 0.3$

and $P_{I_2(g)} = P_{total} \times$ Fraction of I_2 molecules

$= 10^5\ Pa \times 0.7$

$$K_p = \frac{\left(P_{I(g)}\right)^2}{P_{I_2(g)}} = \frac{\left(0.3\times10^5\ Pa\right)^2}{0.7\times10^5\ Pa}$$

$= 1.28 \times 10^4\ Pa$

78. **(A)** Alkenes do not contain a divalent functional group on the either side of which the alkyl chain can differ and hence alkenes do not show metamerism.

79. **(B)** Equilibrium shifts backward.

80. **(B)** When cement is mixed with water, it absorbs water to form a gelatinous mass which 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.

81. **(D)** The strength of a sample of hydrogen peroxide solution is expressed in terms of volume of oxygen at STP that one volume of hydrogen peroxide gives on heating. For example, '20 volumes of H_2O_2' means 1 litre of this solution liberates 20 L of O_2 at STP. Hydrogen peroxide acts both as an oxidising and a reducing agent. As an oxidising agent, H_2O_2 is converted to H_2O and as reducing agent, it is converted to O_2.

82. **(A)** Average atomic mass $= \frac{19\times10 + 81\times11}{100}$

$= 10.81$

83. **(C)** Given : Average velocity = 400 m/s

We know

$$u_{rms} = \sqrt{\frac{3\,RT}{M}} \quad \text{and} \quad u_{av} = \sqrt{\frac{8\,RT}{\pi M}}$$

So $$\frac{u_{rms}}{u_{av}} = \sqrt{\frac{3\,RT/M}{8\,RT/\pi M}} = \sqrt{\frac{3\,\pi}{8}}$$

$= \sqrt{1.178} = 1.085$

Then

$u_{rms} = 1.085 \times u_{av} = 1.085 \times 400$ m/s

$= 434.2$ m/s

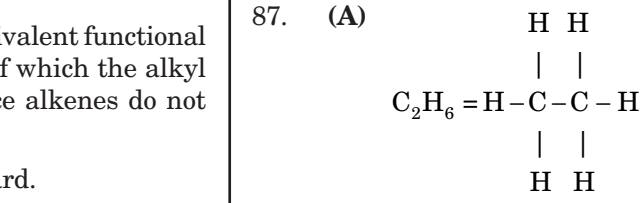
84. **(A)** Displacement of σ - electrons.

85. **(D)** Protons and neutrons have relatively the same mass, while an electron is much less lighter. Neutrons are neutral, while protons and electrons are charged particles.

86. **(C)** $BaO_2 + H_2SO_4 \longrightarrow BaSO_4 + H_2O_2$

In this reaction, none of the elements undergoes a change in oxidation number or valency.

87. **(A)**



$C_2H_4 \rightarrow H_2C = CH_2$

$C_2H_2 \rightarrow HC \equiv CH$

88. **(D)** Thallium metal marks the paper like lead metal.

89. **(C)** The reaction for the oxidation of one mole of benzene is

$$C_6H_6(l) + \frac{15}{2}O_2(g) \longrightarrow 6CO_2(g) + 3H_2O(l)$$

$\Delta H = -781.0$ k cal

Δn for the reaction $= 6 - \frac{15}{2} = -1.5$

Therefore, $\Delta H = \Delta E + \Delta n\,RT$

$\Delta E = \Delta H - \Delta n\,RT$

$= -781000$ cal $-(-1.5$ mole$) \times$

$(2$ cal K^{-1} mol$^{-1}) \times 298$ K

$= -780106$ cal

$= -780.1$ k cal

90. **(B)** trans-2-Butene has zero dipole moment.

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

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