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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION - 2013

SOLUTIONS FOR CLASS : 11 (PCB)

Biology

1. (C) Root nodules are found on the roots of leguminous plants. It consists of rhizobium bacteria in root nodules. Leguminous plants and rhizobium bacteria exhibit symbiotic relationship.

2. (D) Castor is an endospermic seed. Seeds in which food is stored in endosperm are called endospermic seeds.

3. (B) The cestodes are intestinal parasites. They are commonly called tapeworms. They have alimentary canal and mouth (Gut) but food is taken through its body surface.

4. (B) The scientific name of flying fish is Exocoetus. It is a true fish. It is found in shoals. It has all the characteristics of fishes.

5. (C) Pellem → Endodermis → Pericycle → Phloem. (cork)

6. (D) If bile duct is choked. It obstruct the flow of bile pigment, which helps in the emulsification of fats.

7. (C) Crocodile is a reptile. The given characteristic features are found in reptiles.

8. (D) Formation of red blood cells is called erythropoiesis. It occurs in the liver and spleen in foetus and in red bone marrow after birth.

9. (C) Prawn is an arthropod. It respires through gills. Earthworm is an annelid it has no respiratory organ it breathes through its moist body skin.

10. (C) Mitochondria bring about oxidation of foodstuffs and release energy. The released energy is carried to the energy carrier ATP, ATP is used to bring about energy requiring activities in the cell. On account of this mitochondria are often described as the power house the cell.

11. (A) Kingdom Monera includes unicellular Prokaryotic organisms.

12. (D) Annelida (annulus) - ring, segmented worms includes segmented worms

13. (D) The hierarchy of classification is

Kingdom → Phylum → Class → Order → Family → Genus → species.

14. (B) Takhtajan remarked "Taxonomy without Phylogeny as bones without flesh".

15. (B) Selaginella is called the resurrection plant. Selaginella plants are capable of flexing their branches and roll to assume the shape of balls. Under prolonged dry conditions, when dipped in water or moistened they resume their normal form. Such plants are called resurrection plants.

16. (C) A lizard exhibits the phenomenon of autotomy. If it is caught by its tail, it breaks off the tail and escapes. It regrows the tail later. This process is called autotomy.

17. (B) Aves are mostly aerial animals. They have a light body which helps them to flight adaptation. They have long hollow bones (Pneumatic bones) and are interconnected with air passages.

18. (C) Liver worts - Marchantia

Pteridophyte - Selaginella

Algae - Chlamydomonas

Gymnosperm - Cycas

i - s, ii - r, iii - p, iv - q

19. (D) Antedon, echinus and ophiothrix are the examples of echinodermata.

20. (B) In unicellular organisms like amoeba, parent cells undergo binary fission. It is like mitotic division. Mitosis is the division of parent cell into two identical daughter cells. In multicellular organisms in somatic cells and growing parts, it brings about growth and repair of tissues.

21. (C) Isotonic solutions have a concentration such that it neither gains nor loses water by osmosis. Blood is stored in isotonic saline water to avoid haemolysis. Haemolysis is the rupture of red blood cells with release of haemoglobin. Haemolysis occurs when blood is stored in pure water.

22. (C) Osmosis is the net diffusion of water molecules from a dilute solution (hypotonic) to the concentrated solution (cell sap) through a semipermeable membrane.

Imbibition is the phenomenon of adsorption of water or any other liquid by the solid particles of a substance with out forming a solution.

23. (D) Potassium acts as an activator of many enzymes involved in respiration and photosynthesis. It maintains the osmotic potential and turgor pressure of cells. Potassium acts as a key element in opening and closing of the stomata.

24. (C) Deficiency of copper cause die back disease in plants, manganese cause grey speck of oats, boron cause heat rot of beets, molybdenum cause whip tail disease of cauliflower.

i-r, ii-s, iii-q, iv-p

25. (C) Gametes (male and female) are formed in gametogenesis. Fertilisation of gametes is called syngamy. Fertilisation results in the formation of a zygote. Zygote undergoes various division to form an embryo.

26. (C) In earthworm respiration occurs through its moist skin.

27. (D) Neuron - Nissil granules

Melanin pigment is present in skin

28. (D) Uracil is found only in RNA.

29. (A) The golgi complex gives rise to the acrosome in an animal sperm.

30. (C) Ruben, Hassid and Kamen used O^{18} and confirmed that oxygen, evolved in photosynthesis comes from water and not from CO_2.

31. (D) Acetyl CoA is the entrant molecule for Krebs cycle and the ending compound of glycolysis.

32. (C) Lysosomes reduces the old worn out organelles in a cell and are broken down to make the component molecules for the formation of new cells.

33. (B) Esterbonds are found in fats.

34. (C) Cerumen - earwax. It is a soft brownish waxy secretion (a modified cebum) of the ceruminous glands of the external auditory canal.

35. (B) The movement of a plant in response to an external stimulus in which the direction of response is not determined by the direction of the stimulus are called nastic movement. The nastic movements of plants are induced by the stimuli such as heat, light and touch.

36. (B) In the given figure carbon dioxide in the air is fixed by green plants during photosynthesis. Plants, animals and human beings give out carbon dioxide during respiration. Death and decay of plants, animals and human beings by the action of decomposers decomposes to forms fuel.

37. (C) All the capillary networks return blood containing materials to the renal venules which join to form a renal vein that opens into the inferior vena cava.

38. (C) Endocrine glands secretes hormones for calcium regulation of blood and bones.

39. (A) The given information is about fibre. Fibre in diet prevents constipation.

40. (B) The branch of biology that deals with the study of nose and its diseases is called rhinology.

Physics

41. (A) Here, $v = 7\sqrt{3}$ m s^{-1}; $r = 5\sqrt{3}$ m.

Let θ be the inclination of the cyclist with the vertical.

$$\text{Then, } \tan\theta = \frac{v^2}{rg} = \frac{\left(7\sqrt{3}\right)^2}{5\sqrt{3}\times 9.8} = \sqrt{3}$$

$$\Rightarrow \theta = 60^\circ$$

42. (A) Dimensions of :

(i) Torque x angular displacement

$= M^1L^2T^{-2} \times M^oL^oT^o = ML^2T^{-2}$

(ii) Rotational inertia x (angular frequency)^2

$= M^1L^2T^o \times (M^oL^oT^{-1})^2$

$M^1L^2T^{-2}$

(iii) Displacement $\times$ momentum

$= M^oL^1T^o \times M^1L^1T^{-1} = ML^2T^{-1}$

Dimensions of P.E. = mgh = ML^2T^{-2}

Both (i) and (ii) have same dimensions of P.E.

43. (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

$= V \times 1000$ kg $= 0.04 \times 1000 = 40$ kg

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

44. (A) When the brakes are on, the wheels of the bike cannot rotate. So, it has to slide. The sliding friction is comparatively larger than the rolling friction.

45. (C) A couple produces a pure rotational motion as it is a combination of two equal, unlike, parallel forces acting on a body producing a turning movement.

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

$$\therefore A = \frac{F}{Y\times \text{strain}} = \frac{2\times 10^4 \times 100}{7\times 10^9 \times 0.4}$$

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

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

47. (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.

48. (D) Let the angle between vectors P and Q be θ.

$(P+Q)^2 + (P-Q)^2 + 2(P+Q)(P-Q)\times\cos\theta$
$= P^2 + Q^2$

which gives $\cos\theta = (P^2+Q^2)/2(Q^2-P^2)$

$$(\text{or})\ \theta = \cos^{-1}\left[\frac{(P^2+Q^2)}{2(Q^2-P^2)}\right]$$

49. (C) $T^2 \alpha R^3$

$$\frac{T_A^2}{T_B^2} = \frac{R_A^3}{R_B^3}$$

$$\text{or } \frac{R_A^3}{R_B^3} = 64$$

Or $R_A = 4R_B$

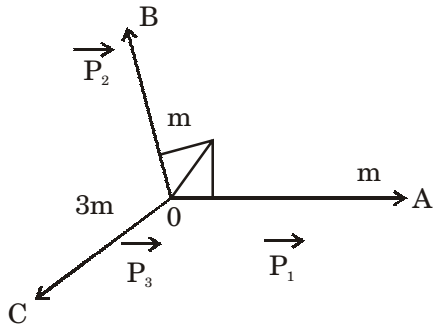
50. (B) Let the mass of the three fragments be m kg, m kg and 3m kg

Total mass = 1 kg

$\Rightarrow m + m + 3m = 1kg$

$\Rightarrow 5m = 1$ kg

$\Rightarrow m = \frac{1}{5}$ kg



Momentum along OA is P_1

$$= \text{mass} \times \text{velocity} = \frac{1}{5}\times 30$$

$P_2 = 6$ kg m s^{-1} = 6 kg m s^{-1}

$P_3 = 3\ m \times V$

Total momentum after collision

= Total momentum before collision.

$$\vec{P_1} + \vec{P_2} + \vec{P_3} = 0$$

$$\vec{P_3} = (\vec{P_1} + \vec{P_2});\ |\vec{P_3}| = \sqrt{P_1^2 + P_2^2}$$

$$\sqrt{6^2+6^2} = \sqrt{72} = 6\sqrt{2} \text{ kg m s}^{-1}$$

$3\ m\ V = 6\sqrt{2}$

$$V = \frac{6\sqrt{2}}{3\times\frac{1}{5}} = 10\sqrt{2} = 14.14 \text{ m s}^{-1}$$

51. (D) As oxygen and hydrogen are diatomic gases, their specific heat is the same.

$\therefore 1\times C\times(100-\theta) = 1\times C\times(\theta-10)$

$2\theta = 110^o \Rightarrow \theta = 55^o$.

52. (C) The angle of contact depends upon the nature of liquid taken in the container, temperature and on the nature of material of the container.

53. (A) For a perfectly elastic collision e = 1 and for a perfectly inelastic collision, e = 0. Therefore $0 < e < 1$. While in actual practice, collision between all real objects are neither perfectly elastic nor perfectly inelastic.

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. (C) $$\frac{\Delta R}{R} = \frac{\Delta R1}{R1} + \frac{\Delta R2}{R2} + \frac{\Delta R1 + \Delta R2}{R1+R2}$$

$$= \frac{0.2}{5} + \frac{0.1}{8} + \frac{0.2+0.1}{5+8}$$

$= 0.04 + 0.0125 + 0.02 = 0.0725$

Hence % of error = 7.25%

56. (B) $$\frac{gR^2}{(R+h)^2} = g\left(1-\frac{h}{R}\right)$$

$$\text{or } \left(1-\frac{h}{R}\right)\left(1+\frac{h^2}{R^2}+\frac{2h}{R}\right) = 1$$

$$\text{or } \frac{h^3}{R^3} + \frac{h^2}{R^2} - \frac{h}{R} = 0$$

$$\text{or } \frac{h}{R}\left(\frac{h^2}{R^2} + \frac{h}{R} - 1\right) = 0$$

$$\text{or } \frac{h}{R} = \frac{-1\pm\sqrt{1+4}}{2}$$

$$= \frac{\sqrt{5}-1}{2}$$

$$\text{or } h = \frac{\sqrt{5}R - R}{2}$$

57. (D) $V_0 = \sqrt{\frac{GM}{r}} \Rightarrow V_o \alpha \frac{1}{\sqrt{r}}$

So, $\frac{V_1}{V_2} = \sqrt{\frac{r_2}{r_1}}$ (orbital velocity of a satellite is independent of mass of satellite).

$= \sqrt{\frac{2r}{r}} = \sqrt{2} : 1$

58. (D) $W = Fd = 1\ gf \times 1\ cm$

$= \frac{1}{1000} kgf \times \frac{1}{100} m$

$= \frac{1}{1000} \times 10\,N \times \frac{1}{100} m = 10^{-4} J$

$= 0.0001$ J.

59. (D) Total kinetic energy $(U_k) = \frac{1}{2} I\omega^2 + \frac{1}{2} Mv^2$

$= \frac{1}{2} \times \frac{2}{5} MR^2\omega^2 + \frac{1}{2} Mv^2$

$= \frac{1}{5} Mv^2 + \frac{1}{2} Mv^2$

$= \frac{7}{10} Mv^2 = \frac{7}{10} \times \frac{1}{2} \times (0.2)^2$

$= 0.014$ J

60. (B) Impulse = change in momentum

$= mv - mu = m(v - u)$

$= 0.1[30 - (-20)] = 5$ N s

61. (D) $Dn = u + \frac{a}{2}(2n - 1)$

$2 = 0 + \frac{a}{2}(2 \times 1 - 1)$

$\therefore a = 4\ cm\ s^{-2}$. Again from

$v = u + at = 0 + (4 \times 4) = 16\ cm\ s^{-1}$.

62. (C) 1 Poiseuille = N s m^{-2}

$= 10^5$ dyne s $\times (100\ cm^{-2})$

$= 10$ dyne cm^{-2} s $= 10$ poise

1 poise $= \frac{1}{10}$ N m^2 s

$= 0.1$ N m^{-2} s

63. (C) Damping is the periodic decrease in the amplitude, thereby frequency and time period also changes. But phase of the S.H.M. wave does not change.

64. (B) The moment of inertia of a spherical shell with axis along the diameter is $\frac{2}{3} MR^2$

65. (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.

Chemistry

66. (C) Dipole moment is defined as the product of magnitude of charge and distance of separation between the charges.

Alkanes are non-polar in nature. Non-polar molecules have zero dipole moment. Hence, pentane's dipole moment is zero.

67. (B) $1\ m^3 = 1000$ litres

At S.T.P.,

1 mole of any gas occupies 22.4 l

? mole of any gas occupies 1000 l

Number of moles $= \frac{1000}{22.4} = 44.6$ moles.

68. (A) If S is the solubility product of AX_2

$AX_2(aq) \rightleftharpoons \underset{S}{A^{+2}}(aq) + \underset{2\ S}{2\ X^-}(aq)$

Then, $K_{sp} = [A^{+2}]\,[X^-]^2 = S \times (2S^2) = 4S^3$

$= 4 \times (1.0 \times 10^{-5}\ mol\ L^{-1})^3$

$= 4 \times 10^{-15}\ mol^3\ L^{-3}$

69. (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.

70. (D) Hydrogen is given off when palladium is heated in vacuum. This phenomenon is known as occlusion.

71. (C) When the boiling points of the two, four or more miscible liquids in any mixture do not differ very much and hence boil within a narrow range of temperature, then a fractionating column helps in condensing these liquids at different levels of the column. Thus, separating the liquid components by this process is known as fractional distillation.

72. (A) Lithium is the only alkali metal which reacts with nitrogen to give Lithium nitride, Li_3N (ruby red solid).

$6\ Li + N_2 \rightarrow 2Li_3N$

73. (B) The state of hybridisation of nitrogen in NH_4^+ is sp^3 and its molecular shape is tetrahedral.

74. (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 $BeCl_2$

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

75. (C) The reaction is

$N_2 + 3H_2 \rightarrow 2NH_3$

1 mol 3 mol 2 mol

(2×14)g $2 \times (1 \times 14 + 3 \times 1)$g

= 28 g = 34 g

Thus, to produce 34 g of ammonia (NH_3), 28g of nitrogen is needed.

76. (B) Na_2ZnO_2 and H_2 are produced on dissolving metallic zinc in excess of NaOH.

$2\,NaOH + Zn \rightarrow Na_2ZnO_2 + H_2$

77. (D) In the shell, n = 4 a maximum of $2n^2 = 2\times4^2 = 32$ electrons can be accommodated. In this shell $m_s = -\frac{1}{2}$ will be present for half of these 32 electrons i.e., 16 electrons.

78. (A) In potassium dichromate titrations the most commonly employed indicators are diphenylamine or N – phenylanthranilic acid.

79. (C) The maximum limit of nitrate in drinking water is 50 ppm. Excess nitrate in drinking water can cause a disease known as methemoglobinemia or 'blue baby syndrome'.

80. (A) According to de Broglie equation $\lambda = \frac{h}{mv}$

$= 6.63\times10^{-27}$ erg sec

$= 200\ g\times3\times10^{3}\ cm\ s^{-1}$

$= 1.1\times10^{-32}$ cm

81. (C) $P_1V_1 = P_2V_2 = P_3V_3 = P_4V_4$

$P_2 = 125$ Torr ; $P_3 = 200$ Torr ;

$V_2 = 64$ ml ; $V_3 = ?$

$P_2V_2 = P_3V_3$

or $V_3 = \frac{P_2V_2}{P_3} = \frac{125\times64}{200} = 40\,ml$

82. (D) Quartz, cristobalite and tridymite are some of the crystalline forms of silica and they are interconvertible at suitable temperature.

83. (A) The first law of thermodynamics can be mathematically represented as:

$\Delta U = q + w$

where ΔU - change in internal energy,

q - heat given to the system

w - work done on the system.

84. (D) Total no. of moles of $CO_2 = \frac{wt.\,in\,g}{mol.\,wt}$

$= \frac{0.2}{44} = 0.00454$

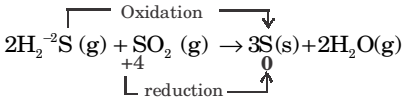
No. of moles removed

$= \frac{10^{21}}{6.022\times10^{23}} = 0.00166$

No. of moles of CO_2 left = 0.00454 – 0.00166

= 0.00288.

85. (C) Graphite is thermodynamically, the most stable allotrope of carbon and therefore, Δ_fH^o of graphite is taken as zero. Δ_fH^o value of diamond and fullerene are 1.90 and 38.1 kJ mol^{-1} respectively.

86. (B) 

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

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.

87. (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

$= \frac{w}{M}, \frac{RT}{P} = \frac{22}{44}\times\frac{0.0821\times300\times760}{780}$

$= 12\,l.$

88. (A) When KCl is dissolved in water, heat is absorbed. Thus, the enthalpy of solution of KCl is positive. For a dilution of 200, the enthalpy of KCl is + 18.6 kJ mol^{-1}

89. (A)

Element	Position
Cesium	6th period, I A group
Magnesium	3rd period, II A group
Barium	6th period, II A group
Lead	6th period, IV A group

For an element to have largest atomic size, it should be in greatest period and least group. So, in the given elements cesium has the largest atomic radius.

90. (C) For the reaction

$Cu(s) + 2\,Ag^{+}(aq) \rightleftharpoons Cu^{+2}(aq) + 2Ag(s)$

the reaction quotient (Q) is,

$Q = \frac{[Cu^{+2}(aq)]}{[Ag+(aq)]^2} = \frac{1.8\times10^{-2}\,mol\,L^{-1}}{(3\times10^{-9}\,mol\,L^{-1})^2}$

under the given conditions, value of Q = K i.e., reaction quotient = equilibrium constant. Therefore, the system is at equilibrium.