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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION

Paper Code: UN439 (UPDATED)

Solutions for Class : 11_PCB

BIOLOGY

1. **(B)** Lepidoptera (scale wings) is an insect order comprising butterflies and moths.

2. **(A)** 'One gene one enzyme hypothesis' proposed by Beadle and Tatum (1958) was based on nutritional mutations in the pink mold Neurospora crassa.

3. **(A)** Sibling species resemble morphologically but do not interbreed, e.g., Drosophila persimilis and D. pseudo-obscura.

4. **(C)** Ammonia is a nitrogenous excretory product of freshwater organisms.

5. **(C)** In yeast, a large nuclear vacuole is found in the cell. During budding, gamete formation and ascospore formation, nuclear vacuole does not disappear. It disappears only when ascus mother cell is formed.

6. **(A)** Gills of Agaricus produce hymenium layer to develop basidia and basidiospores for reproduction.

7. **(A)** Seedlings of orchids fail to grow longer unless they develop mycorrhizal association, hence orchids are usually propagated by vegetative means, rather than by seeds.

8. **(D)** Spermatogenous cell means the cells producing antherozoids or sperms.

9. **(B)** Only the eusporangiate sporangia develop multicellular jacket whose inner most layer develops into tapetum. Tapetum provides nutrition to developing spore mother cells and spores (nutritive in function) and finally abort.

10. **(A)** Taenia (tapeworm) is a pseudocoelomate.

11. **(A)** Tornaria is the larva of Balanoglossus which belongs to the subphylum Hemichordata.

12. **(B)** Statocysts are organs of equilibrium and muscular coordination found in the medusa of Obelia.

13. **(C)** Enterobius is a nematode, not a flatworm.

14. **(A)** Cysticercus is a larval stage of Taenia.

15. **(B)** The posterior end of the male Ancylostoma is in the form of a broad, umbrella-like structure, the copulatory bursa, surrounding the cloaca.

16. **(B)** The setae of earthworm are curved S-shaped with swollen middle part called nodulus.

17. **(C)** Forewing is modified into the leathery tegmina in grasshopper and cockroach. It is reduced, often serves not so much in flight. Tegmina is a protective cover for the delicate membranous hindwings when at rest.

18. **(B)** Aplacophora and Polyplacophora are included in a class called Amphineura by some taxonomists. These molluscs possess one pair of interconnected nerve cords. Chitons are marine molluscs of class polyplaco phora formerly known as amphineura.

19. **(D)** When irritated or when subjected to unfavourable conditions, many species of sea cucumbers cast out a partof their viscera by a strong muscular contraction that may either rupture the body wall or evert its contents through the anus. The lost parts regenerate again.

20. **(B)** Sea horse is a fish.

21. **(C)** The eggs of reptiles and birds contain a large amount of yolk, mostly towards vegetal pole, hence called telolecithal.

22. **(B)** The vampire bat, Desmodus of South America, drinks blood and has the upper incisors modified into cutting blades.

23. **(A)** Camel, an even-toed animal, belongs to the mammalian order artiodactyla.

24. **(B)** Companion cell provide proteins to sieve tube.

25. **(B)** Irregular flowers are isobilaterally symmetrical.

26. **(B)** Microvilli increase surface area and are specialized for absorption.

27. **(A)** Pectin is a carbohydrate present in the middle lamella of plant cell wall.

28. **(C)** The virus lacks the typical structure of a cell.

29. **(D)** Phagocytosis is triggered by the presence of certain particles on the cell surface.

30. **(A)** Peptide bond is rigid and planar, having no rotational freedom, such that the carbonyl oxygen and the amino hydrogen are always in a trans (opposite) position.

31. **(D)** Trypsinogen, chymotrypsinogen and pepsinogen are inactive zymogen precursors of gastrointestinal enzymes. Ribonuclease, which catalyses the depolymerization of ribo-nucleic acid, is secreted in its active form.

32. **(C)** Hypothalamus forms the floor of third ventricle or ventral part of diencephalon.

33. **(A)** Cones are photoreceptor cells in the retina of eye that enables a person to visualize colours.

34. **(D)** A muscular diaphragm present in crocodiles is analogous to that found in mammals.

35. **(B)** Brush border indicates the presence of microvilli of small intestine.

36. **(C)** When no change occurs in a cell after placing it in 0.5 M sugar solution, it means the solution is isotonic and thus concentration of cell sap is also 0.5 M.

37. **(A)** Glucose is the chief respiratory substrate and thus gives energy on oxidation instantly.

38. **(B)** Root meristem is sub-apical in position due to presence of root cap.

39. **(A)** Photophosphorylation refers to ATP synthesis during light reaction of photosynthesis discovered by Arnon.

40. **(B)** Stanley Cohen, the molecular biologist of Stanford University and Herbert Boyer of University of California at san Francisco invented genetic engineering.

PHYSICS

41. **(C)** It falls with terminal velocity. (i.e., acquires a constant velocity)

42. **(B)** Rise of cold drink in a straw is an example of atmospheric pressure.

43. **(C)** The dimensions of K are same as that of pressure, which are same as that for modulus of elasticity.

Modulus of elasticity $Y = \frac{\text{Stress}}{\text{Strain}} = \frac{N}{m^2}$

44. **(C)** The pressure inside the soap bubble is more than that outside it.

45. **(C)** The total momentum of the ball and the earth is conserved.

46. **(A)** $p_1V_1 = p_2V_2$

When radius is doubled, volume becomes 8 times.

Hence $(p + H)\ V_1 = H \times 8V_1$

That is, $p = 7H$.

47. **(B)** Statements (i) and (iii) are not correct. Instantaneous speed is equal to the magnitude of instantaneous velocity.

48. **(B)** Acceleration due to gravity on planet

$$= \frac{\text{Gravitational potential difference}}{\text{Distance between two points}}$$

$$= \frac{4}{10} = 0.4 \text{ ms}^{-2}$$

Work done = 4 × 0.4 × 2.5 = 4 J

49. **(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 = 2R

50. **(D)** The acceleration acting on both the bodies is due to gravity.

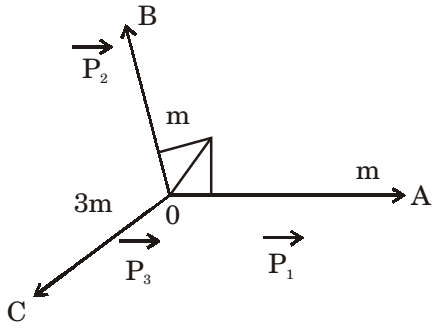
51. **(B)** Let the mass of the three fragments be m kg, m kg and 3m kg

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

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

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

P_3 = 3 m × V

Total momentum after collision

= Total momentum before collision.

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

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

$\sqrt{6^2+6^2} = \sqrt{72} = 6\sqrt{2}$ 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 ms^{-1}

52. **(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.

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

$\Rightarrow \theta = 60^\circ$

53. **(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 $\cos\theta = (P^2 + Q^2)/2(Q^2 - P^2)$

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

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

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

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

55. **(B)** Impulse = change in momentum

= mv – mu = m(v – u)

= 0.1[30 – (–20)] = 5 N s

56. **(C)** V = (100 ± 5) V

I = (10 ± 0.2) A

$$R = \frac{V}{I} = \frac{100}{10} = 10 \text{ ohm}$$

$$\frac{\Delta R}{R} = \pm\left(\frac{\Delta V}{V} + \frac{\Delta I}{I}\right)$$

$$= \pm\left(\frac{5}{100} + \frac{0.2}{10}\right) = \pm\frac{7}{100}$$

$$\frac{\Delta R}{R}\times 100 = \pm\frac{7}{100}\times 100 = \pm 7\%$$

57. **(B)** The downward force on the elevator is

$F = mg + F_f = 3600 \times 10 + 8000 = 44000$ N

The motor must supply enough power to balance this force. Hence,

P = F.v = 44000 × 4 = 176000 W = 236 hp

58. **(A)** The set of quantities with the same dimensional formula ML^2T^{-3} are luminous intensity and radiant flux.

59. **(C)** From the law of conservation of linear momentum,

$MV = m_1v_1 + m_2v_2$

or $m_1v_1 + m_2v_2 = 0$ (Because $V = 0$.)

or $m_1v_1 = -m_2v_2$

or $v_1 = \frac{-m_2v_2}{m_1}$

Substituting m_2 = 8 kg; v_2 = 6 $m\ s^{-1}$, m_1 = 4kg, we get

v_1 = 12 m s^{-1} (neglecting –ve sign).

Hence, kinetic energy is given by

$K = (1/2)m_1 v_1^2 = (1/2) \times 4 \times (12)^2 = 288$ J.

60. **(D)** dQ = 400 cal. dW = –105 J

= –105 / 4.2 cal = –25 cal.; dU = ?

dU = dQ – dW

dU = 400 – (–25) = 425 cal

Note dW is negative because work is done on the system.

61. **(B)** Energy stored per unit volume

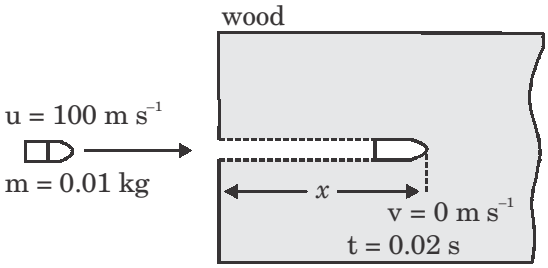
$$U = \frac{1}{2}\text{stress} \times \text{strain}$$

$$= \frac{1}{2}\text{stress} \times \frac{\text{strain}}{Y}$$

$$= \frac{1}{2}S \times \frac{S}{Y} = \frac{1\,S^2}{2\,Y}$$

62. **(C)** On the surface of the earth, the atmospheric pressure is quite high. The astronauts will feel great discomfort if they move on the earth immediately after coming back from the moon. To avoid it, they need to get used to normal air pressure gradually. That is why, they have to live for some days in a caravan with the air pressure lower than outside.

63. **(B)**



u = 100 m s^{-1} v = 0 m s^{-1}

a = ? t = 0.02 s

v = u + at

0 = 100 + a × 0.02

0.02 a = – 100

a = – 100 / 0.02

a = – 5000 m s^{-2}

A bullet penetrating a wooden block

F = ? m = 0.01 kg a = – 5000 m s^{-2}

F = ma

F = 0.01 × (– 5000)

The average retarding force exerted by the wood is – 50 N.

64. **(A)** Relative velocity of overtaking =

40 m s^{-1} – 30 m s^{-1} = 10 m s^{-1}.

Total distance covered with this relative velocity during overtaking will be =

100 m + 200 m = 300 m.

Time taken t = 300 m/10 m s^{-1} = 30 s

65. **(C)** $$\upsilon = \frac{m_1u_1 + m_2u_2}{m_1 + m_2} = \frac{40\times4 + 60\times2}{40+60}$$

= 2.8 m s^{-1}

Loss in K.E. =

$$\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 - \frac{1}{2}(m_1+m_2)\upsilon^2$$

$$\frac{1}{2}\left[40\times16 + 60\times4 - 100\times2.8^2\right] = 48\text{ J}$$

CHEMISTRY

66. **(C)** In borax, two boron atoms are in triangular geometry and two boron atoms are in tetrahedral geometry. The ion is $[B_4O_5(OH)_4]^{2-}$ and the remaining 8 water molecules are associated with 2 sodium ions and borax is formulated as $Na_2[B_4O_5(OH)_4]\cdot 8H_2O$.

67. **(D)** Chromatography may be used for the purification/separation of the constituents of a mixture consisting of :

(i) gases, (ii) liquids, (iii) solids

68. **(B)** $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

At STP → 65 g Zn liberates → 22.4 litre of hydrogen.

3.25 g of Zn liberated → ? litre of hydrogen.

$$\Rightarrow \frac{3.25\text{g}\times22.4\,l}{65\text{g}} = 1.12\text{ litre}.$$

69. **(D)** The favourable conditions are :

(i) Low temperature, (ii) Catalyst

(iii) High pressure

70. **(B)** Tertiary carbonium ion is more stable as the positive charge on the carbon can be neutralized by positive I effect of 3 methyl radicals.

71. **(D)** Inert gases do not form any compounds. Therefore, the distance between two adjacent atoms is considered for the calculation of atomic radius. As two adjacent atoms are bound by non-bonded forces of attraction called Vander Waal's forces the atomic radius is called Vander Waal's radius. Inert gases belong to zero group.

72. **(D)** All the given mixtures form buffer solutions. In case of (II) sodium acetate reacts with HCl to form CH_3COOH and NaCl.

73. **(B)** For the given reaction,

(i) ΔH is negative

(ii) ΔS is negative

74. **(C)** Mass of 1 drop or 0.05 ml of H_2O = 0.05 g (1 g = 1 ml)

No. of moles in 0.05 g = $\frac{0.05}{18}$

One mole contains 6.02×10^{23} molecules

$\therefore$ No. of water molecules in one drop

$= \frac{0.05}{18} \times 6.02 \times 10^{23} = 1.67 \times 10^{21}$ molecules

75. **(A)** Exhaust system in limekilns drive away CO_2 formed so that the equilibrium shifts towards forward reaction.

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

$2\ NaOH + Zn \rightarrow Na_2\ ZnO_2 + H_2$

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

$AX_2(aq) \rightleftharpoons S\ (aq) + 2S\ (aq)$

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

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

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

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

79. **(D)** 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}

80. **(D)** Total no. of moles of CO_2

$= \frac{wt.\ in\ g}{1000g} = \frac{200}{1000} = 0.2\ g$

No. of moles of CO_2 = $\frac{wt.\ in\ g}{mol.\ wt.\ of\ CO_2}$

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

No. of moles removed

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

No. of moles of CO_2 left = 0.00454 – 0.00166

= 0.00288.

81. **(B)** $C(s) + O_2(g) \rightarrow CO_2(g)$

1 mol (= 44 g)

Amount of CO_2 in 35.2 g

$= \frac{1\ mol}{44\ g} \times 35.2\ g = 0.8\ mol$

Heat released during the formation of 35.2 g CO_2 = – 393.5 kJ mol^{-1} × 0.8 mol = – 314.8 kJ

82. **(C)** Molar mass of sodium nitrate ($NaNO_3$) = (23 + 14 + 48) g mol = 85 g mol

Mass of 1 dm^3 (or 1 litre) of the solution = Volume × Density

= 1000 cm^3 × 1.25 g cm^{-3} = 1250 g

Therefore,

Mass of the water containing

85 g of $NaNO_3$ = (1250 – 85) g = 1165 g

= 1.165 kg

So, Molality (*m*) of the solution

$= \frac{1\ mol}{1.165\ kg} = 0.86\ mol\ kg^{-1}$

83. **(C)** From the given data, 2.0×10^{-50}

$= \frac{[O_3]^2}{[O_2]^3} = \frac{[O_3]^2}{(1.6 \times 10^{-2})^3}$

This gives, $[O_3]^2 = 2.0 \times 10^{-50}(1.6 \times 10^{-2})^3$

$= 8.2 \times 10^{-56}$

or $[O_3] = \sqrt{8.2 \times 10^{-56}}$

$= 2.86 \times 10^{-28}\ mol\ L^{-1}$

84. **(A)**

(i) The similarity between lithium and magnesium is striking particularly in their similar sizes of atomic, ionic radii etc.

(ii) They are harder and lighter than other elements in their respective groups.

(iii) They form nitrides by direct combination with nitrogen.

(iv) Their chlorides are soluble in ethanol.

(v) Oxides and hydroxides of both Li and Mg are much less soluble and their hydroxides decompose on heating.

85. **(A)** The given characteristics belong to borazine, a compound of boron with the formula $B_3 N_3 H_6$.

(i) It is a colourless liquid with an aromatic smell and is also called inorganic benzene.

(ii) It has alternate BH and NH groups in its ring structure.

(iii) It is isoteric because it has the same number of atoms and electrons as that of benzene.

(iv) On heating or by passing silent electric discharge through borazine, it forms a product similar to naphthalene which is also known as inorganic naphthalene.

86. **(B)** HNO_3 is added to decompose Na_2S and NaCN otherwise Na_2S will give black ppt. of Ag_2S and NaCN will give white ppt. of AgCN which would interfere with the test of halogens.

87. **(C)** $BaO_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O_2$

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

88. **(A)** Structure of B_2H_6 contains four 2c - 2e bonds and two 3c – 2e bonds.

89. **(B)** % of S = $\frac{32}{233} \times \frac{0.233}{0.32} \times 100 = 10$

90. **(B)** Rise in temperature,

Δt = (300.78 K – 294.05 K) = 6.73 K

Heat capacity of the calorimeter =

8.93 kJ K^{-1}

Then,

Heat transferred to calorimeter =

Heat capacity of calorimeter × Rise in temperature

= 8.93 kJ K^{-1} × 6.73 K = 60.1 kJ

GENERAL AWARENESS

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

95. **(B)** 96. **(A)** 97. **(D)** 98. **(C)**

99. **(B)** 100. **(A)**

The End