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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION

Paper Code: UN 423

Solutions for Class : 11 (PCB)

Biology

1. **(B)** Helminthology is the study of worms. Entomology is the study of insects. Ornithology is the study of birds. Phycology is the study of algae.
2. **(C)** Ivan P. Pavlov (1910) is the father of conditioned reflex. He demonstrated conditioned reflex in dog.
3. **(C)** Endospores of bacteria are fairly resistant to heat and protect bacterium during extreme drought and dessication. In boiling water, endospores survive and when water is cooled, they produce vegetative cells to grow and multiply.
4. **(A)** Taenia, commonly known as tapeworm is not a protist, it belongs to phylum Platyhelminthes (Kingdom Animalia).
5. **(D)** Division – class – order – family – genus – species
6. **(C)** Non-vascular embryophytes have been classified in Bryophyta.
7. **(A)** Nitrosomonas oxidises ammonia to nitrates and Nitrobacter oxidises nitrites to nitrates and thus they are called nitrifying bacteria. They synthesize their food using inorganic raw materials with the help of energy derived from oxidation reactions, thus they are chemoautotrophs or chemolithotrophs.
8. **(A)** In 4 hours duration, 256 bacterial cells will be produced as given below.

No. of cells produced	Time in minutes
2	30
4	60
8	90
16	120
32	150
64	180
128	210
256	240

9. **(A)** Spongilla, the best known fresh water sponge, is found in ponds, lakes and slow streams.
10. **(A)** Ptyalin is an enzyme in saliva, other three are hormones.
11. **(C)** Epinephrine is synthesized from the amino acid tyrosine.
12. **(C)** In the given figure of brain, part labelled 'X' represents cerebellum.
13. **(C)** P = Head, Q = Sheath, R = Collar, S = Tail fibres
14. **(A)** Algae belongs to plantae, Phycomycetes is a fungi, Euglenoids is a protista and Archaebacteria is a monera.
15. **(A)** Osculum controls the exit of water.
16. **(B)** Urea is synthesized in the liver and is carried from liver by hepatic vein.
17. **(D)** The kidney which is left out in the body undergoes enlargement and carries out the extra work of missing kidney. This is called compensatory hypertrophy.
18. **(C)** The total reabsorption of glucose by active transport takes place in proximal convoluted tubule of nephron.
19. **(C)** Lymph flows slower than the blood in the body. Its plasma has less protein, calcium and phosphrus. It transports materials from tissue cells into the blood.
20. **(D)** Mn and Cl help in photolysis of water.
21. **(B)** Cork cells are dead cells and hence, they do not respire.
22. **(B)** Sugarcane is a monocot, where scattered vascular bundles occur in stem and hence girdling experiments cannot be performed in it.
23. **(B)** The blood vessel labelled 'Q' carries glucose rich blood from liver to small intestine.
24. **(C)** P-Right atrium, Q-Right ventricle, R-Oxygenated blood, S-Left atrium

25. **(B)** Soil → Root hairs → Cortex → Endodermis → Pericycle → Protoxylem → Metaxylem

26. **(A)** For phosphorylation or ATP formation, N and P are used.

27. **(D)** Gaseous exchange in the book lungs takes place with the help of lamellae arranged one over the other like the leaves of a book in spider and scorpions.

28. **(B)** Water and carbon dioxide are the byproducts of respiration.

29. **(D)** $NADPH_2$ formed during light reaction of photosynthesis is a reducing agent required in dark reaction of photosynthesis for reducing PGA to PGAL.

30. **(B)** 20 lacteal teeth in a child will be replaced by permanent teeth.

31. **(B)** When terminal bud of a plant is removed, apical dominance is removed and thus lateral buds will grow.

32. **(D)** Structure Z is the ventral root which consists of the axons of motor neurons. Structure X is the dorsal root ganglion which consists of the cell bodies of the sensory neurons. Structure W is the spinal nerve which consists of both motor and sensory neurons.

33. **(A)** After adding excess of fertilizer and irrigation in grass field, the outer soil solution becomes hypertonic. Hence, exosmosis occurs which leads to plasmolysis of cells and results in wilting which leads to drying and browning of leaves.

34. **(B)** Xylem conducts water, when xylem is blocked water is not conducted to the cell. Loss of water in cells of plants cause wilting.

35. **(A)** There are five oxidation steps in aerobic respiration (one in intermediate step and 4 in Kreb's cycle). These are catalyzed by dehydrogenases.

36. **(D)** p-iv, q-i, r-iii, s-ii

37. **(B)** Olfactory nerve arises as bipolar neurons from the olfactory mucosa of the nasal cavity. It conveys impulses related to smell to brain.

38. **(A)** In gymnosperms, trees are very common (Cycas, Pinus, Abies, Pices, Araucaria, Taxus, Cephalotaxus, Cedrus, Juniperus etc), shrubs are rare (Ephedra) and climbers or lianas are only a few (some species of Gnetum). Herbs and annuals or seasonals are altogether absent in gymnosperms. They are always perennial and long lived.

39. **(B)** Hydra reproduce by budding.

40. **(A)** Pepsin is secreted by stomach wall cells and it acts on caesin.

Physics

41. **(B)** Here, $m_1 = 10$ kg, $m_2 = 5$ kg, $v_1 = ?$, $v_2 = 0$, $v = 4$ m/s

Applying the principle of conservation of linear momentum,

$m_1v_1 + m_2v_2 = (m_1 + m_2)v$

$10v_1 + 5 \times 0 = (10 + 5)4 = 60$

$$v_1 = \frac{60}{10} = 6 \text{ m s}^{-1}$$

42. **(C)** $d = 0.005 \text{ mm} = 0.005 \times 10^{-3}$ m,

$R = 10/2 = 5 \text{ cm} = 0.05$ m,

$\sigma = 0.072 \text{ Nm}^{-1}$

Force required

$$= \frac{2\sigma}{d} \times \pi R^2 = \frac{2 \times 0.072 \times 3.14 \times (0.05)^2}{0.005 \times 10^{-3}}$$

$= 226$ N

43. **(C)** Here $\alpha = (10/2)$ rad s^{-2}

$I = MR^2 = \frac{1}{2} \times (0.2)^2 = 0.02$ kg ms^2.

Here $\tau = I\alpha = 5 \times 0.02$ Nm $= 0.10$ Nm.

44. **(D)** $\eta = \frac{W}{Q_1}$ $W = \eta Q_1 = \frac{1}{3} \times 1000$ cals.

$$= \frac{1000}{3} \times 4.2 \text{ joule} = 1400 \text{ J}.$$

45. **(B)** Mean value of refractive index.

$$n_m = \frac{1.49 + 1.50 + 1.52 + 1.54 + 1.48}{5}$$

$= 1.506 = 1.51$

46. **(C)** Spring constant, $k = F/x$.

$$\text{Workdone} = \frac{1}{2} k x^2 = \frac{1}{2} \times \frac{4 \times 9.8}{0.02} \times (0.05)^2$$

$= 2.45$ J

47. **(A)** $\rho = 0.09$ kg m^{-3}, $v_{rms} = 1.84 \times 10^3$ m s^{-1}

$$\text{Pressure} = P = \frac{1}{3}\rho v_{rms}^2$$

$$P = \frac{1}{3} \times 0.09 \times (1.84 \times 10^3)^2 = 1.015 \times 10^5 \text{ N/m}^2$$

48. **(D)** At height h, $\frac{g'}{g} = 1 - \frac{2h}{R} = \frac{90}{100}$

or $\frac{2h}{R} = 1 - \frac{90}{100} = \frac{10}{100} = \frac{1}{10}$

or R = 20 h = 20 × 320 = 6400 km

At depth d,

$\frac{g'}{g} = 1 - \frac{d}{R} = \frac{95}{100}$

or $\frac{d}{R} = 1 - \frac{95}{100} = \frac{5}{100} = \frac{1}{20}$

or $d = \frac{R}{20} = \frac{6400}{20} = 320$ km

49. **(C)** Hydrogen atom is assumed to be at the origin

$x_1 = 0$, $m_1 = m$, $x_2 = 1.27$ Å

$= 1.27 \times 10^{-10}$ m

$m_2 = 35.5$ m

The position of centre of mass

$$x = \frac{m_1x_1 + m_2x_2}{m_1 + m_2}$$

$$= \frac{m \times 0 + 35.5\ m \times 1.27 \times 10^{-10}}{m + 35.5\ m}$$

$$= \frac{45.08 \times 10^{-10} m}{36.5}$$

$= 1.24 \times 10^{-10}$ m

50. **(C)** Power = $\vec{F}.\vec{v}$ = Fv

$$F = v\left(\frac{dm}{dt}\right)$$

$$= v\left\{\frac{d(\rho \times \text{volume})}{dt}\right\} \quad (\rho = \text{density})$$

$$= \rho v\left\{\frac{d(\text{volume})}{dt}\right\} = \rho v(Av) = \rho Av^2$$

$\therefore$ power $P = \rho Av^3$

or $P \propto v^3$

51. **(D)** Sudden compression causes heating and rise in temp. With the passage of time, temp, falls and hence pressure also decreases.

52. **(D)** A + B = 17 ..... (i)

A – B = 7 ..... (ii)

On solving A = 12 units and B = 5 units

$R = \sqrt{A^2 + B^2} = \sqrt{12^2 + 5^2} = 13$ units.

53. **(B)** Impulse = change in linear momentum

= m v – m u = 0.1 × 40 – 0.1 × (– 30)

54. **(B)** Sum of P.E. and K.E. of the ball at A = Sum of P.E. and K.E. of the ball at B. At the point A, the ball is at rest, so K.E. = 0.

At B the speed of the ball is v. At B, h = 0 So, P.E. = 0

(P.E. + K.E.) at A = (P.E. + K.E.) at B

$mgh + 0 = 0 + \frac{1}{2}mv^2$

$v\sqrt{2gh}$

$= \sqrt{2 \times 9.8 \times 10}$

= 14 m/s

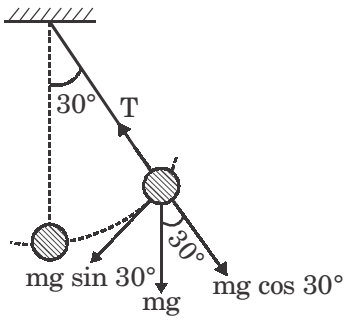
55. **(B)** Rate of change of speed

$\frac{dv}{dt}$ = tangential acceleration

$$= \frac{\text{tangential force}}{\text{mass}}$$

$$= \frac{mg\sin 30°}{m} = g\sin 30°$$

$$= 10\left(\frac{1}{2}\right) m/s^2 = 5\ m/s^2$$



56. **(B)** Workdone = $\frac{1}{2} \times Y \times (\text{strain})^2 \times \text{volume}$

For a given strain, workdone $\propto$ Y.

As Y for copper is less than that of steel, so less work is done on copper spring than that on steel spring.

57. **(A)** As on the surface of planet g = (GM/R^2)

$$\frac{g_M}{g_E} = \frac{M_M}{M_E} \times \left(\frac{R_E}{R_M}\right)^2 = \frac{1}{80} \times (4)^2 = \frac{1}{5}$$

$$\therefore g_M = \frac{g}{5} = \frac{9.8}{5} = 1.96 \text{ m/s}^2$$

Further more as escape velocity

$$v_e = \sqrt{(2GM/R)}$$

$$\frac{v_M}{v_E} = \sqrt{\frac{M_M}{M_E} \times \frac{R_E}{R_M}} = \sqrt{\frac{1}{80} \times 4} = \frac{1}{\sqrt{20}}$$

i.e., $v_M = \left(v_E / \sqrt{20}\right) = (11.2/4.47) = 2.5$ km/s.

58. **(A)** Mass = m = 700 gm = 0.7 kg

Radius of gyration = K = 20 cm = 0.2 m

Moment of inertia = $I = mK^2 = 0.7 \times 0.2 \times 0.2 = 0.028$ kg m^2.

59. **(C)** Let a be the acceleration of sprinter for time t = 4 s.

Distance travelled in 4 s = $\frac{1}{2}at^2 = \frac{1}{2} \times a \times 4^2 = 8a$

Velocity of sprinter at time 4 sec is

$v = at = a \times 4 = 4a$

Distance covered by sprinter with uniform velocity in time 4 sec to 9 sec (= 5 s) = $4a \times 5 = 20a$

As per question, $8a + 20a = 140$

or $a = 5 \text{ m s}^{-2}$

60. **(D)** $$\frac{P_1}{P} = \frac{T_1}{T}$$

or $T_1 = P_1 \frac{T}{P} = \frac{2P \times 293}{P} = 586 \text{ K} = 313^\circ \text{ C}$

61. **(B)** Here, m = 120 g = 0.12 kg

$$\vec{v} = \left(2\hat{i} + 5\hat{j}\right) \text{m/s}$$

$$v = |\vec{v}| = \sqrt{2^2 + 5^2} = \sqrt{29} \ m/s$$

$$KE = \frac{1}{2}mv^2 = \frac{1}{2} \times 0.12 \times 29 = 1.74 \text{ joule.}$$

62. **(A)** Work done in a cyclic process = area between the cycle

= AB × BC

= (2P – P) × (2V – V)

= PV

63. **(A)** Given, $\frac{mg'}{mg} = \frac{30}{90}$ or $\frac{g'}{g} = \frac{1}{3}$

Now $g' = g\frac{R^2}{(R+h)^2}$ or $g' = g\frac{R^2}{(R+h)^2} = \frac{1}{3}$

$$\text{or} \frac{R}{R+h} = \frac{1}{\sqrt{3}} \text{ or} (R+h) = \sqrt{3}\ R$$

or $h = \left(\sqrt{3} - 1\right)R = 0.73\ R$

64. **(B)** $$\frac{4}{3}\pi R^3 = 10^6\left(\frac{4}{3}\pi r^3\right)$$

or $R = (10^2 r)$

$U_i = 10^6 (4\pi r^2)T$

$U_f = (4\pi R^2)T$

$$\therefore \frac{U_f}{U_i} = \frac{1}{10^2}$$

65. **(B)** Thrust = normal force

Mass ejected per sec = 250×10^{-3} kg s^{-1}

Change of velocity = 8000 m s^{-1}

$$F = \frac{m(v-u)}{t}$$

= Mass per sec × Change of velocity

$F = 250 \times 10^{-3} \times 8 \times 1000 = 2000$ N

Chemistry

66. **(B)** $\overset{1}{CH_3} - \overset{2}{CH}(H_3C) - \overset{3}{CH}(CH_2CH_3) - \overset{4}{CH_2} - \overset{5}{CH_3}$

3-Ethyl-2-methylpentane

67. **(D)** O^{2-} (8 + 2 = 10) and Mg^{2+} (12 – 2 = 10) are isoelectronic with F^- (9 + 1 = 10)

68. **(A)** $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O,\ \Delta H_1 = -x$ kJ ..... (i)

$$CH_3OH + \frac{3}{2}O_2 \rightarrow CO_2 + 2H_2O,\ \Delta H_2 = -y \text{ kJ}$$ ..... (ii)

Subtracting (ii) from (i), we get

$$CH_4 + \frac{1}{2}O_2 \rightarrow CH_3OH,\ \Delta H_3 = \text{–ve}$$

i.e., – x – (–y) = –ve

y – x = –ve.

Hence, x > y

69. **(B)**

$2BCl_3$	+ $3H_2(g)$	$\rightarrow$	2 B	+ 6 HCl
	3 mol		2 mol	
	3×22.4 L (STP)		2×10.8 g = 21.6 g	
	= 67.2 L			

70. **(C)**

We can write, $2\,HI(g) \rightleftharpoons H_2(g) + I_2(g)$

Initial pressure, 0.2 atm, 0 0

Equilibrium partial presssure,

0.04 atm $\frac{(0.2-0.04)}{2}$ $\frac{(0.2-0.04)}{2}$

= 0.08 = 0.08

Then, $K_p = \frac{[H_2][I_2]}{[HI]^2} = \frac{0.08\times0.08}{(0.04)^2} = 4$

71. **(D)** Na_2CO_3 is completely dissociated to Na^+ and CO_3^{2-} ions thus giving high concentration of CO_3^{2-} ions which would precipitate Mg^{2+} as $MgCO_3$.

72. **(C)** From the given data,

$$n(H_2) = \frac{0.5\text{ g}}{2\text{ g/mol}} = 0.25\text{ mol}$$

$$n(O_2) = \frac{10\text{ g}}{32\text{ g/mol}} = 0.31\text{ mol}$$

$$n(H_2) = \frac{15\text{ L}}{22.4\text{ L/mol}} = 0.67\text{ mol}$$

$$n(N_2) = \frac{5\text{ L}}{22.4\text{ L/mol}} = 0.22\text{ mol}$$

Number of molecules $\propto$ No. of moles of the gas

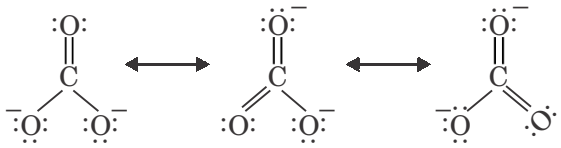
So, 15 L of H_2 gas at STP will contain the maximum number of molecules.

73. **(A)** $\left(\frac{1}{1^2}-\frac{1}{2^2}\right)=\frac{3}{4}, \left(\frac{1}{2^2}-\frac{1}{3^2}\right)=\frac{5}{36}, \left(\frac{1}{3^2}-\frac{1}{4^2}\right)=\frac{7}{144}$ and so on.

Thus, $1/\lambda$ decreases from transition n = 2 to n = 1, to n = 3 to n = 2 and so on or λ increases in the reverse order, i.e., λ is maximum for n = 5 to n = 4. As by de Broglie equation, $\lambda \propto 1/p$, therefore, momentum p will be maximum for the transition n = 2 to n = 1.

74. **(D)** $2K_2CrO_4 + 2HCl \longrightarrow K_2Cr_2O_7 + 2KCl + H_2O$

75. **(B)** According to the experimental findings, all carbon to oxygen bonds in CO_3^{2-} are equivalent. Therefore, the carbonate ion is best described as a resonance hybrid of the canonical forms I, II and III shown below.



(I) **(II)** **(III)**

76. **(B)** The equation is $BaO_2 + H_2SO_4 \longrightarrow BaSO_4(s) + H_2O_2$

The most electronegative atom in the products is oxygen. The oxidation state of O in H_2O_2 is –1, whereas that is $BaSO_4$ is –2.

77. **(D)** $\%P = \frac{62}{222}\times\frac{0.444}{0.31}\times100 = 40.$

78. **(D)**

2 Mg	+	O_2	$\rightarrow$	2MgO
2 × 24		32 g		2 (24 + 16)
= 48 g				= 80 g

30 g Mg will react completely with O_2 = $\frac{32}{48}\times30 = 20$ g

$\therefore$ O_2 left = 30 – 20 = 10 g

MgO formed = $\frac{80}{48}\times30 = 50$ g

79. **(D)** CCl_4 has tetrahedral, symmetrical structure, hence does not show dipole moment.

80. **(C)** Boron halides, BX_3 have only six electrons (three from B atom and three from three halogen atoms) around central B atom and thus B octet is not complete. Hence, boron halides behave as electron deficient compounds or Lewis acids.

81. **(A)**

	A	+ 2 B	$\rightleftharpoons$ C
Initial moles	1	0.5	
Moles at eqm.	0.9	0.3	0.1
Molar concs.	0.3	0.1	0.1/3

$$K = \frac{0.1/3}{0.3\times(0.1)^2} = 11.11$$

82. **(B)** Here, IE_2 involves the removal of an electron from the inert gas configuration ($1s^2\ 2s^2\ p^6$)

83. **(C)** $PbS + 4\ H_2O_2 \rightarrow PbSO_4 \downarrow + 4H_2O\ (l)$

84. **(C)** The boiling points of benzene (353 K) and chloroform (334 K) differ by 19° and hence can be separated by distillation.

85. **(B)** Given

Amount of the gas, n = 4.0 mol

Volume of the gas, V = 5 dm^3

Pressure of the gas, P = 3.32 bar

R = 0.083 bar $dm^3\ K^{-1}\ mol^{-1}$

From the gas equation, PV = nRT

$$T = \frac{PV}{nR} = \frac{3.32\ \text{bar} \times 5\ \text{dm}^3}{4.0\ \text{mol} \times 0.083\ \text{bar dm}^3\text{K}^{-1}\text{mol}^{-1}} = 50\ \text{K}$$

86. **(B)** Eqm. const. is constant at constant temperature.

87. **(A)** $MgSO_4 . 7\ H_2O$. Because of smaller size, Mg^{2+} ions are extensively hydrated.

88. **(C)** The process (C) cannot go by itself after initiation.

89. **(B)** Graphite is thermodynamically, the most stable allotrope of carbon. That is why $\Delta_f H°$ (graphite) is taken as zero.

$\Delta_f H°$ (diamond) = + 1.90 kJ mol^{-1}

$\Delta_f H°$ (fullerene) = + 38.1 kJ mol^{-1}

90. **(B)** Heterocyclic and aromatic, i.e., furan.