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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION - UN412

Solutions for Class : 11 (PCB)

Biology

1. **(B)** Helminthology – Study of worms

   Entomology – Study of insects

   Ornithology – Study of birds

   Phycology – Study of algae

2. **(B)** The statement 'Omnis cellula e cellula' was made by Rudolf Virchow (1821-1902), German professor of pathological anatomy at Berlin.

3. **(C)** Ivan P. Pavlov (1910) demonstrated conditioned reflex in dog.

4. **(A)** Polio is a viral disease, Tuberculosis, typhoid and diphtheria are bacterial diseases.

5. **(B)** Animals in lower hierarchy possess more characters in common.

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

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

8. **(A)** In 4 hours duration, 256 cells will be produced. A bacterial cell produces 2 cells in just 30 minutes, 4 cells in one hour, 8 cells in one hour and 30 minutes, 16 cells in 2 hours, 32 cells in two and half hours, 64 cells in 3 hours, 128 cells in three hours and 30 minutes and thus 256 cells in four hours.

9. **(B)** Autotrophic nutrition is not generally observed in animals.

10. **(A)** Volvox 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.

11. **(C)** The bordeaux mixture is a fungicide. It is prepared by using cupric sulphate with lime and water and is a potent killer for most of the pathogenic fungi of crop plants.

12. **(A)** A zygospore of Spirogyra produces only one filament hence 100 zygospores can produce only 100 filaments.

13. **(A)** In gymnosperms, trees are very common (Cycas, Pinus, Abies, Picea, 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 gymnopserms. They are always perennial and long lived.

14. **(B)** Dicot stem is characterized by having vascular bundles, as seen in Achyranthus, Amaranthus, Boerhaavia, Baugainvellia, Mirabilis, etc). In Peperomia, (-a dicot plant) vascular bundles are scattered (abnormal nature) in stem.

15. **(B)** Number of microsporangia in monothecous anthers is only two and in dithecous anthers, four.

16. **(C)** The seeds of Abrus precatorius are used as "Jeweller's weight" as their weight is always one 'Ratti'.

17. **(B)** Glowworm, silkworm, housefly and bedbug are insects. All belong to the class Insecta of the phylum Arthropoda.

18. **(A)** The sponges are "multicellular grade" organisms, do not possess tissues.

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

20. **(B)** Silverfish (Lepisma) is a wingless, primitive insect. It is a common small household pest.

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

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

23. **(D)** Ascaris is monogenetic; its infection is through contaminated food and water.

24. **(B)** Filariasis is a disease caused by a nematode.

25. **(C)** Phagocytes are the largest cells with membranous folds, chloragogen cells are small cells having yellowish granules, circular cells are cells with characteristic marking on the surface and mucocytes are elongated cells.

26. **(B)** Spider, scorpion and tick belong to class Arachnida.

27. **(C)** Tracheae are respiratory organs of silkworm, bedbug and sandfly, hence they belong to tracheate group.

28. **(A)** The uneven growth during the embryonic development rotates the visceral organs upto 180° in gastropods. Hence, in gastropods, the anus and mantle cavity are placed anteriorly above the head.

29. **(A)** Acinonyx jubatus, commonly called cheetah, has gone extinct in recent times in India due to the rapid destruction of its habitat, high rate of mortality of the cubs and killing by hunters. Complete failure of its breeding in capativity is another factor for its extinction.

30. **(B)** Concentric and closed vascular bundles are found only in some monocots like Yucca and Dracaena stems.

31. **(A)** Insectivory develops only when the plants grow in nitrogen deficient soil or medium. If nitrogen is made available to them in appreciable quantity, they do not exhibit insectivory, do not produce pitchers or bladders to trap insects and then behave in a normal manner.

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

33. **(B)** Lodicules of Poaceae are reduced perianth which are represented by two creamish white outgrowths only.

34. **(A)** Carrot is rich in vitamin A

35. **(C)** In amphitropous ovules, the embryo is horse shoe shaped.

36. **(B)** Haversian canals are found in the long bone of a mammal, e.g., radius.

37. **(B)** Deficiency of iron results in microcytic anaemia.

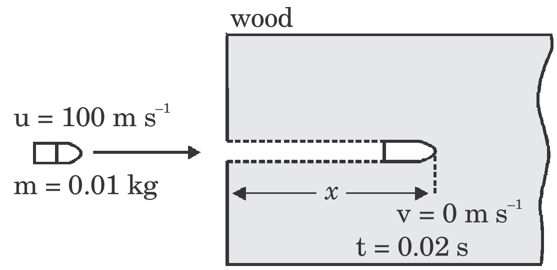
38. **(C)** Neutrophils and monocytes in the blood are phagocytic.

39. **(D)** The nodes of Ranvier represent the space between adjacent units of myelination. They increase the efficiency of nerve conduction because energy-dependent Na^+ influx is limited to only the nodal regions.

40. **(B)** Bats and whales are classified as mammals because of the presence of mammary gland, they give birth to young and suckle their young ones.

Physics

41. **(B)**



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

$a = ?$ $\quad$ $t = 0.02\ s$

$v = u + at$

$0 = 100 + a \times 0.02$

$0.02\ a = -100$

$a = -100 / 0.02$

$a = -5000\ m\ s^{-2}$

A bullet penetrating a wooden block

$F = ?$ $\quad$ $m = 0.01\ kg$ $\quad$ $a = -5000\ m\ s^{-2}$

$F = ma$

$F = 0.01 \times (-5000)$

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

42. **(A)** $T_1 = 27 + 273 = 300\ K$

$T_2 = -13 + 273 = 260\ K$

Coefficient of performance =

$$\frac{T_2}{T_1 - T_2} = \frac{260}{300 - 260} = \frac{260}{40} = 6.5$$

43. **(B)** On the surface of the earth

$g = \frac{GM}{R^2}$; Weight mg = 99 N

At a height h above the earth

$$g' = \frac{GM}{(R+h)^2}, \text{ where } h = \frac{R}{2}$$

$$\frac{g'}{g} = \frac{R^2}{(R+h)^2} = \frac{R^2}{\left(R + \frac{R}{2}\right)^2} = \frac{R^2}{\frac{9}{4}R^2}$$

$$g' = \frac{4g}{9}$$

$$\text{Weight} = mg' = m \times \frac{4g}{9} = mg \times \frac{4}{9}$$

$$\text{Here } mg = 99\ N = 99 \times \frac{4}{9} = 44\ N$$

44. **(B)** Mean diameter =

$$\frac{0.39 + 0.38 + 0.39 + 0.41 + 0.38 + 0.37 + 0.40 + 0.39}{8}$$

$\bar{d} = 0.38875$ mm

= 0.39 mm (rounded off to two significant figures)

Absolute error in the first reading =

0.39 – 0.39 = 0.00 mm

Similarly finding the absolute error in the other seven readings and taking the mean;

Mean absolute error = $\overline{\Delta d}$ =

$$\frac{0.00+0.01+0.00+0.02+0.01+0.02+0.01+0.00}{8}$$

= 0.00875 = 0.01 mm

Relative error = $\frac{\overline{\Delta d}}{d} = \frac{0.01}{0.39} = 0.0256$

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

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

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

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

46. **(B)** A raw egg behaves like a spherical shell and a half boiled egg behaves like a solid sphere.

$\therefore \frac{I_r}{I_s} = \frac{2/3\ MR^2}{2/5\ MR^2} = \frac{5}{3} > 1$

47. **(B)** $x_1 = 30 \times \frac{1}{2}$ km, $x_2 = 50 \times \frac{1}{2}$ km

$x = x_1 + x_2 = 40$ km

$v = \frac{x}{t} = \frac{40\text{ km}}{1\text{ h}} = 40\text{ km h}^{-1}$

48. **(C)** Mass m = 1500 kg, h = 50 m

t = 2 × 60 = 120 s

Power = $\frac{W}{t} = \frac{mgh}{t} = \frac{1500 \times 9.8 \times 50}{2 \times 60}$

= 6125 W

Power of the engine operating the lift

$= \frac{100 \times 6125}{75} = 8166.67$ W

49. **(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.

50. **(B)** Here $\frac{\Delta t}{t} = \frac{1}{10^{11}}$

$\Delta t = \frac{1}{10^{11}} \times t = \frac{1}{10^{11}} \times 10^{11} = 1$

or $\Delta t = 1$ s

Hence, maximum difference in time between two such clocks = 2 s

One may be 1 s faster and the other may be 1 s slower.

51. **(D)** $\frac{4S}{r_1} - \frac{4S}{r_2} = \frac{4S}{r}$

or $\frac{1}{r} = \frac{1}{r_1} - \frac{1}{r_2} = \frac{1}{4} - \frac{1}{5} = \frac{1}{20}$ or r = 20 cm

52. **(B)** As no external torque acts on the system, the angular momentum L is conserved. As the beads slide down, the moment of inertia of the system shall change. As L = I ω = constant and I changes, therefore, ω would change. As no work is being done, total energy cannot change.

53. **(C)** $a = \frac{dm}{dt} = -10\text{ kg s}^{-1}$, $V_r = 5$ km s^{-1} (5000)

M = 1500 kg, t = 50 s

$\frac{10 \times 5000}{1500 - 10 \times 50} = 50\text{ m s}^{-2}$

54. **(A)** Here, m = 0.5 kg, v= 1.5 m s^{-1}

K = 50 N m^{-1}

x = ?

$\frac{1}{2}Kx^2 = \frac{1}{2}mv^2$

$x = v\sqrt{\frac{m}{K}} = 1.5\sqrt{\frac{0.5}{50}} = 0.15$ m

55. **(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

56. **(D)** Specific heat (in cal/g/°C) : Copper (0.09) Aluminium (0.21), Iron (0.11), Lead (0.03).

57. **(B)** Error in time period is

Δ T= (0.1/20)s = 0.005 s.

Also T = (20 s / 20) = 1s

Hence $\frac{\Delta T}{T} = \frac{0.005}{1} = 0.005 \times 100\% = 0.5\%$

58. **(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 $C_v = 2R$

59. **(A)** $g = \frac{GM}{R^2} = \frac{G}{R^2} \times \frac{4}{3}\pi R^3 \rho = \frac{4}{3}\pi GR\rho$,

i.e. $g \propto \rho$

$\therefore \frac{g'}{g} = \frac{2\rho}{\rho} = 2$

or $g' = 2g = 2 \times 9.8 = 19.6 \text{ m s}^{-2}$

60. **(C)** $\upsilon = \frac{m_1u_1 + m_2u_2}{m_1 + m_2} = \frac{40 \times 4 + 60 \times 2}{40 + 60}$

$= 2.8 \text{ m s}^{-1}$

Loss in K.E. =

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

$\frac{1}{2}\left[40 \times 16 + 60 \times 4 - 100 \times 2.8^2\right] = 48 \text{ J}$

61. **(A)** Temperature of source =

$T_1 = 100 + 273 = 373$ K

Temperature of sink =

$T_2 = 30 + 273 = 303$ K

Efficiency = $\eta = \frac{T_1 - T_2}{T_1}$

$= \frac{373 - 303}{373} = 0.188 = 18.8\%$

62. **(A)** The vertical displacement of the two stones and their initial velocities are the same. So, the final velocity acquired by them should also be equal.

For the stone thrown vertically upwards

$a = -g, \quad s = -h$

$v_1{}^2 = u^2 + 2as$

$v_1{}^2 = u^2 + 2(-g)(-h) = u^2 + 2gh$

For the stone thrown vertically downwards,

$a = +g, s = h$

$v_2{}^2 = u^2 + 2gh$

$\frac{v_1{}^2}{v_2{}^2} = \frac{u^2 + 2gh}{u^2 + 2gh} = 1$

$v_1 : v_2 = 1 : 1$

63. **(C)** Time taken in reaching bottom of incline is

$t = \sqrt{\frac{2l\left(1 + K^2/R^2\right)}{g \sin\theta}}$

For solid cylinder (SC), $K^2 = R^2/2$

For hollow cylinder (HC), $K^2 = R^2$

For solid sphere (S), $K^2 = \frac{2}{5}R^2$

$\therefore t_S < t_{SC} < t_{HC}$

64. **(B)** Here $dx_1 = dx_2$, $A_1 = A_2$, $\frac{K_1}{K_2} = \frac{2}{3}$

Let θ be the temp. of the junction.

As $\frac{dQ_1}{dt} = \frac{dQ_2}{dt}$

$\therefore K_1A_1\frac{dT_1}{dx_1} = K_2A_2\frac{dT_2}{dx_2}$

$K_1 = (100 - \theta) = K_2(\theta - 0)$

or $\frac{K_1}{K_2} = \frac{\theta}{100 - \theta} = \frac{2}{3}$

$3\theta = 200 - 2\theta$; $5\theta = 200$; $\theta = 40\,^\circ$C

65. **(C)** $m = 3$ kg, $u = 10 \text{ m s}^{-1}$, $v = 0$

Impulse = $F \times t$ = ?

Impulse = Change in momentum

$F \times t = m(v - u)$

$= 3[0 - 10] = -30$ N s

Chemistry

66. **(C)** The set of elements given in options (A), (B) and (D) have decreasing atomic radius.

Atomic radius in ($\mathring{A}$)

Oxygen 0.73

Sulphur 1.09

Selenium 1.16

Tellurium 1.35

As the atomic number increases within a group, the atomic size increases accordingly.

67. **(D)** All the alkali metals and their salts impart colour to bunsen flame. The colours imparted by different alkali metals are as follows.

Element	Li	Na	K	Rb	Cs
Colour	Crimson red	Golden yellow	Pale violet	Red violet	Bluish

When heat energy is supplied to alkali metal atom or ion in salt, the electronic excitation occurs in which electron jumps to higher energy level. When this excited electron de-excites to ground state, the energy is emitted in the form of electromagnetic radiation which lies in visible region thereby imparting colour to the flame. The colour of flame depends upon the wavelength of radiation emitted e.g., yellow D-line of Na-spectra arises from $3s^1 \rightarrow 3p^1$ transition.

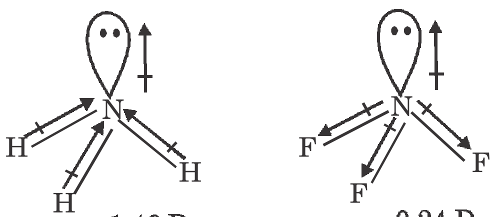
68. **(A)** $CO = N_2 = w\ g \therefore n_1(CO) = \frac{w}{28}$

$n_2(N_2) = \frac{w}{28}$. Hence, $P_{N_2} = P_{CO}$

*69. **(C)**

70. **(D)** Only coloured salts will form coloured metal metaborates.

71. **(B)** BF_3 is triangular planar and B_2H_6 is a dimer of triangular planar molecule (BH_3), therefore, both of these have zero dipole moment. NH_3 and NF_3 , on the other hand have pyramidal structures and thus have dipole moments.



μ = 1.46 D μ = 0.24 D

In NH_3, the dipole moments of the three N–H bonds reinforce the dipole moment due to lone pair of electrons but in NF_3, the dipole moments of the three N–F bonds oppose the dipole moment due to lone pair of electrons. As a result, dipole moment of NH_3 (μ = 1.46 D) is higher than that of NF_3 (μ = 0.24 D).

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

$\Delta t = (300.78\ K - 294.05\ K) = 6.73\ K$

Heat capacity of the calorimeter = $8.93\ kJ\ K^{-1}$

Then,

Heat transferred to calorimeter =

Heat capacity of calorimeter $\times$ Rise in temperature

$= 8.93\ kJ\ K^{-1} \times 6.73\ K$

$= 60.1\ kJ$

73. **(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.

74. **(A)** 2-Ethylanthraquinol $\rightarrow$ 2-Ethylanthraquinone + $2H_2O_2$

75. **(C)** $K_c = \frac{[NO]^2}{[N_2O_4]} = \frac{(1.2\times10^{-2}\ mol\ L^{-1})^2}{4.8\times10^{-2}\ mol\ L^{-1}}$

$= 3 \times 10^{-3}\ mol\ L^{-1}$

76. **(A)** $C : H = \frac{12\times100}{13\times12} = \frac{1\times100}{13\times1} = 1 : 1$

$\therefore$ E.F. = CH

Since, P decolourises Br_2–H_2O, but Q does not, therefore, $P = C_2H_2$ (acetylene) and $Q = C_6H_6$ (benzene).

77. **(B)** According to Fajan's rule, the covalent bonding is maximum when W^+ is small and X^- is large.

78. **(A)** $TiH_{1.73}$ is a non-stoichiometric metallic or interstitial hydride.

79. **(A)** Except lime (50 – 60%), the major constituent of cement is silica (20 – 25%).

80. **(D)** (a) It is exact neutralisation. Hence, pH = 7.

(b) After neutralisation, $\frac{M}{10}$ HC*l* left = 10 m*l*.
Total volume = 100 m*l*
Dilution = 10 times.
$\therefore [H^+] = 10^{-2}$
or pH = 2

(c) After neutralisition, $\frac{M}{10}$ NaOH left = 80 m*l*.
Total volume = 100 m*l*. pH > 7.

(d) After neutralisation, $\frac{M}{5}$ HC*l* left = 50 m*l*.
Total volume = 100 m*l*
Dilution = 2 times

$\therefore [H^+] = \frac{1}{10} = 10^{-1}$ M or pH = 1

81. **(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.

82. **(A)** Structure of B_2H_6 contains four 2c - 2e bonds

*69. **(C)** The sum of mass % is 99.8. Hence, there is no oxygen in the given compound.

Element	Mass %	Atomic mass	Atomic ratio	Simplest ratio	Simplest whole number ratio
C	64.4	12	64.4 / 12 = 5.37	5.37 / 0.53 = 10.1	10
H	5.5	1	5.5 / 1 = 5.5	5.5 / 0.53 = 10.4	10
Fe	29.9	56	29.9 / 56 = 0.53	0.53 / 0.53 = 1	1

Thus, the empirical formula of the compound is $C_{10}H_{10}Fe$.

and two 3c – 2e bonds.

83. **(C)** Molar mass of acetylene (C_2H_2),

$M = (2 \times 12 + 2 \times 1)$ g/mol = 26 g/mol

Mass of acetylene, m= 5.0 g

Temperature, T = (50 °C + 273) = 323 K

Pressure, P = 740 mm Hg = $\frac{740}{760}$ atm

= 0.9737 atm

Using the gas equation,

$$PV = nRT = \frac{m}{M} RT$$

$$V = \frac{m\,RT}{M\,P}$$

$$\frac{5.0\,g \times 0.082\ L\,atm\,K^{-1} mol^{-1} \times 323\,K}{26\ g\ mol^{-1} \times 0.9737\ atm}$$

= 5.23 L

84. **(A)** $c = v\lambda$ or $\lambda = \frac{c}{v} = \frac{3\times10^{8}\,m\ s^{-1}}{589\times10^{-9}\,m}$

$= 5.1 \times 10^{14}\ s^{-1}$ (or Hz)

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

86. **(D)** I has the tendency to lose as well as gain electrons. Oxidation states of

Cs = +1

F = –1, 0

Xe = Nil

I = –1, 0, +1, +3, +5, +7

87. **(A)** NH_4^+ is a conjugate acid of the base NH_3.

88. **(B)** Cs with low IE is used in photoelectric cells.

89. **(C)** For PCl_3,

$$X = \frac{1}{2} = [VE + MA - c + a]$$

$$\frac{1}{2}[5 + 3 - 0 + 0] = 4$$

∴ Hybridization of P in PCl_3 is sp^3 .

For PCl_5.

$$X = \frac{1}{2}[5 + 5 - 0 + 0] = 5$$

∴ Hybridization of P in PCl_5 is sp^3d.

90. **(B)** Due to the poor shielding (screening) effect of d-electrons in case of Ga, the valence electrons are attracted more strongly and hence, the size is not increased.

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