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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION

CLASS - 11 (PCB)

Question Paper Code : UN494

KEY

1. B	2. B	3. D	4. D	5. C	6. A	7. A	8. C	9. B	10. B
11. A	12. D	13. C	14. A	15. D	16. C	17. B	18. A	19. B	20. B
21. A	22. B	23. C	24. B	25. D	26. C	27. C	28. C	29. B	30. B
31. B	32. D	33. C	34. C	35. D	36. C	37. B	38. A	39. A	40. B
41. C	42. D	43. A	44. D	45. C	46. B	47. A	48. A	49. D	50. D
51. B	52. C	53. B	54. B	55. C	56. C	57. A	58. D	59. B	60. B

SOLUTIONS

BIOLOGY

01. (B) Casparian bands occurs in Endodermis.

02. (B) P-i, Q-iv, R-ii, S-iii

03. (D) Viruses are obligate parasites.

04. (D) Chondrichthyes : possess cartilaginous endoskeleton.

05. (C) During a cardiac cycle, each ventricle pumps out approximately 70mL of blood, thus, both the ventricles pump out same volume of blood in each cardiac cycle.

06. (A) Heartwood is dead and have non-conducting elements.

07. (A) Starch, glycogen, cellulose.

08. (C) R→Q→P→T→S

These are the five phases of prophase I of Meiosis I based on the chromosomal behaviour.

09. (B) They make the soil porous, leave their castings and take organic debris in the soil.

10. (B) Folic acid and cobalamin

11. (A) In grasses, adaxial epidermal cells along the veins modify themselves into large, empty, colourless cells. These are called bulliform cells. When there is water stress leaves curl themselves inward to minimise water loss. When the cells have absorbed water and are turgid, the leaf surface is exposed.

12. (D) Centriole.

13. (C) Five Kingdom Classification.

14. (A) External intercostal muscles and diaphargm relax.

15. (D) The enzymes of the electron transfer chain are embedded in the outer membrane.

16. (C) There are of three main types-cytotoxic T-cells, helper T-cells and suppressor Tcells.

17. (B) P $\rightarrow$ iii, Q $\rightarrow$ i, R $\rightarrow$ ii, S $\rightarrow$ v, T $\rightarrow$ iv

18. (A) Represents the correct ascending order of cell's size. Cells in organism vary greatly in their size, shapes and activities. I. Mycoplasmas are the smallest cell with size only 0.3mm. II. Bacterial cell are of size 30-5 p,m. III. In human red blood cells are of about 7.0 p-m in diameter. IV. Ostrich eggs are among the largest cells with size (15 × 13) cm. Mycoplasma like Organisms (MLOs) or mycoplasma are the smallest cell followed by the size of bacterial cell, then RBCs and ostrich egg cell is the largest known cell.

19. (B) Adrenocorticotrophic hormone.

20. (B) Amphibians have three-chambered heart, while reptiles have incomplete four-chambered heart (except crocodiles). Crocodiles, birds and mammals have complete, four-chambered heart.

21. (A) Nucleus, cytoplasm.

22. (B) One scientific name consisting of a generic and a specific name.

23. (C) Oxygen carrying capacity of haemoglobin decreases.

24. (B) 1-A, 2-D, 3-B, 4-C

25. (D) Wuchereria — filariasis.

PHYSICS

26. (C) Average speed is never less than average velocity. Average velocity of a particle moving once around a circle can be zero but instantaneous velocity is never zero in the interval.

Average velocity of a particle moving on a straight line is never zero.

When a particle is in vertical motion, then at the highest point, the instantaneous velocity of the particle is zero but the acceleration is not zero.

27. (C) Impulse delivered to the ball = F × t

= Area enclosed by the force-time graph with the x-axis.

$= \frac{1}{2} \times 1.5 \times 1750$

= 1312.5 N s

The average force exerted on the ball

$= \frac{\text{Impulse}}{\text{Time}} = \frac{1312.5}{1.5} = 875\ \text{N}$

28. (C) The graph between applied force and extension will be straight line because in elastic range,

Applied force $\propto$ extension,

But the graph between extension and stored elastic energy will be parabolic in nature.

As, $U = \frac{1}{2} kx^2$ or $U \propto x^2$

29. (B) $mgh = \frac{1}{2} I\omega^2 + \frac{1}{2} mv^2$

$= \frac{1}{2} I\omega^2 + \frac{1}{2} mr^2\omega^2 = \frac{\omega^2}{2}[I + mr^2]$

$\omega = \left[\frac{2mgh}{I+mr^2}\right]^{1/2}$

30. (B) Mean diameter

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

$$\bar{d} = 0.38875 \text{ mm}$$

= 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

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

31. (B) $\vec{A}+\vec{B}$ is the resultant of $\vec{A}$ and $\vec{B}$. Let $|\vec{A}| = |\vec{B}| = x = |\vec{A}+\vec{B}|$, $x^2 = x^2 + x^2 + 2x^2 \cos\theta$, $\cos\theta = -1/2$, $\theta = 120°$

When $\vec{R} = \vec{A}-\vec{B} = x$, $x^2 = x^2 + x^2 - 2x^2 \cos\theta$, $\cos\theta = +1/2$, $\theta = 60°$

32. (D) The acceleration due to gravity at a depth d inside the earth is

$$g' = g\left(1-\frac{d}{R}\right) = g\left(\frac{R-d}{R}\right) = g\frac{r}{R}$$

Where, R – d = r = distance of a place from the centre of earth. Therefore 'g'αr.

33. (C) We can assume that the process is isothermal because the temperature of the surrounding remains constant

So, by applying Boyle's law

$P_s V_s = P_d V_d$ ..... (I)

Where s = surface of water

d = depth

Given that Depth of lake = h

Volume $V_s = 3V_d$

P_s = 75 cm Hg

$$P_d = 75 + \frac{h}{10}$$

Put the value of equation (1)

$$75 \times 3 = 75 + \frac{h}{10}$$

$$225 - 75 = \frac{h}{10}$$

h = 1500 cm

h = 15 m

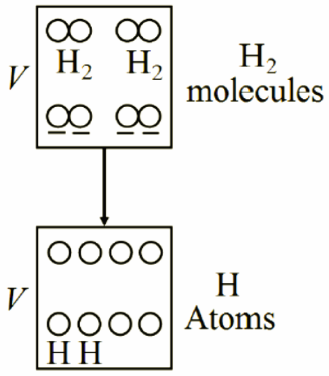
Hence, the depth of lake is 15 m

34. (C) The work done by a variable force is defined as $W = \int \vec{F}.d\vec{s}$

- It may or may not depend on the path followed.
- It is always dependent on the initial and final positions.

35. (D) The situation is shown in the diagram given below. H_2 gas is contained in a box is heated and gets converted to a gas of hydrogen atoms. Then the number of moles would become twice.

According to gas equation, PV = nRT



P = Pressure of gas, n = Number of moles

R = Gas constant, T = Temperature PV = nRT

As volume (V) of the container is constant.

Hence, when temperature (T) becomes 10 times, (from 300K to 3000K) pressure (P) also becomes 10 times, as P ∝ T.

Pressure is due to the bombardment of particles and as gases break, the number of moles becomes twice of initial, so $n_2 = 2n_1$

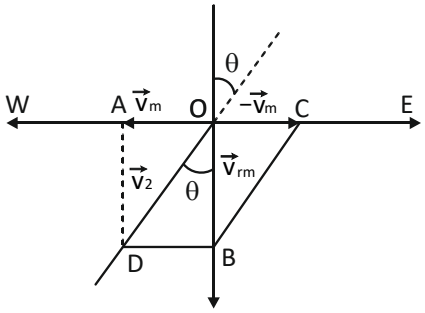
So, P ∝ nT

$$\Rightarrow \frac{P_2}{P_1} = \frac{n_2 T_2}{n_1 T_1} = \frac{(2n_1)(3000)}{n_1(300)} = 20$$

$\Rightarrow P_2 = 20\ P_1$

Hence, final pressure of the gas would be 20 times the pressure initially.

36. (C) Observe the figure given below.



$\vec{v}_m$ = 6 km/h due west = $(\overrightarrow{OA})$

$\vec{v}_{rm}$ = 6 km/h vertically downwards

= $(\overrightarrow{OB})$

Let $\vec{v}_r$ = true velocity of rain. It must be represented by $(\overrightarrow{OD})$

$$\therefore \vec{v}_{rm} = \vec{v}_r + (-\vec{v}_m)$$

$$\text{or } \vec{v}_r = \vec{v}_{rm} - (-\vec{v}_m) = (\vec{v}_{rm} + \vec{v}_m)$$

$$= (\overrightarrow{OB}) + (\overrightarrow{OA}) = (\overrightarrow{OD})$$

where OD = $\sqrt{6^2 + 6^2}$

$= 6\sqrt{2}$ km/h

If $\angle BOD = \theta$, then

$$\tan\theta = \frac{BD}{OB} = \frac{6}{6} = 1 = \tan 45°$$

or $\theta = 45°$

$\therefore$ velocity of rain is $6\sqrt{2}$ km/h at angle 45° with the vertical towards east.

37. (B) Let us assume that $T_1 > T_2, T_3$ and $T_1 > T > T_2, T_3$

Now heat loss by M_1 = Heat gained by M_2 and M_3

$M_1 S(T_1 - T) = M_2 S(T - T_1) + M_3 S(T - T_3)$

$\Rightarrow$ $M_1 T_1 + M_2 T_2 + M_3 T_3 = (M_1 + M_2 + M_3)T$

$$\Rightarrow T = \frac{M_1 T_1 + M_2 T_2 + M_3 T_3}{M_1 + M_2 + M_3}$$

38. (A) Escape velocity from the surface of Mars.

$$v = \sqrt{\frac{2GM_m}{R_m}}$$

Mass of Mars = $M_m = 6.42 \times 10^{23}$ kg

Radius of Mars = $R_m = 3.375 \times 10^6$ m

$$v = \sqrt{\frac{2GM_m}{R_m}} = \sqrt{\frac{2 \times 6.67 \times 10^{-11} \times 6.42 \times 10^{23}}{3.375 \times 10^6}}$$

$= 5.037 \times 10^3$ m/s

39. (A) $T = P^a D^b S^c$

So, $[T] = [M^0 L^0 T^1] = [ML^{-1}T^{-2}][ML^{-3}]^b[MT^{-2}]^c$

$= [M^{a+b+c} L^{-a-3b} T^{-2a-2c}]$

Applying principle of homogeneity

$a + b + c = 0$; $-a - 3b = 0$; $-2a - 2c = 1$

On solving, we get $a = -\frac{3}{2}$, $b = \frac{1}{2}$, $c = 1$

40. (B) Friction is absent. Therefore, mechanical energy of the system will remain conserved. From constraint relations we see that speed of both the blocks will be same. Suppose it is v. Here gravitational potential energy of 2 kg block is decreasing while gravitational potential energy of 1 kg block is increasing. Similarly, kinetic energy of both the blocks is also increasing.

Decrease in gravitational potential energy of 2 kg block = increase in gravitational potential energy of 1 kg block + increase in kinetic energy of 1 kg block + increase in kinetic energy of 2 kg block.

$$m_Q gh = m_P gh + \frac{1}{2} m_P v^2 + \frac{1}{2} m_Q v^2$$

or $(2)(10)(1) = (1)(10)(1) + \frac{1}{2}(1)v^2 + \frac{1}{2}(2)v^2$

or $20 = 10 + 0.5\,v^2 + v^2$

or $1.5\,v^2 = 10$

$\therefore$ $v^2 = 6.67\ m^2/s^2$

or $v = 2.58$ m/s

CHEMISTRY

41. (C) When an electron is added to O^- anion, there is strong electrostatic repulsion between the two negative charges. Due to this, the second electron gain enthalpy of oxygen is positive.

Thus, process of formation of O^{2-} in gas phase is unfavourable even though O^{2-} is isoelectronic with neon. It is due to the fact that electron repulsion outweighs the stability gained by achieving noble gas configuration.

42. (D) Higher the critical temperature, more easily is the gas liquefied. Hence, the order of liquefaction of given gases with the gas liquefying first will be O_2, N_2, H_2, He.

43. (A)

	$CH_3COOH + H_2O \rightleftharpoons H_3O^+ + CH_3OOH^-$		
Initial conc.	0.01	0	0
At equilibrium	$0.01 - x$	x	x

$$K_a = \frac{\left[H_3O^+\right]\left[CH_3COO^-\right]}{\left(CH_3COOH\right)} = \frac{x^2}{0.01 - x}$$

Since $x << 0.01$,

Therefore, $0.01 - x \approx 0.01$

$$\frac{x^2}{0.01} = 1.74 \times 10^{-5}$$

$x^2 = 1.74 \times 10^{-7}$ or $x = 4.2 \times 10^{-4}$

pH = $-\log(4.2 \times 10^{-4}) = 3.4$

44. (D) As we know that

Number of atoms = Mol. $\times N_A$

Number of moles = $\frac{\text{Wt.}}{\text{Mol.wt.}}$

1. 4g He = $\frac{4}{4}$ – 1 mole
2. 46g Na = $\frac{46}{23}$ = 2 moles
3. 0.40g Ca = $\frac{0.40}{40}$ = 0.01 mole
4. 12g He = $\frac{12}{4}$ = 3 moles

Hence, 12 g of He contains the greatest number of atoms at it contains maximum number of moles.

45. (C) The second period elements of p-block starting from boron are restricted to a maximum covalency of four (using one 2s and three 2p orbitals).

46. (B) Isostructural pairs that have the same shape and hybridisation are given in option (B).

NF_3 is pyramidal whereas BF_3 is planar triangular.

BF_4^- and NH_4^- ions both are tetrahedral.

BCl_3 is triangular planar whereas $BrCl_3$ is pyramidal.

NH_3 is pyramidal whereas NO_3 is triangular planar.

47. (A) $Be(OH)_2$ being an amphoteric hydroxide reacts with both alkalies and acids as given below.

$Be(OH)_2 + 2NaOH \rightarrow Na_2BeO_2 + 2H_2O$

$Be(OH)_2 + 2HCl \rightarrow BeCl_2 + 2H_2O$

48. (A) H_2O_2 acts as an oxidising as well as reducing agent because oxidation number of oxygen in H_2O_2 is –1.

Rest of the given statements are correct.

49. (D) Boiling point of a liquid is directly proportional to atmospheric pressure. Shimla has the lowest atmospheric pressure. Hence, the liquid in Shimla will boil first.

50. (D) Highest O.N. of any transition element = (n – 1)d electrons +ns electrons. Therefore, larger the number of electrons in the 3d orbitals, higher is the maximum O.N.

(A) $3d^1 4s^2 = 1 + 2 = 3$

(B) $3d^3 4s^2 = 3 + 2 = 5$

(C) $3d^5 4s^1 = 5 + 1 = 6$

(D) $3d^5 4s^2 = 5 + 2 = 7$

Hence, the element with outer electronic configuration of $3d^5 4s^2$ exhibits largest oxidation number.

51. (B) According to the first law of thermodynamics,

$\Delta E = q + W = 500 + (-350) = +150$ cal

52. (C) sp-hybridisation involves the mixing of one s and one p-orbital resulting in the formation of two equivalent sp-hybrid orbitals. The suitable orbitals for sp-hybridisation are s and P_z, if the hybrid orbitals lie along the z-axis.

53. (B) Solubility of metal halides in water depends on lower lattice enthalpy and hydration enthalpy. In case of LiF, the lowest solubility in water is due to its very high lattice enthalpy.

54. (B) As per De Broglie equation

$$\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34}}{1.67 \times 10^{-27} \times 1 \times 10^{3}}$$

$= 3.97 \times 10^{-9}$m = 0.40 nm

55. (C) When the electrophile attacks $CH_3 - CH = CH_2$, delocalisation of electrons can take place in two possible ways.

$CH_3 - CH = CH_2 + H^+ \rightarrow CH_3 - CH - CH_3$ (2° carbocation)

$CH_3 - CH_2 - \overset{\oplus}{C}H_2$ (1° carbocation)

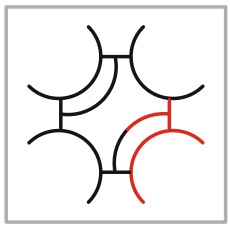
As 2° carbocation is more stable than 1° carbocation, the first addition is more feasible.

CRITICAL THINKING

56. (C) The ladder in picture R is the least stable or most likely to slip.

57. (A) Suspension of trade agreements between the two countries directly correlates with an economic impact.

58. (D)



59. (B) Given the rules, let's first list down the contacts.

1. B contacts E, contacted by C.
2. D contacted by A, E, F.
3. F contacts C, contacted by A.
4. D contacts C and E.

Now, to relay a message from A to B:

Starting with A, we see the robots A can directly contact or who can contact A. From the rules, A can contact D and F. B can only be contacted by C, so our goal is to find the shortest path from A to C.

Using the given rules:

$A \rightarrow D \rightarrow C$ (A contacts D and D contacts C)

OR

$A \rightarrow F \rightarrow C$ (A contacts F and F contacts C)

Both paths have two robots between A and B (either D and C or F and C).

Therefore, the minimum number of robots required between robot A and robot B to send a message is 2.

60. (B)