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UNIFIED COUNCIL OLYMPIADS

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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION

CLASS - 12 (PCB)
Question Paper Code : UN484

KEY

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

SOLUTIONS

BIOLOGY

01. (B) Multiple sclerosis is an auto-immune disease in which the immune system attacks the central nervous system, leading to demyelination. Disease onset usually occurs in young adults, and it is more common in females. It was first described in 1868 by Jean-Martin Charcot.

02. (B) 2-celled pollens represent a partially developed male gametophyte.

03. (C) Secondary nucleus is diploid, whereas, the endosperm nucleus is triploid in nature of all typical embryo sacs.

04. (A) Wolffian duct (also called as mesonephric duct) gives rise to epididymis.

05. (D) Glands of Skene (paraurethral glands) in female are homologous to prostate of male.

06. (B) Meiosis I results in the production of secondary oocytes before fertilization.

07. (C) Adult frog performs pulmonary respiration with the help of lungs.

08. (B) In human beings, curly hair is dominant and straight hair is recessive.

09. (C) Haploid contains only one set of genes either paternal or maternal.

10. (A) Adenine pair with uracil.

11. (C) Pribnow box conserved motifs are found in E-coli.

12. (A) The blood vessels and nerve enter ovary at hilus. The kidney also possesses a similar structure.

13. (D) Yellow fever is transmitted by mosquitoes.

14. (A) 40 divisions are required to produce 40 embryo sacs from megaspores. Megaspore mother cell when divide reductionally, it produces 4 megaspores. In monosporic development, three megaspores degenerate. In bisporic type development two megaspore nuclei degenerate and two remain functional. In tetrasporic type development, all the four megaspore nuclei remain functional but in all these three cases only one embryo sac is produced. Hence, for 40 embryo sacs, 40 reductional divisions are required.

15. (B) Two types of gametes produced are AbC and abC.

16. (B) Colchicine treatment is given toconvert haploid callus into diploid callus. Colchicine is an artificial polyploidizing agent capable of causing chromosomal doubling.

17. (A) Sir Richard Owen (1804-1892) was an English biologist, comparative anatomist and palaeontologst carried out studies on parthenogenesis.

18. (D) The central follicular cavity or antrum is lined by membrane granulosa.

19. (C) Hotspot is any region in a gene that mutates at very higher frequencies than neighbouring regions of the same gene.

20. (B) The unfertilized egg or zygote before cleavage is a single cell.

21. (A) Roux in 1885 demonstrated the formation of grey crescent opposie to the site of sperm entry in amphibian egg and marks the dorsal side of the developing embryo.

22. (C) Echinoderms such as starfish exhibit autotomy.

23. (C) Recessive gene can express only in homozygous condition.

24. (D) Mantoux test, after the French physician Charles Mantoux, is a tuberculin skin test.

25. (A) Salk vaccine is the Inactivated Polio Virus (IPV) vaccine recommended for infants and children to confer immunity to polio.

PHYSICS

26. (B) Molar mass of copper M = 63.5 gram = 63.5×10^{-3} kg

Density of copper $\rho = 9 \times 10^3$ Kg/m^3

No. of copper atoms per unit volume:

N = No. of moles in unit volume × No. of atoms in 1 mole (N_A) ...(1)

No. of moles in unit volume = $\dfrac{\text{Mass of unit volume}}{\text{Mass of one mole}}$

$$= \frac{\text{Density}}{\text{Molar Mass}} = \frac{\rho}{M}$$

Therefore, Using Equation (1), We get:

$N = \dfrac{\rho}{M} \times N_A$ Where $N_A = 6.023 \times 10^{23}$

$$\Rightarrow N = \frac{9 \times 10^3 \times 6.023 \times 10^{23}}{63.5 \times 10^{-3}} = 8.54 \times 10^{28}\ m^{-3}$$

One copper atom contributes one conduction electron.

So, No. of conduction electrons per unit volume = No. of copper atoms per unit volume

$\therefore n = N = 8.54 \times 10^{28}\ m^{-3}$

Given: Current I = 1.5 A, Cross sectional area $A = 1 \times 10^{-7}\ m^2$

We know that,

$I = neAv_d$

So, Drift Velocity $v_d = \dfrac{I}{neA}$

$\Rightarrow$ Vd =

$$\frac{1.5\text{ A}}{8.5\times10^{28}\times(1.6\times10^{-19}\text{ C})\times(10^{-7}\text{m}^{-2})}$$

$= 1.1 \times 10^{-3}$ m/s

27. (C) As the current is in the phase with the applied voltage, X must be R.

$$R=\frac{V_0}{I_0}=\frac{200\text{ V}}{5\text{ A}}=40\ \Omega$$

As current lags behind the voltage by 90°, Y must be an inductor.

$$X_L=\frac{V_0}{I_v}=\frac{200\text{ V}}{5\text{ A}}=40\ \Omega$$

In the series combination of X and Y,

$$Z=\sqrt{R^2+X_L^2}=\sqrt{40^2+40^2}=40\sqrt{2}\text{ ohm}$$

$$I_{rms}=\frac{V_{rms}}{Z}=\frac{V_0}{\sqrt{2}\,Z}=\frac{200}{\sqrt{2}\times(40\sqrt{2})}=\frac{5}{2}\text{A}$$

28. (B) Because of large permeability of soft iron, magnetic lines of force prefer to pass through it. Concentration of lines in soft iron bar increases as shown.

29. (D) Radius of the ring = a = 0.10 m

Total charge = q = 50×10^{-6} C

Distance = x = 0.10 m

(i) $$E=\frac{1}{4\pi E_0}\cdot\frac{qx}{(a^2+x^2)^{3/2}}$$

$$=\frac{9\times10^9\times50\times10^{-6}\times0.1}{(0.1^2+0.1^2)^{3/2}}=1.59\times10^7\text{ N/C}$$

(ii) When x = 100 cm = 1 m,

$$E=\frac{9\times10^9\times50\times10^{-6}\times0.1}{(0.1^2+1^2)^{3/2}}=4.45\times10^4\text{ N/C}$$

30. (C) $$v=\frac{c}{\lambda}=c.R\left(\frac{1}{n_1^2}-\frac{1}{n_2^2}\right)$$

$$=3\times10^8\times10^7\left(\frac{1}{2^2}-\frac{1}{4^2}\right)=\frac{9}{16}\times10^{15}\text{ Hz}.$$

31. (D) $$dB=\frac{\mu_0}{4\pi}\frac{Idl\sin\theta}{r^2}$$

$$=\frac{10^{-7}\times(5\times10^{-2})\times\sin45^\circ}{(2)^2}$$

$= 8.8 \times 10^{-10}$ T vertically downwards

32. (A) The object and its image always move in opposite directions.

$$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$$

Differentiating with respect to time, we get

$$-\frac{1}{v^2}\frac{dv}{dt}-\frac{1}{u^2}\frac{du}{dt}=0$$

Let $\frac{dv}{dt}=V$ (Velocity of image)

$\frac{du}{dt}=U$ (Velocity of object)

then $\frac{v}{u}=-\frac{v^2}{u^2}$

The negative sign shows that V and U are always oriented in opposite directions irrespective of the nature of the mirror.

33. (A) Each atom of ${}_6C^{14}$ contains 6 p, 6 e and 8 n

$\therefore$ In 14 gram of ${}_6C^{14}$

p = $6 \times 6 \times 10^{23} = 36 \times 10^{23}$

p = $8 \times 6 \times 10^{23} = 48 \times 10^{23}$

e = p = 36×10^{23}

34. (B) The cut-off wavelength of the continuous X-rays does not depend on the atomic number of the target but it depends on accelerating potential applied to the anode.

35. (B) Radius of the small drop = r = 0.02 m

Radius of the bigger drop = R = ?

Volume of one bigger drop = Volume of 64 small drops

$$\frac{4}{3}\pi R^3 = 64 \times \frac{4}{3}\pi r^3$$

$R^3 = 4^3 r^3$

R = 4r = 4 × 0.02 = 0.08 m

Total charge on the bigger drop = q = 64 × 0.5 × 10^{-6} = 32 × 10^{-6} C

Potential at the surface of the bigger drop

$$= \frac{q}{4\pi\varepsilon_0 R} = 9 \times 10^9 \times \frac{32 \times 10^{-6}}{0.08}$$

= 3.6 × 10^6 V

36. (C) The electromagnetic wave being packets of energy moving with the speed of light may pass through the region.

37. (B) As, $\phi_0 = \frac{hc}{\lambda_0}$; so $\frac{\phi_{0_T}}{\phi_{0_{Na}}} = \frac{\lambda_{Na}}{\lambda_T}$

or $\lambda_T = \lambda_{Na} \times \frac{\phi_{0_{Na}}}{\phi_{0_T}} = \frac{5460 \times 2.3}{4.5} = 2791$ Å

38. (D) $B_1 = \frac{\mu_0}{4\pi}\frac{2\pi ni}{r}$ and

$$B_2 = \frac{\mu_0}{4\pi}\frac{2\pi nir^2}{(r^2+h^2)^{3/2}} 80$$

$$\frac{B_2}{B_1} = \left(1 + \frac{h^2}{r^2}\right)^{-3/2}$$

Fractional decrease in the magnetic field will be

$$= \frac{B_1 - B_2}{B_1} = \left(1 - \frac{B_2}{B_1}\right)$$

$$= \left[1 - \left(1 + \frac{h^2}{r^2}\right)^{-3/2}\right]$$

$$= 1 - \left(1 - \frac{3h^2}{2r^2}\right) = \mathbf{\frac{3h^2}{2r^2}}$$

39. (B) From $s = ut + \frac{1}{2}at^2 = \frac{1}{2}at^2$ ($\because$ u = 0)

$t = \sqrt{\frac{2s}{a}}$ As s is same, $\because t \propto \frac{1}{\sqrt{a}}$

$$\frac{t_2}{t_1} = \sqrt{\frac{a_1}{a_2}} = \sqrt{\frac{q_e/M_e}{q_p/M_p}} = \sqrt{\frac{M_p}{M_e}}$$

40. (B) $e = \frac{Mdi}{dt} = \left(\frac{\mu_0 N_1 N_2 A}{l}\right)\frac{di}{dt}$

$$= \frac{4\pi \times 10^{-7} \times 2000 \times 300 \times 1.2 \times 10^{-3}(4)}{0.3 \times 0.25}$$

= 4.8 × 10^{-2} V

CHEMISTRY

41. (C) Concentration of $ZnSO_4$ solution = 0.1 M

Percentage of dissociation of $ZnSO_4$ solution = 95%

∴ Concentration of Zn^{2+} ions in $ZnSO_4$ solution =

$$\frac{0.1 \times 95}{100} = 0.095 \text{ M}$$

Thus, the electrode can be represented as :

Zn (s) | Zn^{2+} (aq. 0.095 M)

Reduction reaction taking place at this electrode is :

Zn^{2+} (aq. 0.095 M) + $2e^-$ $\longrightarrow$ Zn (s) (Here n = 2)

According to Nernst equation, the reduction potential of the above electrode [$(E_{red})_{elec}$] is given by :

$$(E_{red})_{elec} = (E^o_{red})_{elect} - \frac{RT}{nF}\ln\frac{[Products]}{[Reactants]}$$

or

$$(E_{red})_{elec} = (E^o_{red})_{elect} - \frac{2.303RT}{nF}\log\frac{[Products]}{[Reactants]}$$

or

$$E_{Zn^{2+}/Zn} = E^{o}_{Zn^{2+}/Zn} - \frac{2.303\,RT}{nF}\log\frac{[Zn]}{[Zn^{2+}(aq)]}$$

or $$E_{Zn^{2+}/Zn} = -0.76 - \frac{2.303\,RT}{nF}\log\frac{1}{0.095}$$

$$= \frac{-0.76 + 2.303\times 8.31\times 298\log 0.095}{2\times 96500}$$

or $$E_{Zn^{2+}/Zn} = -0.79 \text{ Volt}$$

42. (B) Fe^{3+}, Zn^{2+} and Cu^{2+} ions are present in slightly acidic solution. On adding 6 H NH_3 solution i.e., 6 M NH_4OH we get the following reactions :

$$Fe^{3+} + 3\,OH^- \longrightarrow Fe(OH)_3$$
Dark brown ppt.

$$Zn^{2+} + 4\,NH_3 \longrightarrow [Zn(NH_3)_4]^{2+}$$
Colourless solution

$$Cu^{2+} + 4\,NH_3 \longrightarrow [Cu(NH_3)_4]^{2+}$$
Deep blue solution

In this way dark brown ppt. of $Fe(OH)_3$ can be separated from Cu^{2+} and Zn^{2+} ammine complex solution in a single step by adding 6 M NH_3.

43. (C) A Compound given in option (C) is a 3° alcohol, it undergoes dehydration very easily.

44. (B) The rate law equation can be written as,

Rate = $k[CH_3CHO]^n$ Where n = order of reaction

Substituting the given data, we get,

$0.70 = k[300]^n$ ..... (i)

$0.31 = k[200]^n$ ..... (ii)

Dividing equation (i) by (ii)

$$\frac{0.70}{0.31} = \left(\frac{300}{200}\right)^n$$

Taking log on both sides

or $$\log\left(\frac{0.70}{0.31}\right) = n\log\left(\frac{300}{200}\right)$$

log 2.258 = n log 1.5

or $$n = \frac{\log 2.258}{\log 1.5} = \frac{0.3537}{0.1761}$$

∴ Order of reaction = 2.00

45. (A) In acidic solution, NH_3 forms a bond with H^+ to form NH_4^+ ion which does not have a lone pair on N to act as a ligand.

46. (B) Volume of water = 500 cm^3

Density of water = 0.997 g cm^{-3}

Mass of water = Volume × Density

= 500 × 0.997 = 498.5 g

Amount of acetic acid

$$= \frac{3.0\times 10^{-3}\times 1000\text{ g}}{60\text{ g mol}^{-1}}$$

= 0.05 mol

Molality =

$$\frac{\text{Moles of acetic acid}}{\text{Mass of water in grams}} = 1000\text{ g/kg}$$

$$= \frac{0.05\times 1000}{498.5}\text{ mol kg}^{-1} = 0.1003\text{ mol kg}^{-1}$$

Acetic acid dissociates in water in accordance with the reaction,

	$CH_3COOH \rightleftharpoons$	CH_3COO^-	$+H^+$
Initial amount:	1	0	0
Amount at equilibrium:	$1-\alpha$	α	α

Total number of moles at equilibrium = $1 - \alpha + \alpha + \alpha = 1 + \alpha$

So, van't Hoff's factor, $i = \frac{1+\alpha}{1}$

We have, α = 23% = 0.23

Then, $$i = \frac{1+0.23}{1} = 1.23$$

$\Delta T_f = i \times K_f \times m$

= 1.23 × 1.86 K kg mol^{-1} × 0.1003 mol kg^{-1}

= 0.229 K

47. (A) Reactivity decreases as the magnitude of +ve charge on the carbonyl carbon decreases or the steric hindrance in the intermediate increases, i.e.,

$H_2C = O > RCHO > ArCHO > R_2C = O > Ar_2C = O$

48. (C) Rate $\propto$ [A] $[B]^0$ $[C]^2$. Hence, order = 3.

49. (D) NO_2 group withdraws electrons from o- and p-positions and hence activates the Cl towards nucleophilic substitution reactions.

50. (A) The net flow of the solvent is from dilute solution to concentrated solution.

51. (A) $Cr^{3+} + e^- \longrightarrow Cr^{2+}$, E° = – 0.41 volts

and

$Mn^{3+} + e^- \longrightarrow Mn^{2+}$, E° = + 1.51 volts

E° values show that Cr^{2+} is unstable and has a tendency to acquire more stable Cr^{3+} state by acting as a reducing agent. On the other hand Mn^{3+} is unstable and is reduced to more stable Mn^{2+} form.

52. (A) Only 1° alkyl halides, i.e., CH_3Br undergoes S_N2 reaction.

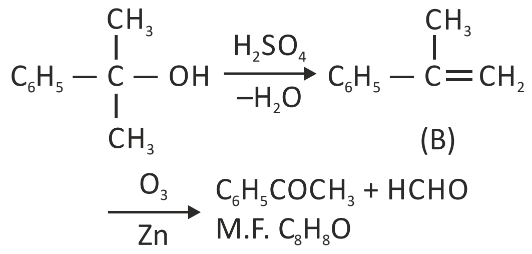
53. (A) As the standard reduction potentials of MnO_4^- (aq) + $8H^+$ (aq) + $5e^- \rightarrow Mn^{2+}$ + $4H_2O$ (l) and Cl_2 (g) + $2e^- \rightarrow 2Cl^-$ (aq) are almost of the same order, MnO_4^- cannot be used for quantitative estimation of aqueous $Fe(NO_3)_2$.

54. (B) $K = k_1 \times k_2 = (6.8 \times 10^{-3}) \times (1.6 \times 10^{-3}) = 1.08 \times 10^{-5}$

55. (A) As ketone with M.F. C_8H_8O shows +ve iodoform test, therefore, it must be a methyl ketone, i.e., $C_6H_5COCH_3$. As this ketone is obtained by the ozonolysis of an olefin (B) which is obtained by the addition of excess of CH_3 MgBr to an ester (A) with M.F. $C_9H_{10}O_2$, therefore, ester

(A) is $C_6H_5COOC_2H_5$ and the olefin (B) is $C_6H_5C(CH_3) = CH_2$ as explained below :

$$\underset{A(\text{M.F. } C_9H_{10}O_2)}{C_6H_5COOC_2H_5} \xrightarrow[\text{(ii) } H^+/H_2O]{\text{(i) } 2CH_3MgBr}$$



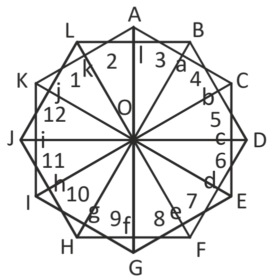
CRITICAL THINKING

56. (A) JOL, LOB, BOD, DOF, FOH, HOJ = 3×6=18

KOA, AOC, COE, EOG, GOI, IOK = 3×6=18

12K1, 1L2, 2A3, 3B4, 4C5, 5D6, 6E7, 7F8, 8G9, 9H10, 10I11, 11J12 = 12 × 3 = 36

18 + 18 + 36 = 72



Aoa, Bob, Coc, Dod, Eoe, Fof, Gog, Hoh, Ioi, Joj, Kok, Lol

72 + 12 = 84

57. (C) According to the passage, 'Last winter 50% of all fatal road accidents involved drivers with upto 5 years driving experience and an additional 15% were drivers who had between 6 to 8 years of experience.

This piece of data only mentions experience, not age. Although the main idea of the passage is that younger drivers are generally more likely to be involved in fatal car accidents, we cannot assume all relatively inexperienced drivers are young.

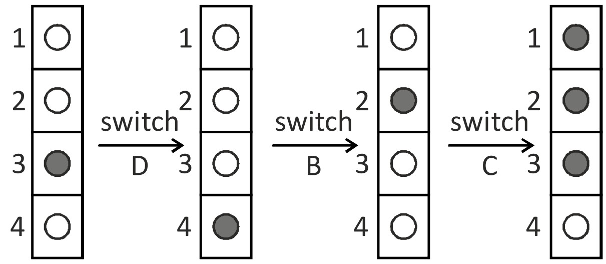
We do not know how many of those 15% with 6 to 8 years of experience are younger drivers and how many are older drivers.

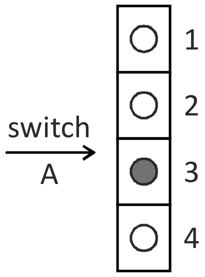
As this comparison is impossible to make on the basis of the information provided in the passage, the answer is cannot say.

58. (D) The given two statements are effects of two independent causes.

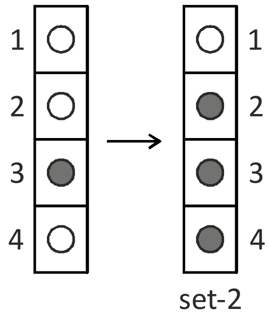
59. (A) The end supporting the punctured balloon tips upward as it is lightened by the weight of air that escapes. Although there is a loss of byouant force of the punctured balloon, that decrease in upward force is less than the weight of air loss, since the density of air in the balloon before puncturing was greater than the density of surrounding air.

60. (B) Switch B is faulty





D, B, C and A thrown in turn set - 1 chaned to set - 2. But the result figure



lights 2 and 4 are fault.

Hence, switch (B) is fault.

The End