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UNIFIED COUNCIL OLYMPIADS

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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION (UPDATED)

CLASS - 12 (PCB)

Question Paper Code : UN489

KEY

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

SOLUTIONS

BIOLOGY

1. (C) A and B explain why such insecticides remain in the bodies of consumers that happen tot ake in polluted water or feed on contaminated prey. D explains why such insecticides persist for a long time in the environment, thus increasing the likelihood of contaminating living organisms in the ecosystem. C is false because such insecticides are non-biodegradable and unlikely to be viable food sources.

2. (D) Carbon is cycled constantly in the environment (via processes that make up the carbon cycle). Thus the amount of carbon present in the environment is conserved. The carbon cycle does not indicate the quantity of carbon (A). There are many other carbon compounds apart from carbon dioxide, e.g. organic matter (B). The breakdown of certain carbon compounds releases heat, but carbon itself is not converted heat and lost (C).

3. (A) Warm-blooded animals typically have to expend a lot more energy to keep themselves warm. Thus, they usually need a higher intake of food, which is used to drive metabolism and thus generate heat.

4. (A) Keeping track of biomass instead of numbers would take into account the size/mass of organisms. Only the pyramid of energy would take into account reproductive rate (B). A pyramid of biomass can be inverted in some cases (C). Only a pyramid of energy would indicate energy content in each trophic level (D).

5. (A) The sum total mass of living organisms in a specific unit of area or volume.

6. (C) Tissue culture enables us to select desirable characteristics or traits.

7. (C) Gene therapy refers to the insertion of genes into an individual's cells and tissues to treat a disease. Essentially, defective/mutant genes that are harmful to the organism are replaced with healthy, functional ones.

8. (A) The anticodon CAG corresponds to the mRNA codon GUC, which would have been transcribed from the complementary DNA base triplet CAG. Thus the corresponding DNA base triplet is identical to the tRNA anticodon.

9. (A) The mitotic spindle comprises microtubules, fibrous structures that elongate from two pairs of centrioles during prophase of mitosis.

10. (D) Genetic variation introduced into a population due to variation among gametes is crucial in rendering a species adaptable to environmental changes. While A is a true statement, it is far more crucial that daughter cells of meiosis are genetically different, rather than being highly similar. B is false since clones are genetically identical copies of the parent organism. C is a true but the number of daughter cells is not particularly crucial for living organisms.

11. (B) The fertile period occurs around the day of ovulation, which is usually day 14 for a 28-day menstrual cycle.

12. (A) Upon fusion of the sperm and egg during fertilisation, a single diploid cell known as a zygote is formed. Mitotic divisions of the zygote form a multicellular diploid organism known as an embryo. The embryos does not have fully differentiated tissues until the subsequent stages of its development into a fetus.

13. (B) A refers to the intestinal villi which are used for absorption purposes. The villi are made up of only embryonic tissue (C). The embryo ultimately detaches from the placenta and is only attached to it via the umbilical cord (D).

14. (A) HIV infects specific types of white blood cells and kills these cells, crippling the immune system. It does not infect red blood cells (B). HIV does not directly cause diseases. It simply weakness the body such that other pathogens easily invade the body and cause such diseases (C). HIV does not directly target antibodies but it cripples the immune system's ability to secrete antibodies (D).

15. (D) The Biuret test would yield positive results (violet solution) because trypsin is an enzyme that is made of proteins.

16. (B) Gonads are derived from the mesodermal germinal ridges of the embryo which contain mesodermal epithelium and large spherical primitive germ cells.

17. (C) Promoter sites are initiation sites for transcription. This process starts when RNA polymerase binds to the promoter.

18. (A) Male honeybee, called drones, are developed from unfertilized eggs by parthenogenesis.

19. (D) A matured Graafian follicle possesses three layers of cells namely, theca externa, theca interna and granulosa. The cells of theca interna are the primary source of estrogen.

20. (D) 5-Bromouracil is a bass analogue.

21. (D) Implantation in the endometrium of uterus usually occurs at blastocyst stage, on approximately the seventh or eighth day after fertilization.

22. (B) Jelly envelope of frog's egg also hold eggs together in masses, protect eggs from infection, make them tasteless and unappetising to predators.

23. (A) Autotomy is the voluntary casting off of a part of the body in self defence.

24. (D) Tuberculosis is caused by Mycobacterium.

25. (A) Polio is transmitted from person-to-person through faecal contamination or oropharyngeal secretions.

PHYSICS

26. (D) Current through arm AE = 2 + 1 = 3 A

Current through arm ED = Current through arm AE = 3 A

Current through arm DB = 3 – 2 = 1 A

Let, V_A and V_B be the electric potential at A and B

Then, $V_A - V_E = 1 \times 3 = 3$ V

$V_E - V_D = 3 \times 3 = 9$ V

$V_D - V_B = 3 \times 1 = 3$ V

$\therefore$ $V_A - V_B = (V_A - V_E) + (V_E - V_D) + (V_D - V_B)$

$= 3 + 9 + 3 = 15$ V.

27. (A) $\frac{n_p}{n_s} = \frac{5}{4}$ $E_p = 220$ V

As $\frac{I_p}{I_s} = \frac{n_s}{n_p} = \frac{4}{5}$

28. (D) This is because copper is a diamagnetic material

29. (C) Dipole moment = p = charge × separation

$= q \times 2l = 1.602 \times 10^{-19} \times 4 \times 10^{-10}$

$= 6.408 \times 10^{-29}$ C m

Torque = $pE \sin\theta$

$= 6.408 \times 10^{-29} \times 3 \times 10^5 \times \sin 30°$

$= 9.612 \times 10^{-24}$ N m

30. (D) In the first case, energy emitted,

$E_1 = 2E - E = E$

In the second case, energy emitted,

$E_2 = \frac{4E}{3} - E = \frac{E}{3}$

As E_2 is $\frac{1}{3}$rd, λ_2 must be 3 times, i.e., 3λ

31. (C) $I_g = \frac{10 \times 10^{-3}}{5} = 2 \times 10^{-3}$ A

$R = \frac{V}{I_g} - G = \frac{1}{2 \times 10^{-3}} - 5 = 495\ \Omega$

32. (B) From the condition of no emergence

$$\mu = \frac{1}{\sin\frac{A}{2}}$$

Here, A = 90°, therefore

$$\mu > \frac{1}{\sin 45^\circ} \text{ or } \mu > \sqrt{2}$$

In this case as $\mu = \frac{3}{2} > \sqrt{2}$, therefore, light ray will not emerge out for any angle of incidence.

33. (C) Mass per nucleon in a hydrogen atom is slightly greater than mass per nucleon in oxygen because in the latter, some mass is appearing as binding energy.

34. (D) For diffraction of circular aperture. The condition of 1st minima is

$$d\sin\theta_1 = (1)\lambda$$

$$5 \cdot \left(\frac{x}{f}\right) \simeq (1)\lambda$$

$$\frac{5 \times x}{100} = 5 \times 10^{-5}$$

$x = 10^{-3}$ cm.

35. (D) Three plates in a parallel plate capacitor, gives rise to two capacitors. If there are N plates, then there will be (N – 1) capacitors.

Given, N = 201 plates

Dielectric constant = ε_r = 2.5

Separation between the plates = d = 0.001 cm = 10^{-5} m

Area = 15 × 30 = 450 cm^2

= 4.50 × 10^{-2} m^2

$$\text{Capacitance} = C = \frac{\varepsilon_0 \varepsilon_r A}{d} \times (N-1)$$

$$= \frac{8.85 \times 10^{-12} \times 4.50 \times 10^{-2} \times 2.5 \times 200}{10^{-5}}$$

= 19.91 × 10^{-6} F

36. (B) X-rays are produced when there is a vacancy for the electron on inner complete orbits of an atom and jumping of electrons takes place from higher orbit to lower energy orbit of atom.

37. (C) $\frac{1}{2} m v^2 = \frac{hc}{\lambda} - \phi_0 (\text{in eV})$

$$= \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{4000 \times 10^{-10} \times 1.6 \times 10^{-19}} - 2$$

= 3.1 – 2 = 1.1 eV = 1.1 × 1.6 × 10^{-19} J

$$v = \left[\frac{2 \times 1.1 \times 1.6 \times 10^{19}}{(9.1 \times 10^{-31})}\right]^{1/2}$$

= 6.2 × 10^5 m/s.

38. (C) For a long solenoid, B = $\mu_0 nI$.

Where n is the no. of turns per unit length.

When length of solenoid is doubled, the no. of turns per unit length will remain unchanged.

$$B' = \frac{\mu_0 nI}{2L2} = \frac{B}{4}$$

39. (C) At any point over the spherical Gaussian surface, net electric field is vector sum of electric fields due to + q_1' – q_1 and q_2.

40. (B) As e = M $\frac{dI}{dt}$

$$\therefore \quad M = \frac{e}{dI/dt} = \frac{2 \times 10^{-3}}{15.0} = 1.67 \times 10^{-3} \text{ H}$$

As ϕ = MI

$$\therefore \quad \phi = 1.67 \times 10^{-3} \times 3.6 = 6 \times 10^{-3} \text{ Wb}$$

= 6 m Wb

CHEMISTRY

41. (D) Hint: The deposition of K means the reduction of K+ ions to K metal on cathodes. This can be represented by the following reduction half-reaction.

$K^+ + e^- \longrightarrow K$

IF 39 g = 1 × 96500 C = 96500 C

This equation shows that :

39g of K are deposited by 96500 C

$\therefore$ 19.5g of K are deposited by

$\frac{96500 \times 19.5}{39} C = 48250\ C$

The deposition of Al can be shown by the equation.

$Al^{3+} + 3e^- \longrightarrow Al$

3 F 27 g

= 3 × 96500 C

This equation shows that : 3 × 96500 C deposit 27g of Al.

$48250\ C \text{ deposit} = \frac{27 \times 48350}{3 \times 96500}$

= 4.5 g of Al.

42. (C) The existence of Fe^{2+} and NO^+ in nitropruside ion, $[Fe(CN)_5NO]^{2-}$ can be established by measuring the magnetic moment of the solid compound which should correspond to ($Fe^{2+} = 3d^6$) four unpaired electrons.

43. (B) Only the compound, $PhCHOHCH_3$ contains the grouping CH_3CHOH attached to C, therefore, it gives indoform test.

44. (C) Let the initial concentration of

SO_2Cl_2 = 100 moles litre^{-1}

So, a = 100 moles litre^{-1}

a – x = (100 – x) moles litre^{-1}

k = 2.2 × 10^{-5} sec^{-1}

t = 90 × 60 sec = 5400 sec

$2.2 \times 10^{-5} = \frac{2.303}{5400} \log \frac{100}{100 - x}$

$\frac{100}{100 - x} = \text{Antilog} \frac{5400 \times 2.2 \times 10^{-5}}{2.303}$

$\frac{100}{100 - x} = 1.126$

$\therefore \quad x = 100 - \frac{100}{1.126} = 11.2\%$

45. (C) The complexes $CoCl_3 . 6\ NH_3$ and $PtCl_4 . 5\ NH_3$ are represented as $[Co(NH_3)_6]\ Cl_3$ and $[Pt(NH_3)_5Cl]Cl_3$ respectively.

$[Co(NH_3)_6]Cl_3 \xrightarrow{\text{in solution}} [Co(NH_3)_6]^{3+} + 3Cl^-$

$[Pt(NH_3)_5Cl]Cl_3 \xrightarrow{\text{in solution}} [Pt(NH_3)_5Cl]^{3+} + 3Cl^-$

As the number of ionic species in both the complexes is the same, their equimolar solutions will show approx. same conductance.

46. (D) The depression in the freezing point is given by, (subscript 1 is for solvent water and 2 is for solute, methyl alcohol).

$\Delta T_f = \frac{1000\ g/kg \times K_f \times w_2}{w_1 \times M_2}$

K_f = 1.86 K kg mol^{-1}

Volume of water = 8 L = 8000 mL

So, Mass of water, w_1

= 8000 mL × 1 g/mL = 8000 g

Volume of alcohol = 2 L = 2000 mL

So, Mass of alcohol,

w_2 = 2000 mL × 0.8 g/mL = 1600 g

Molar mass of methyl alcohol

M_2 = 32 g/mol

So,

$\Delta T_f = \frac{1000\ g/kg \times 1.86\ K\ kg\ mol^{-1} \times 1600\ g}{8000\ g \times 32\ g\ mol^{-1}}$

= 11.6 K = 11.6° C.

Therefore, Freezing point of the solution = 0°C – 11.6°C = – 11.6°C

So, the motor vehicle can be parked outdoors safely upto = – 11.6°C.

47. (Delete)

48. (B) $2NO_2 \underset{k_2}{\overset{k_1}{\rightleftharpoons}} N_2O_4$

$$\text{Rate} = -\frac{1}{2}\frac{d[NO_2]}{dt}$$

$= k_1 [NO_2]^2 - k_2 [N_2O_4]$

$\therefore$ Rate of disappearance of NO_2

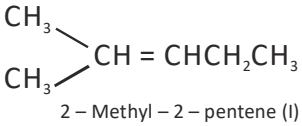
$$\text{i.e., } -\frac{d[NO_2]}{dt} = 2k_1[NO_2]^2 - 2k_2[N_2O_4]$$

49. (B) Out of CH_3COCH_3, CH_3CHO, CH_3CH_2CHO and $(CH_3)_2CHCHO$, two pairs containing a total of six carbon atoms are :

(i) $CH_3COCH_3 + CH_3CH_2CHO$

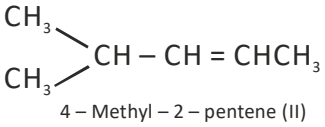
(ii) $CH_3CHO + (CH_3)_2CHCHO$

The alkenes which will give these pairs of compounds on ozonolysis are :



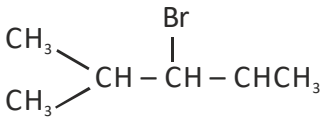
2 – Methyl – 2 – pentene (I)

and



4 – Methyl – 2 – pentene (II)

These two alkenes can be obtained as dehydrogenation products if the alkyl halide is



3 – Bromo – 2 – methylpentene

50. (B) Greater the lowering of V.P., greater is the depression in F. pt, i.e., lower is actual F pt.

51. (B) Mn^{2+} in $MnSO_4 . 4H_2O$ has d^5 configuration (five unpaired electrons);

Cu^{2+} in $CuSO_4 . 5H_2O$ has d^9 configuration (one upaired electron);

Fe^{2+} in $FeSO_4 . 6H_2O$ has d^6 configuration (four unpaired electrons);

Ni^{2+} in $NiSO_4 . 6H_2O$ has d^8 configuration (two unpaired electrons).

Thus, $CuSO_4 . 5H_2O$ has lowest degree of paramagnetism.

52. (D) Addition of Br_2 (trans) to trans-2-butene gives meso-2, 3-dibromobutane.

53. (A) Given values are reduction potentials $M^{+2} \rightarrow M^{3+} + e^-$ means oxidation. Oxidation potential of Cr will be highest and hence most easily oxidized.

54. (A) In metal carbonyls, the total bonding is M = C = 0. Thus, the bond order of C–O bond is reduced from triple bond to double bond. As a result, C–O bond length of 1.28 Å in CO increases to about 1.15 Å in many carbonyls.

55. (A) As NH group is electron-donating and o, p-directing while C = O is electron-withdrawing and m-directing, therefore, bromination will occur in the ring attached to the NH group predominantly at the unhindered p-position.

CRITICAL THINKING

56. (C) The passage mentions differences expected in 'executive functions' of the brain between children who have command of a single language and children who have mastered more than one.

However, it cannot be inferred that this effect continues as the number of languages continues to grow. For instance, it is not clear whether the difference in executive functions is also present between children who have command of two languages and children who have command of more than two languages.

57. (D)

Person	Department			Color						
	CISF	BSF	CRPF	Green	Blue	Red	Pink	Black	Violet	Purple
A	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗
B	✗	✓	✗	✓	✗	✗	✗	✗	✗	✗
C	✗	✗	✓	✗	✓	✗	✗	✗	✗	✗
D	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗
E	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓
F	✓	✗	✗	✗	✗	✗	✗	✓	✗	✗
G	✗	✗	✓	✗	✗	✗	✓	✗	✗	✗

Person	Department	Colour
A	CISF	Violet
B	BSF	Green
C	CRPF	Blue
D	CISF	Red
E	BSF	Purple
F	CISF	Black
G	CRPF	Pink

Following the common explanation we get combination of D – CISF – Red is true.

58. (C) We are tempted to assume that technological progress is real progress. (1st line)

59. (B) Lets simplify the statements

Rohan : X will not go up unless Y goes down

Mahesh : When Y went Down X didn't change.

Mahesh thinks Rohan is saying when Y goes down X will go up. Find the answer which says this.

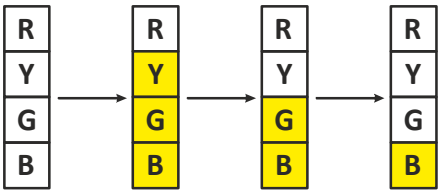
(A) housing prices will rise only if interest rates fall X will go up when Y goes down (Wrong)

(B) if interest rates fall, housing prices must rise when Y goes down X must rise (Correct)

(C) interest rates and housing prices tend to rise and fall together X and Y rise together and fall together(Wrong)

(D) interest rates are the only significant economic factor affecting housing prices Only Y affects X (not even close)

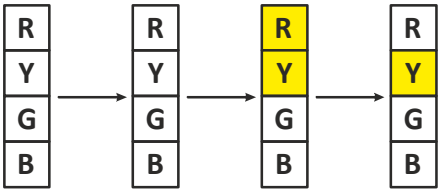
60. (C) If Switch A is fault :



. But given output is 

not matched. Hence switch (A) is working.

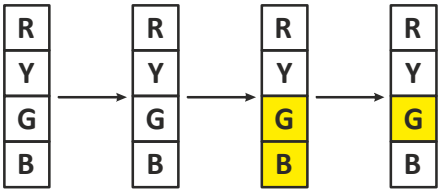
If Switch B is fault :



given output is 

. Both are not matching. Hence switch (B) is working.

If Switch C is fault :



given output is 

. Both are matched.

Hence switch (C) is fault.

Switch (C) is not given in the question figure.