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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION (UPDATED)

CLASS - 11 (PCB)
Question Paper Code : UN489

KEY

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

SOLUTIONS

BIOLOGY

01. (D) The rough ER comprises flattened membranous sacs. It has ribosomes, organelles responsible for polypeptide synthesis, attached to its outer surface. Hence, the rough ER is involved in the transport of polypeptides. The smooth ER comprises tubules and is involved in the synthesis of substances such as fats and steroid hormones.

02. (C) The bond formed between amino acids in a protein is called a peptide bond.

03. (D) Structural features like thin membrane for efficient diffusion, elastic membrane to squeeze through narrow lumens, presence of haemoglobin for oxygen transport, biconcave shape to increase surface area to volume ratio are related to its functions.

04. (A) Splitting of water into hydrogen and oxygen using light energy is a light dependent stage in photosynthesis.

05. (D) After the digestion of carbonhydrates, glucose will be transported via the hepatic portal vein, from the small intestines to the liver.

06. (B) Using a thinner membrane would result in a faster rate of diffusion because there would be a shorter diffusion path, thus the molecules travel across the membrane more quickly. A steeper concentration gradient would also result in a faster rate of diffusion. By increasing the size of the particles, the rate of diffusion would be reduced because the heavier the molecule, the slower it diffuses.

07. (A) Only the neutrophils are able to squeeze through the walls of blood capillaries and enter the tissue fluid to remove any foreign substances such as bacterial cells or viruses.

08. (B) In aerobic respiration, glucose is broken down in the presence of oxygen to produce carbon dioxide and water. A large amount of energy is released in this process.

09. (B) Due to the branched nature of glycogen, it occupies less space (more compact) than its individual glucose molecules, and this reduces the space it will take up within the cell.

10. (C) The stones in the stomach of the bird help to masticate the food.

11. (B) Proteins in the egg were initially soluble but dematured and became insoluble. This occurred because vinegar is an acid (ethanoic acid) and this low pH caused the proteins to denature and solidify.

12. (B) The pollen grain wall helps to protect the male gametes from drying up or Chemical attack, thus protecting the DNA in the male gametes. This helps to maintain the integrity of genetic material that would be inherited by subsequent generations.

13. (C) Fertilisation is the fusion of a male gamete with the haploid ovum sac to form a diploid zygote.

14. (B) The fatty substances are first deposited in the inner walls of the coronary arteries, narrowing the lumens. This creates a rough surface that increases the risk of blood clot formation. This cuts off the supply of blood containing oxygen and glucose to the heart muscles for respiration and they eventually die, leading to a heart attack.

15. (B) By being highly folded, the dialysis tubings increase the surface area for metabolic waste products to diffuse out from the blood into the dialysis fluids.

16. (A) The aorta is the main artery that carries blood away from the heart to the rest of the body with high blood pressure.

17. (A) Cellular respiration does not require energy to occur. Instead, it produces energy in the form of ATP required for metabolic reactions in cells.

18. (D) Instead of chemical energy, light energy from the sun is required for photosynthesis.

19. (B) When a person runs to catch the bus, the adrenaline levels will increase (endocrine coordination) and the brain will fire nerve impulses to the muscles in the legs to increase their speed of contraction (nervous coordination).

20. (D) Osmosis is the net movement of water molecules from a region of higher water potential to a region of lower water potential across a partially permeable membrane.

21. (A) In response to a change in the external environment, the organism can respond to maintain a constant, internal environment about a set point.

22. (B) The shape of the active site is complementary to the shape of the substrate (lock and key hypothesis). If its shape is changed, the enzyme will not be able to function normally. Ribosomes are essential for the production of proteins in a cell and since enzymes are made of proteins, enzyme production is not possible without ribosomes.

23. (C) (ii) Describes asexual reproduction, (iii) describes growth and development of an individual organism and (N) describes tissue repair. All three processes require the production of new cells that are genetically identical to one another and the parent cell(s). Sperm cells, which are haploid gametes, are formed by meiosis from a diploid cell (i).

24. (B) Progesterone is secreted by the ovaries and it helps to maintain the endometrium lining for implantation. To stimulate the release of a mature egg cell from the ovary, there is a surge in LH levels. Before ovulation, FSH levels increase to stimulate the maturation of follicles and after menstruation, oestrogen is secreted to repair the endometrium.

25. (C) Amylase is not a hormone because it is not secreted into the bloodstream (ii). It also digests starch into maltose, so it does not exert a profound effect on a target tissue/organ but acts on a substrate.

PHYSICS

26. (C) Distance travelled in n second is equal to $n\nu_0 + \frac{1}{2}an^2$

Distance travelled in (n – 1) second is equal to (n – 1) $\nu_0 + \frac{1}{2}a(n-1)^2$

Distance travelled in n^{th} second is

$$x_n = \left[n\nu_0 + \frac{1}{2}an^2\right] - \left[(n-1)\nu_0 + \frac{1}{2}a(n-1)^2\right]$$

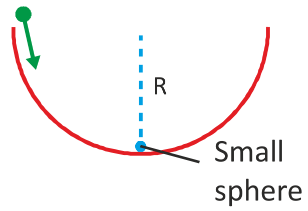
$$x_n = \nu_0 + \frac{1}{2}a(2n-1)$$

27. (Delete)

28. (D) Given, stress in steel wire = Stress in brass wire so,

$$\frac{T_1}{A_1} = \frac{T_2}{A_2} \text{ or } \frac{T_1}{T_2} = \frac{A_1}{A_2} = \frac{0.1}{0.2} = \frac{1}{2}$$

29. (D) It is clear from the figure given below.



On reaching the bottom of the bowl, loss in P.E. = mg R, and

Gain in K.E. = $\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

$$= \frac{1}{2}mv^2 + \frac{1}{2} \times \left(\frac{2}{5}mr^2\right)\omega^2$$

$$= \frac{1}{2}mv^2 + \frac{1}{5}mv^2 = \frac{7}{10}mv^2$$

As gain in K.E. = Loss in P.E.

$$\therefore \quad \frac{7}{10}mv^2 = mgR$$

$$v = \sqrt{\frac{10\,gR}{7}}$$

30. (B) $u = \frac{3GM^2}{5R}$

$$u' = \frac{3}{5} \times \frac{GM^2}{R} = \frac{3GM^2}{5R/2}$$

$$= \frac{3 \times 2}{5} \times \frac{GM^2}{R}$$

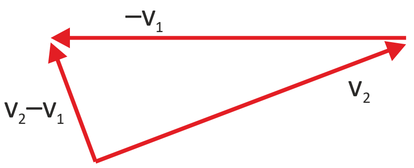
$$u' - u = \frac{3}{5}\frac{GM^2}{R}$$

$$= \frac{3}{5} \times \frac{6.67 \times 10^{-11} \times (2 \times 10^{30})^2}{7 \times 10^8}$$

$$= \frac{(3 \times 6.67 \times 4 \times 10^{60})}{5 \times 7 \times 10^8}$$

$= 2.3 \times 10^{41}$ J

31. (C) By definition, $\bar{a} = \frac{\Delta v}{\Delta t}$. We determine $\Delta v = v_2 - v_1 = v_2 + (-v^1)$ geometrically as follows:



As Δt is a positive scalar, the direction of $\bar{a}$ is the same as the direction of Δv, which is displayed above.

32. (D) Gravitational potential energy,

$$E_P = \frac{GMm}{(R_e + R_e)} = -\frac{GMm}{2R_e} = -\frac{1}{2}mgR_e$$

33. (C) Pressure inside the cavity

$= P_0 + h\rho g + \frac{2S}{r}$

$= 0.76 \times (13.6 \times 10^3) \times (9.8) + 0.2 \times 0.85$

$\times 10^3 \times 9.8 + \frac{2 \times 26 \times 10^{-3}}{13 \times 10^{-6}}$

$= 1.013 \times 10^5 + 0.0167 \times 10^5 + 0.04 \times 10^5$

$= 1.0697 \times 10^5 \text{ N m}^{-2}$ or $1.07 \times 10^5 \text{ N m}^{-2}$.

34. (C) In a time t_0, the displacement of the block with respect to ground is $\frac{1}{2}at_0^2$ (downward). Therefore, the work done by mg is $W = mg\left(\frac{1}{2}at_0^2\right) = \frac{1}{2}mg\,at_0^2$

35. (A) The sphere has the least surface area, therefore, it takes the longest time to cool down.

The circular plate with the maximum surface area is the fastest to cool down.

36. (C) Let s be the total length of trains and u_1, u_2 be their speeds. As per question,

$$\frac{s}{u_1 + u_2} = 3 \text{ and } \frac{s}{\frac{3}{2}u_1 + u_2} = \frac{5}{2}$$

or $3u_1 + 3u_2 = \frac{5}{2} \times \frac{3}{2}u_1 + \frac{5}{2}u_2$

or $12u_1 + 12u_2 = 15u_1 + 10u_2$

or $3u_1 = 2u_2$ or $u_1 = \frac{2}{3}u_2$

If t is the time taken to cross distance s when the train pass in the same direction, then

$$t = \frac{s}{u_2 - u_1} = \frac{3(u_1 + u_2)}{u_2 - u_1}$$

$$= \frac{3\left(\frac{2}{3}u_2 + u_2\right)}{u_2 - \frac{2}{3}u_2} = \frac{3 \times 5}{3 - 2} = 15\text{ s}$$

37. (D) Internal energy U = No. of moles × No. of degrees of freedom = $\frac{1}{2}RT$

Out of four cases, product of no. of moles (1000) degrees of freedom (3) and T (= 900 K) is maximum for argon gas.

38. (C) $m_1 = 1$ kg, $m_2 = 6 \times 10^{24}$ kg

Force of attraction = F = ?

$G = 6.67 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$

Distance between the two masses = r = 6.38×10^6 m

$$F = \frac{Gm_1m_2}{r^2} = \frac{6.67 \times 10^{-11} \times 1 \times 6 \times 10^{24}}{(6.38 \times 10^6)^2} = 9.83 \text{ N}$$

Acceleration of $m_1 = a_1 = \frac{\text{Force}}{m_1}$

$$a_1 = \frac{9.83}{1} = 9.83 \text{ m/s}^2$$

Acceleration of $m_2 = a_2 = \frac{\text{Force}}{m_2} = \frac{9.83}{6 \times 10^{24}}$

$a_2 = 1.64 \times 10^{-24} \text{ m/s}^2$

39. (A) $\frac{mg}{\eta r} = \frac{M(LT^{-2})}{(ML^{-1}T^{-1})L} = LT^{-1} = v_T$

40. (A) Here, $h_1 = 550$ m, $h_2 = 50$ m

$m = 2000$ kg, $t = 1$ sec

Efficiency = 80%

$\therefore$ Maximum electrical power output

$$= \frac{80}{100} \times \frac{mg(h_1 - h_2)}{t}$$

$$= \frac{4}{5} \times \frac{2000 \times 10(550-50)}{1}$$

$P = 8 \times 10^6$ watt = 8 MW.

CHEMISTRY

41. (A) 1 E + EA = 275 + 86 = 361 k cal mol^{-1}

= 361 × 4.184

= 1510.42 kJ mol^{-1}

$\therefore$ Electronegativity

$$= \frac{1510.42}{540} = 2.797 = 2.8$$

42. (D) $\underset{1-\alpha}{N_2O_4} \rightleftharpoons \underset{2\alpha}{2NO_2}$ Total = $1 + \alpha$

43. (C) There is no restriction that resonating structures should have +ve and –ve charges on atoms that are far apart.

44. (D) $\overset{6}{C}H_3\overset{5}{C}H_2 - \overset{4}{C}H = \overset{3}{C}H - \overset{2}{C}(=O) - \overset{1}{C}H_3$

(3–Hexen–5–one)

45. (C) Mass of NaOH required = 0.184 g

Molar mass of NaOH = 40 g/mol

Molarity of NaOH solution = 0.150 mol^{-1}

Let, V be the volume of NaOH required to be added into the reaction vessel. Then

Amount of NaOH added = $M_{NaOH} \times V_{NaOH}$

From the given data,

$$\frac{0.184 \text{ g}}{40 \text{ g/mol}} = 0.150 \text{ mol L}^{-1} \times V$$

$$V = \frac{0.184}{40} \text{mol} \times \frac{1}{0.150 \text{ mol L}^{-1}} = \frac{0.184}{40 \times 0.150} \text{L}$$

$$= \frac{0.184 \times 1000}{40 \times 0.150} \text{mL} = 30.7 \text{ mL}$$

46. (B) Half-cell reaction :

Cu^{2+} (aq) + $2e^-$ $\longrightarrow$ Cu

The half-cell potential is given by,

$$E = E° + \frac{0.059 \text{ V}}{2} \log [Cu^{2+}]$$

E = E° + (0.0295 V) log [Cu^{2+}]

The half-cell potential when the solution is diluted 100 times

E = E° + (0.0295 V) log (10^{-2} [Cu^{2+}])

Thus, E' – E = (0.0295 V) log 10^{-2} = – 0.059 V

The potential of half cell will decrease by 59 mV.

47. (A) We have $\Delta x \cdot (m\,\Delta v) = \frac{h}{4\pi}$

or $m = \frac{h}{4\pi} \times \frac{1}{\Delta x \cdot \Delta v}$

$$= \frac{6.625 \times 10^{-34} (kg \cdot m^2\, s^{-1})}{4 \times 3.14 \times (10^{-10} m)(5.27 \times 10^{-24}\ m\, s^{-1})}$$

= 0.10 kg

48. (D) Due to thunderstorm, temperature increases, i.e., [H^+] increases which means pH decreases.

49. (A) $C : H : Cl : O = \frac{18.5}{12} : \frac{1.55}{1} : \frac{55.04}{35.5} : \frac{24.81}{16}$

= 1.54 : 1.55 : 1.55 : 1.55

$\therefore$ E.F. = CHClO.

50. (B) Rise in temperature,

Δt = (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 × Rise in temperature = 8.93 kJ K^{-1} × 6.73 K = 60.1 kJ

51. (B) $6\text{ g } O_2 = \frac{6}{32}\text{mol} = 0.1875$,

$6\text{ g } SO_2 = \frac{6}{64}\text{mol} = 0.09375$

As no. of moles of SO_2 is less, so the no. of molecules will also be less.

52. (A) μ (100% ionic)

$= (1.602 \times 10^{-19}\text{ C}) \times (1.6 \times 10^{-10}\text{ m})$

$= 2.56 \times 10^{-29}$ C m

$\therefore$ % of Ionic character $= \frac{2.0 \times 10^{-29}}{2.56 \times 10^{-29}} \times 100 = 78\%$

53. (A) $r = \frac{n^2 h^2}{4\pi^2 m Ze^2}$. Here m = mass of e^-.

Mass of atom is not involved.

As Z = 1 for both, ratio = 1 : 1

54. (C) For the reaction,

$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$

$K_p = 1.80 \times 10^{-3}$ kPa

$K_c = ?$

We know that,

$K_p = K_c(RT)^{\Delta n}$

Where $\Delta n = \Sigma n_g\text{ (products)} - \Sigma n_g\text{ (reactants)}$

For the given reaction,

$\Delta n = 2 + 1 - 2 = 1$

So, $K_p = K_c \times RT$

$R = 0.082\text{ L atm K}^{-1}\text{ mol}^{-1} = 0.082$ L atm $K^{-1}\text{ mol}^{-1} \times \frac{101.3\text{ kPa}}{1\text{ atm}} = 8.31\text{ L kPa K}^{-1}\text{ mol}^{-1}$

Then,

$$K_c = \frac{K_p}{RT} = \frac{1.80 \times 10^{-3}\text{ kPa}}{8.31\text{ L kPa K}^{-1}\text{ mol}^{-1} \times 700\text{ K}}$$

$= 3.09 \times 10^{-7}\text{ mol L}^{-1}$

55. (C) The outer electronic configuration of group 15 elements is s^2p^3.

CRITICAL THINKING

56. (A) Starting from the outer end of the spiral (the loop on the rope) the green and white sections are longest, and the white sections are of similar length to the green sections. As you move towards the other end of the rope, both green and white sections get shorter. Only rope (A) shows this, hence (A).

57. (C) We can see from the image that the tube is coming out of the upper wall of the first pool; this means that the second pool will only start to fill up after the first pool is completely full. We need to total the amount of time it will take to fill up each pool.

Step 1- we calculate the volume of the pools.

Pool 1: 1*1*3.6 = 3.6[m^3]

Pool 2: 1*1*0.6 = 0.6[m^3]

Step 2- We use the following familiar conversion : 1[m^3] = 1000[liter]

We insert the data obtained in the first step:

The volume of pool 1 : 3.6[m^3]*1000

= 3600[liter]

The volume of pool 2 : 0.6[m^3]*1000

= 600[liter]

Step 3- We use the following conversion : 1[hour] = 3600[seconds]

Combining with the data we have already obtained:

The time taken to fill pool 1:

3600[liter] / 1[liter/second]

= 3600[seconds] = 1[hour]

The time taken to fill pool 2:

600[liter] / 1[liter/second]

= 600[seconds] = 10[minutes]

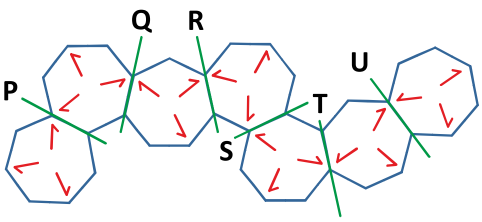
Therefore, the total amount of time: 60 min + 10 min = 70 minutes

58. (C) S1 and S2 together are not sufficient to answer the Question.

59. (B) S – R. S lives in hostel & R lives in house.

Students	Subject	Living place
P	English	Paying guest
Q	History	House
R	Philosophy	House
S	Physics	Hostel
T	Mathematics	Paying guest
U	Commerce	Hostel

60. (B)



The End