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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION (UPDATED)

CLASS - 11 (PCB)
Question Paper Code : UN499

KEY

1. D	2. C	3. D	4. A	5. D	6. B	7. A	8. B	9. B	10. A
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. B	27. B	28. D	29. A	30. D
31. A	32. C	33. D	34. B	35. D	36. D	37. B	38. D	39. C	40. A
41. A	42. B	43. D	44. C	45. C	46. A	47. D	48. D	49. B	50. B
51. B	52. B	53. B	54. C	55. A	56. D	57. A	58. D	59. B	60. C

EXPLANATIONS

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 increase in 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 capillaies 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. (A) N represents the site on the enzyme where the substrate fits into and is known as the active site.

11. (B) Proteins in the egg were initially soluble but denatured 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 creates energy for cell. But it need energy to start cellular respiration. In the first half of glycolysis energy in the form of two ATP molecules is required to transform glucose.

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.

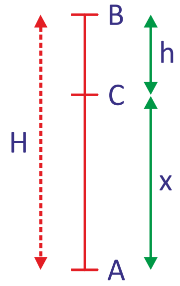
23. (C) (ii) Describes asexual reproduction, (iii) describes growth and development of an individual organism and (N) describes tissue repair. All three processes require the production of new cells that are genetically identical to one another and the parent cell(s). Sperm cells, which are haploid gametes, 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. (B) Let T be the time of ascent and H be the total height. Then T = u/g



And $H = uT - \frac{1}{2}gT^2$

Let (T – t) be the time taken by the ball to go from A to C. The distance covered in time (T–t) is

$x = u\,(T-t) - \frac{1}{2}g\,(T-t)^2$

So, distance covered by ball in last t seconds.

$$h = H - x = \left[uT - \frac{1}{2}gT^2\right]$$

$$-\left[u(T-t) - \frac{1}{2}g(T-t)^2\right]$$

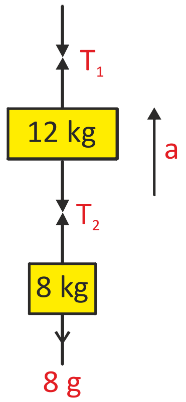
$$= ut - gt\,T + \frac{1}{2}gt^2 = \frac{1}{2}gt^2 \quad [\because T = u/g]$$

27. (B) It is clear from the figure given below, the equation of motion of 8 kg block is

$8 \times a = T_2 - 8\,g$

$T_2 = 8a + 8g = 8\,(a + g)$

$= 8 \times (2.2 + 9.8) = 96$ N



The equation of motion of 12 kg block is

$12 \times a = T_1 - 12\,g - T_2$

$T_1 = 12(a + g) + T_2$

$= 12\,(2.2 + 9.8) + 96 = 240$ N.

28. (D) We know, elongation in wire $(\Delta L) = \frac{FL}{AY}$

or $F = \frac{AY\Delta L}{L}$ ($\because$ F = normal force)

Given:

Material of both wires is same $\therefore Y_A = Y_B$

Elongation in both wires A and B are equal

$\therefore \Delta L_A = \Delta L_B$

So, $F \propto \frac{A}{L}$

$\frac{F_A}{F_B} = \frac{A_A}{L_A} \times \frac{L_B}{A_B}$ But $\frac{A_A}{A_B} = \frac{\pi r_A^2}{\pi r_B^2} = \frac{r_A^2}{r_B}$

$\frac{F_A}{F_B} = \frac{r_A^2}{r_B^2} \times \frac{L_B}{L_B} = (2)^2 \times \frac{1}{4} = 1$

$\left[\because \frac{r_A}{r_B} = \frac{2}{1} \text{ and } \frac{L_A}{L_B} = \frac{4}{1} (\text{given})\right]$

29. (A) $K = \frac{r_1^2 + r_2^2 + ...}{n}$, radius of gyration depends on the distribution of mass about the axis of rotation and it is independent of mass of the body.

30. (D) Arial Magnification $= \frac{\text{Area of image}}{\text{Area of object}}$

$= 1.55 / 1.75 \times 10^4 = 8857$

Linear Magnification $= \sqrt{8857} = 94.11$

31. (A) The resultant of three vectors cannot be zero if one vector does not lie in between the sum and difference value of the two other vectors.

One force must lie in between the sum and difference of two other forces.

32. (C) Let x be the distance of point from the moon where, the gravitational field intensity is zero. The distance of point from the earth = $(60\,R - x)$.

So, $\frac{G\,(M/81)}{x^2} = \frac{G\,M}{(60\,R - x)^2}$

or $\frac{1}{9x} = \frac{1}{60\,R - x}$

or $60\,R = 10\,x$ or $x = 6\,R$

33. (D) Here, R = 2.8 / 2 = 1.4 mm = 0.14 cm;

$\frac{4}{3}\pi R^3 = 125 \times \frac{4}{3}\pi r^3$

or $r^2 = R / 5 = 0.14 / 5 = 0.028$ cm.

Change in energy = S.T. × increase in area

$= 75 \times [125 \times 4\pi\, r^2 - 4\,\pi\, R^2]$

$= 75 \times 4\,\pi \times [125 \times (0.028)^2 - (0.14)^2]$

= 74 erg

34. (B) As water enters into the vessel A, it becomes heavier. Gravity helps it to sink. External work required for immersing A is obviously less than that for immersing B.

35. (D) When difference in temps. of a liquid and the surroundings is small ($\approx$ 30°C), then

$$-\frac{dQ}{dt}\,\alpha\,(\theta-\theta_0)$$

For numerical problems, when a body cools from θ_1 to θ_2 in time t, then

$$\frac{\theta_1-\theta_2}{t}=\alpha\left[\frac{\theta_1+\theta_2}{2}-\theta_0\right]$$

According to Newton's law of cooling, rate of cooling $\propto$ temp. diff. between the liquid and surroundings. As temp. diff. decreases gradually, time taken to cool increases i.e. $T_3 > T_2 > T_1$ or $T_1 < T_2 < T_3$

36. (D) Given, $x = 0.20$ m; $y = 0.20$ m, u = 1.8 m/s.

Let the ball strike the nth step of stairs.

Vertical distance travelled

$$= n\,y = n\times 0.20 = \frac{1}{2}gt^2$$

Horizontal distance travelled = n x = ut

or t = nx/u

$$\therefore\quad n\,y=\frac{1}{2}g\times\frac{n^2x^2}{u^2}$$

or

$$n=\frac{2u^2}{g}\frac{y}{x^2}=\frac{2\times(1.8)^2\times 0.20}{9.8\times(0.20)^2}=3.3\approx 4$$

37. (B) $\upsilon_e=\sqrt{2GM/R}$ i.e. $\upsilon_e\,\alpha\,1/\sqrt{R}$

$$\therefore\quad \frac{\upsilon_{e_1}}{\upsilon_{e_2}}=\sqrt{\frac{R_2}{R_1}}\quad\text{or}\quad\frac{1}{100}=\frac{R_2}{R_1}$$

$$\text{or}\quad R_2=\frac{R_1}{100}=\frac{6400}{100}=64\,\text{km}$$

38. (D) Under isothermal conditions, T = constant.

$\therefore$ Internal energy = constant i.e. change in internal energy is zero.

39. (C) Energy does not have the units of kg-m/sec.

Unit of energy is joule.

40. (A) $\upsilon = 1.5\,\text{m/s},\ \frac{dm}{dt}=5\,\text{kg/s}$

$$F=\frac{dm}{dt}\times\upsilon=5\times 1.5=7.5\,\text{N}$$

P = F × υ = 7.5 × 1.5 = 11.25 W

CHEMISTRY

41. (A) The number of electrons in Na^+ = 11 – 1 = 10

The number of electrons in Ne = 10

The number of electrons in K^+ = 19 – 1 = 18

The number of electrons in O = 8

Thus, Na^+ and Ne are isoelectronic with one another.

42. (B) P_1 = 1.00 atm P_2 = 0.80 atm

V_1 = 175 L V_2 = ?

As temperature remains constant, hence $P_1V_1 = P_2V_2$ (Boyle's law)

$$V_2=\frac{P_1V_1}{P_2}=\frac{1\,\text{atm}\times 175\,\text{L}}{0.80\,\text{atm}}=218.75\text{ L}$$

43. (D) For coordinate bond formation, there should be a lone pair of electrons which the H_2 molecule does not have.

44. (C) KI_3 and $CuSO_4$ give 2 ions whereas K_2HgI_4 gives 3 ions. $FeCl_3$ gives 4 ions.

45. (C) Mass of $NaNO_3$ = 0.38 g

Volume of the solution = 50.0 mL

Molar mass of $NaNO_3$ = 23 g/mol + 14 g/mol + 3 × 16 g/mol

= (23 + 14 + 48) g/mol = 85 g/mol

Amount of $NaNO_3$ dissolved

$$=\frac{0.38\,\text{g}}{85\,\text{g/mol}}=4.47\times 10^{-3}\,\text{mol}$$

Molarity of the solution

$$=\frac{4.47\times 10^{-3}\,\text{mol}}{50.0\,\text{mL}}\times 1000\,\text{mL/L}$$

=0.089 mol L^{-1}

46. (A) B.O. in N_2 = (10 – 4)/2 = 3

B.O. in O_2^{2+} = (10 – 4)/2 = 3

B.O. in O_2^- = (10 – 5)/2 = 2.5

B.O. in N_2^- = (10 – 5)/2 = 2.5

B.O. in O_2 = (10 – 6)/2 = 2

B.O. in O_2^+ = (10 – 5)/2 = 2.5

Thus, N_2 and O_2^{2+} have identical bond order of 3.0

47. (D)

(a) O.N. of Cl^- = – 1

(b) O.N. of Cl in ClO^- = $x - 2 = -1$ or $x = +1$

(c) O.N. of Cl in ClO_2^- = $x + 2 \times (-2) = -1$ or $x = +3$

(d) O.N. of Cl in ClO_3^- = $x + 3 \times (-2) = -1$ or $x = +5$

48. (D) One electron in the outermost shell of the given group 1 elements causes them to have similar properties.

49. (B) Ethyl alcohol undergoes combustion according to the reaction,

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O \quad \Delta H = -1367 \text{ kJ mol}^{-1}$$

Then $\Delta_c H = \sum aH_{products} - \sum bH_{reactants}$

Since, the enthalpy of a compound is taken as equal to its heat of formation, and the enthalpy of an element is taken as zero, we can write,

$$-1367 = [2\Delta_f H\ (CO_2) + 3\Delta_f H(H_2O)] - [\Delta_f H(C_2H_5OH) + 0]$$

Therefore, $\Delta_f H\ (C_2H_5OH) = 2(-393.4) + 3(-285.9) + 1367 = -277.5$ kJ mol^{-1}

50. (B) Element Y belongs to group 14 of the periodic table which forms two chlorides YCl_4 (a colourless, volatile liquid) and YCl_2 (a colourless solid).

51. (B) Reaction is reversed. K = 1/0.6 = 1.67.

52. (B) CH_2N_2 is called diazomethane (diazo + methane).

53. (B) Electronic configuration of Z = 105, n + l = 8, for 5f = (5 + 3) = 8 and for 6d = (6 + 2) = 8 and electrons present in 5f = 14

and electrons present in 6d = 3,

Thus, total no. of electrons = 14 + 3 = 17

54. (C) Gases do not have any definite volume.

Liquids have definite volume.

55. (A) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O,\ \Delta H_1 = -x$ kJ

$$CH_3OH + \frac{3}{2}O_2 \rightarrow CO_2 + 2H_2O, \Delta H_2 = -y \text{ kJ}$$

Subtracting (ii) from (i), we get

$$CH_4 + \frac{1}{2}O_2 \rightarrow CH_3OH, \Delta H_3 = -ve$$

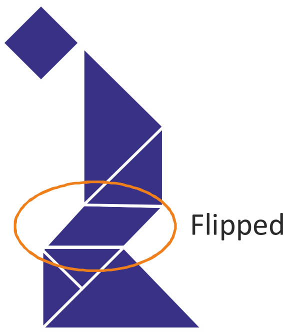
i.e., $-x - (-y) = -$ ve

$y - x = -$ ve

Hence, $x > y$.

CRITICAL THINKING

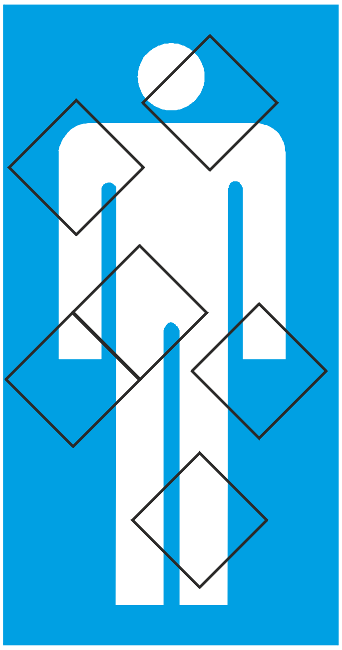
56. (D)



57. (A) Data in Statement I alone is sufficient to answer the question, while the data in Statement II alone is not sufficient to answer the question.

58. (D) If both I and II are implicit

59. (B)



60. (C) Since the weight is 10 Kg and there are 4 sections of rope supporting it, then by dividing 10 by 4, you will get 2.5 Kg. In all cases, just divide the weight by the number of sections of rope supporting it to get the force needed to lift the weight.