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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION (UPDATED)

CLASS - 10

Question Paper Code : UN464

KEY

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EXPLANATIONS

MATHEMATICS

01. (B) Given

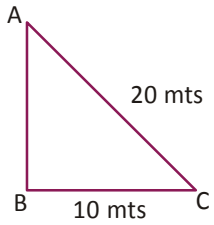
$$\text{Sin}^2\left(\frac{\cancel{2^\circ}}{1^\circ}\times\frac{\cancel{3^\circ}}{\cancel{2^\circ}}\times\frac{\cancel{4^\circ}}{\cancel{3^\circ}}\times.....\times\frac{x-1^\circ}{\cancel{x-2^\circ}}\right)=\frac{3}{4}=\text{Sin}^2 60^\circ$$

$\therefore \text{Sin}^2 (x-1)^\circ = \text{Sin}^2 60^\circ$

$x - 1^\circ = 60^\circ$

$x = 60^\circ + 1^\circ = 61^\circ$

02. (C) $\text{Cos}C = \frac{BC}{AC}$



$$\Rightarrow \text{Cos}C = \frac{10\text{mts}}{20\text{mts}} = \frac{1}{2} = \text{Cos}60^\circ$$

$\therefore \angle C = 60^\circ$

03. (A) Let the point on X – axis be P(x, 0)

$\therefore$ P(x, o) divides the join of (3, –4) and (2, 6) in the ratio $m_1 : m_2$

$$\therefore P(x,0)=\left(\frac{2m_1+3m_2}{m_1+m_2},\frac{6m_1-4m_2}{m_1+m_2}\right)$$

$$\therefore \frac{6m_1-4m_2}{m_1+m_2}=0 \Rightarrow 6m_1-4m_2=0$$

$$\Rightarrow 6m_1=4m_2$$

$$\frac{m_1}{m_2}=\frac{\cancel{4}^{2}}{\cancel{6}_{3}}$$

(OR)

X – axis divides the join of (3, –4) and (2, 6) in the ratio $-y_1:y_2 = -(-4) : 6 = 4 : 6 = 2 : 3$.

04. (B) Given $\text{Sin}(A+B)=\frac{\sqrt{3}}{2}=\text{Sin}60°$

$\therefore$ A + B = 60° $\rightarrow$ (1)

Given $\text{Cos}(A-B)=\frac{\sqrt{3}}{2}=\text{Cos}30°$

$\therefore$ A – B = 30° $\rightarrow$ (2)

$$\text{eq}(1)+(2) \Rightarrow A+\cancel{B}+A-\cancel{B}=60°+30°=90°$$

2A = 90° $\Rightarrow \angle$A = 45°

45° + B = 60°

B = 60° – 45°

B = 15°

05. (D) Volume of cylinder

$$=\pi R^2H=\pi\times\frac{4.5}{2}\times\frac{4.5}{2}\times 10\text{cm}^3$$

$$=\pi\times\frac{405}{8}\text{cm}^3 \rightarrow (1)$$

Volume of each coin

$$=\pi r^2h=\pi\times\frac{1.5}{2}\times\frac{1.5}{2}\times 0.2\text{cm}^3$$

$$=\pi\times\frac{\cancel{15}^{3}}{20}\times\frac{\cancel{15}^{3}}{\cancel{20}_{4}}\times\frac{\cancel{2}}{\cancel{10}_{5}}$$

$$=\frac{9\pi}{80} \rightarrow (2)$$

$$\therefore \text{Number of Coins}=\frac{\text{eq}(1)}{\text{eq}(2)}=\frac{\cancel{\pi}\times\frac{405}{8}\text{cm}^3}{\frac{9\cancel{\pi}}{80}\text{cm}^3}$$

$$=\frac{\cancel{405}^{45}}{\cancel{8}_{1}}\times\frac{\cancel{80}^{10}}{\cancel{9}_{1}}$$

= 450

06. (B) 6 m 5 cm = 605 cm

20 m 35 cm = 2035 cm

HCF of 2035 cm and 605 cm

605)2035(3
1815
220)605(2
440
55)220(4
220
(0)

55)1100(20
1100
(0)

HCF = 55 cm

07. (C) Given the two numbers ratio = 1 : 3 = x : $3x$

Given $x - 6 : 3x - 6 = 2 : 7$

$7(x - 6) = 2(3x - 6)$

$7x - 42 = 6x - 12$

$7x - 6x = 42 - 12 = 30$

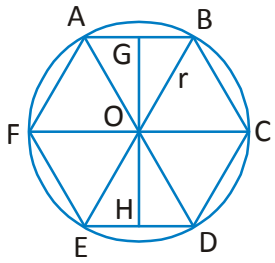
$x = 30$

$\therefore$ Other number = $3x = 3 \times 30 = 90$

08. (D) a = 2, b = 9 & c = 0

Sum of zeros $(\alpha+\beta) = \frac{-b}{a} = \frac{-9}{2}$

09. (C) $OG = \frac{\sqrt{3}}{2} r = OH$



$\therefore$ GH = GO + OH

$= \cancel{2} \times \frac{\sqrt{3}}{\cancel{2}} r = \sqrt{3} r$

10. (B) Mid point of QS =

$$\left(\frac{6+18}{2}, \frac{10+10}{2}\right) = (12,10)$$

Given (12, 10) be the midpoint of PR.

Let R be (x, y)

$$\therefore \left(\frac{10+x}{2}, \frac{4+y}{2}\right) = (12,10)$$

$\frac{10+x}{2} = 12$ and $\frac{y+4}{2} = 10$

$\therefore$ $10 + x = 24$ $y + 4 = 20$

$x = 24 - 10$ $y = 20 - 4 = 16$

$x = 14$

$\therefore$ R = (x, y) = (14, 16)

11. (B) Given AD = 14 cm

Given $DF = FG = \frac{AD}{2} = 7\,cm$

$DE = EF = \frac{DF}{2} = \frac{7\,cm}{2}$

Area of shaded region

$$= \frac{\cancel{60}^{\circ}}{\cancel{360}^{\circ}_{6}} \pi \left[3.5 \times 3.5 + 14 \times 14 - 7 \times 7\right] cm^2$$

$$= \frac{1}{\cancel{6}_{3}} \times \frac{\cancel{22}^{11}}{7} \left[12.25 + 196 - 49\right] cm^2$$

$$= \frac{11}{21} \times 159.25\,cm^2$$

$$= \frac{11}{\cancel{21}_{3}} \times \frac{\cancel{637}^{91}}{4} cm^2$$

$$= \frac{1001}{12} cm^2$$

$\therefore$ Area of unshaded portion = $\frac{1}{4} \times \pi \times 14 \times 14$

$cm^2 - \frac{1001}{12}\ cm^2$

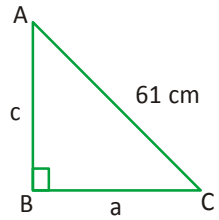
$$= \frac{\cancel{1}}{\cancel{4}_{\cancel{2}}} \times \frac{22}{\cancel{7}_{1}} \times \cancel{14}^{\cancel{7}^{1}} \times \cancel{14}^{7}\ cm^2 - \frac{1001}{12}\ cm^2$$

$= 154\ cm^2 - \frac{1001}{12}\ cm^2$

$= \frac{1848 - 1001}{12}\ cm^2$

$= \frac{847}{12}\ cm^2 = 70\frac{7}{12}\ cm^2$

12. (A) Given $\frac{1}{2}ca = 330 cm^2$



$ca = 660\ cm^2$

Given $c^2 + a^2 = 61^2 = 3721$

$(c - a)^2 = c^2 - 2ca + a^2 = c^2 + a^2 - 2ca$

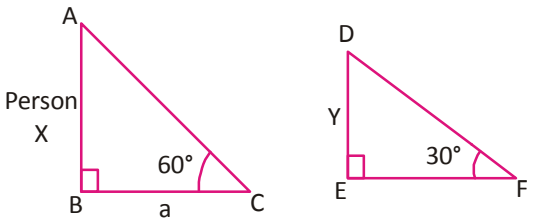
$= 3721 - 660 \times 2 = 3721 - 1320 = 2401\ cm^2$

$(c-a) = \sqrt{2401}\ cm$

$(c - a) = 49$ cm

13. (B)

$$\tan 60° = \frac{AB}{BC} = \frac{X}{BC} \Rightarrow X = \tan 60° \times BC \Rightarrow BC = \frac{X}{\sqrt{3}}$$



$$\tan 30° = \frac{DE}{EF} = \frac{Y}{EF} \Rightarrow Y = \tan(30°)EF$$

$$\Rightarrow EF = \frac{Y}{\left(\frac{1}{\sqrt{3}}\right)} = \sqrt{3}Y$$

Given BC = EF

$$\frac{X}{\sqrt{3}} = \sqrt{3}Y$$

$$\therefore X = \sqrt{3} \times \sqrt{3}Y = 3Y$$

14. (C) Volume of tank = 25 m × 22 m × 0.42 m

Volume of water flown through pipe per hour

$$= \pi r^2 h = \frac{\cancel{22}^{11}}{\cancel{7}_{1}} \times \frac{\cancel{7}}{\cancel{100}_{2}} \times \frac{7}{\cancel{100}_{1}} \times \cancel{50\ 00} m^3$$

$= 77\ m^3$ / 1 hour

$\therefore$ Time taken to rise 42 cm

$$= \frac{25 \times 22 \times 0.42 m^3}{\left(\frac{77 m^3}{1 hour}\right)}$$

$$= 25 \times \cancel{22}^{2} \times \cancel{0.42}^{0.06} \times \frac{1h}{\cancel{77}_{\cancel{11}_{1}}}$$

= 3 hours

15. (D) $$X = \left(\frac{m_1x_2 + m_2x_1}{m_1 + m_2}, \frac{m_1y_2 + m_2y_1}{m_1 + m_2}\right)$$

$$= \left(\frac{(2 \times -3) + 3 \times 7}{5}, \frac{2 \times 6 + 4 \times 3}{5}\right)$$

$$= \left(\frac{-6 + 21}{5}, \frac{12 + 12}{5}\right)$$

$$= \left(\frac{\cancel{15}^{3}}{\cancel{5}}, \frac{24}{5}\right)$$

$$= \left(3, \frac{24}{5}\right)$$

16. (B) Given $\left(2^4\right)^{\left(x^2+3x-1\right)} = \left(2^3\right)^{\left(x^2+3x+2\right)}$

$2^{4x^2+12x-4} = 2^{3x^2+9x+6}$

$\therefore 4x^2 + 12x - 4 = 3x^2 + 9x + 6$

$4x^2 - 3x^2 + 12x - 9x - 4 - 6 = 0$

$x^2 + 3x - 10 = 0$

$x^2 + 5x - 2x - 10 = 0$

$x(x + 5) - 2(x + 5) = 0$

$(x + 5)(x - 2) = 0$

$\therefore x = -5$ (or) 2

$\therefore$ sum of all values of $x = -5 + 2 = -3$

17. (C) Length of the arc $= \frac{x}{360^\circ} \times 2\pi r$

$= \frac{105^\circ}{360^\circ} \times 2 \times \frac{22}{7} \times 36$ m

= 66 m

18. (D) Sum of opposite sides are equal

(OR)

AB + CD = AD + BC

19. (A) Given a = –9 d = $a_2 - a_1$ = –5

$\therefore a_{29} - a_{21} = (a + 28d) - (a + 20d)$

= a + 28d – a – 20d = 8d

= 8 × –5

= –40

20. (C) $m^3 - m = m(m^2 - 1) = (m - 1)(m)(m + 1)$

$\therefore$ Product of three consecutive natural numbers is divisible by 1 × 2 × 3 i.e 6

21. (A) Given $\alpha + \beta = -(-1)$ & $\alpha\beta = -12$

Cubing m both sides

$(\alpha + \beta)^3 = 1^3$

$\alpha^3 + \beta^3 + 3\alpha\beta(\alpha + \beta) = 1$

$\alpha^3 + \beta^3 + 3(-12)(1) = 1$

$\alpha^3 + \beta^3 = 1 + 36 = 37$

22. (B) ABCD is a cyclic quadrilateral

$\therefore \angle A + \angle C = 180^\circ$ & $\angle B + \angle D = 180^\circ$

$2x - 3^\circ + 2y + 17^\circ = 180^\circ$

$y + 7^\circ + 4x - 9^\circ = 180^\circ$

$2x + 2y + 14^\circ = 180^\circ$

$4x + y = 182^\circ \rightarrow 2$

$2x + 2y = 180^\circ - 14^\circ$

$2(x + y) = 166^\circ$

$x + y = \frac{166^\circ}{2} = 83^\circ \rightarrow (1)$

Solving eq (1) & (2) we get $x = 33^\circ$ & $y = 50^\circ$

$\therefore \angle A + \angle B = 2x - 3^\circ + y + 7^\circ = 63^\circ + 50^\circ + 7^\circ = 120^\circ$

23. (D) Let the three consecutive positive integers be x, $x + 1$, $x + 2$

Given $x^2 + (x + 1)^2 + (x + 2)^2 = 50$

$x^2 + x^2 + 2x + 1 + x^2 + 4x + 4 = 50$

$3x^2 + 6x - 45 = 0$

$3(x^2 + 2x - 15) = 0$

$x^2 + 5x - 3x - 15 = \frac{0}{3}$

$x(x + 5) - 3(x + 5) = 0$

$(x - 3)(x + 5) = 0$

$\therefore x = 3$ (or) –5

$x + 1 = 3 + 1 = 4$ [$\because x = -5$ is rejected because it is negative integer]

$x + 2 = 3 + 2 = 5$

$\therefore x + x + 1 + x + 2 = 3 + 4 + 5 = 12$

24. (D) Given $a_8 = a + 7d = m \rightarrow (1)$

$a_{12} = a + 11d = n \rightarrow (2)$

eq (2) – eq (1) $\Rightarrow 4d = n - m$

$d = \frac{n - m}{4}$

$a + \frac{7(n - m)}{4} = m$

$a + \frac{7n - 7m}{4} = m$

$a = m - \left(\frac{7n - 7m}{4}\right) = \frac{4m - 7n + 7m}{4}$

$= \frac{11m - 7n}{4}$

$a_{10} = a + 9d = \frac{11m - 7n}{4} + \frac{9(n - m)}{4}$

$= \frac{11m - 7n + 9n - 9m}{4} = \frac{2m + 2n}{4}$

$= \left(\frac{m + n}{2}\right)$

25. (C) Given $\angle ABC = 90° \Rightarrow AC^2 = AB^2 + BC^2$

$(13\ cm)^2 = (12\ cm)^2 + BC^2$

$169\ cm^2 - 144\ cm^2 = BC^2$

$BC = \sqrt{25cm^2} = 5cm$

In ΔBCD, given $\angle D = 90°$ $BC^2 = BD^2 + DC^2$

$(5\ cm)^2 = (3\ cm)^2 + DC^2$

$25\ cm^2 - 9\ cm^2 = DC^2$

$DC = \sqrt{16cm^2} = 4cm$

PHYSICS

26. (C) $l_1 : l_2 = 1 : 3$, $r_1 : r_2 = 3 : 1$, Area $= A = \pi r^2$

$A_1 : A_2 = r_1^2 : r_2^2 = 9 : 1$

They are made up of the same material. So, the resistivity ρ is the same.

$$\rho = \frac{RA}{l},\ \frac{R_1A_1}{l_1} = \frac{R_2A_2}{l_2}$$

$$\frac{R_1}{R_2} = \frac{l_1}{l_2} \times \frac{A_2}{A_1} = \frac{1}{3} \times \frac{9}{1} = \frac{3}{1}$$

$R_1 : R_2 = 3 : 1$

27. (A) A ray of light incident and parallel to the principal axis, after reflection will pass through the focus.

28. (B) For an equilateral prism the ray inside the prism will be parallel to the base at minimum deviation At minimum deviation

$$r_1 = r_2 = \frac{A}{2} = 30°$$

$$\therefore \quad \mu = \frac{\sin i_1}{\sin r_1} = \frac{\sin 60^\circ}{\sin 30^\circ} = \frac{(\sqrt{3}/2)}{(1/2)}$$

or $\mu = \sqrt{3}$

29. (A) $${}^{d}\mu_a = \frac{5}{2} = \frac{\mu_a}{\mu_d}$$

$${}^{g}\mu_a = \frac{3}{2} = \frac{\mu_a}{\mu_g}$$

$${}^{g}\mu_d = \frac{\mu_d}{\mu_a} \times \frac{\mu_a}{\mu_g} = \frac{2}{5} \times \frac{3}{2} = \frac{3}{5}.$$

30. (C) The magnetic field lines due to a current-carrying wire encircle the wire in closed loops. As the magnetic force is always per-pendicular to the charged particle's velocity vector, it can do work on the changed particle; therefore, it cannot change the particle's kinetic energy. If the charged particle's velocity is parallel (or antiparallel) to the magnetic field lines, then the particle will not exert magnetic force.

31. (B) For minimum deviation, the ray inside the equilateral glass prism i.e., QR is horizontal and parallel to the base of the prism.

32. (C) Size of person's image is $\frac{1}{6}$th of his original height.

u = Distance of person from the mirror = – 30 cm

Magnification $m = \frac{1}{6} = \frac{-v}{-30}$

v = 5 cm

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u},\ \frac{1}{f} = \frac{1}{5} + \frac{1}{-30},\ f = 6\,cm$$

33. (C) The magnetic field inside a straight current carrying solenoid does not depend on its radius.

34. (D) Due to refraction of light in the atmosphere, stars appear to twinkle, the sun appears to be oval in the morning and evening, the period of visibility of the sun is also increased.

35. (B) l = 20.0 cm = 0.20 m

$A = 4.00 \times 10^{-4}\ m^2, \rho = 2.82 \times 10^{-8}\ \Omega$-m

Resistance =

$$R = \frac{\rho l}{A} = \frac{2.82 \times 10^{-8} \times 0.20}{4.00 \times 10^{-4}} = 1.41 \times 10^{-5}\Omega$$

CHEMISTRY

36. (D) Magnesium is a metal, and metals generally form ionic bonds only. The other elements are non-metals and can form covalent bonds.

37. (B) In the given reaction, hydrogen sulphide is acting as a reducing agent.

38. (B) The weak attractive forces present in graphite are called vander waals forces.

39. (D) A solution of NaCl in water is neutral (7).$(NH_4)_2SO_4$ solution is acidic (5 to 6) . CH_3COONH_4 solution is slightly acidic or alkaline (almost neutral). K_2CO_3 solution is alkaline in nature. (10.52 to 11.36)

K_2CO_3 has the highest pH between 10.52 to 11.36. It is formed due to reaction between a strong base KOH and a weak acid H_2CO_3 as given below :

$2KOH + H_2CO_3 \rightarrow K_2CO_3 + 2H_2O$.

40. (B) Sodium metal reacts vigorously with cold water to form sodium hydroxide and release of hydrogen gas as given below :

$$\underset{\text{Sodium}}{2Na\ (s)} + \underset{\substack{\text{Water}\\\text{(Cold)}}}{2H_2O\ (l)} \longrightarrow$$

$$\underset{\text{Sodium hydroxide}}{2NaOH\ (aq)} + \underset{\text{Hydrogen}}{H_2\ (g)} + \text{Heat}$$

The reaction of sodium metal with water is highly exothermic (heat producing) due to which the hydrogen gas formed during the reaction catches fire and burns causing little explosions. Thus, sodium is a very reactive metal.

41. (D) We can balance a chemical equation by adjusting the coefficients in front of the chemical formulae.

42. (C) Statements (A), (B) and (D) are true of diamond. Diamond is a bad conductor of electricity.

43. (D) Plaster of Paris is prepared by heating gypsum ($CaSO_4.2H_2O$) to a temperature of 100°C (373 K) in a kiln. When gypsum is heated, it loses three-fourths of its water of crystallisation and forms Plaster of Paris as given below :

$$\underset{\text{Gypsum}}{CaSO_4.2H_2O} \xrightarrow[\text{(373 K)}]{\text{Heat to 100°C}} \underset{\text{Plaster of Paris}}{CaSO_4.\frac{1}{2}H_2O} + \underset{\text{Water}}{1\frac{1}{2}H_2O}$$

44. (B) Out of the four valence electrons, it forms bonds with 3 other carbon atoms and one electron is free.

45. (B) Potassium and Sodium react vigorously with oxygen in air and catch fire. These metals are stored under kerosene oil to prevent oxidation.

BIOLOGY

46. (C) The function of the cilia is to produce sweeping movements to remove excess mucus.

47. (C) The site of implantation of a fertilised egg cell is at part labelled 3.

48. (D) The gas X that is released is oxygen. It can light up a glowing splinter. It is needed for combustion. It is needed by all organisms.

49. (B) X - carbon dioxide;Y - sunlight and Z - oxygen.

50. (A) The correct sequence of the water movement that is influenced by water potential is root xylem $\rightarrow$ stem xylem $\rightarrow$ leaf xylem $\rightarrow$ atmosphere.

51. (C) Fats are absorbed by the lacteals. The lymph in the lacteals has a milky appearance due to its high fat content and is called chyle.

52. (B) The removal of a ring of bark around the trunk can cause the removal of all tissues external to the xylem, including the phloem. Thus, the translocation of sugars and amino acids from the leaves to the roots is affected. However, water can continue to be transported up the trunk since the xylem would remain intact.

53. (B) X - phloem; Y - xylem.

The phloem in stems is always on the outside.

54. (B) X is platelet,Y is Prothrombin and Z is Fibrinogen.

55. (C) Anthers split open $\rightarrow$ Pollen grain ataches to stigma $\rightarrow$ Growth of pollen tube $\rightarrow$ Male gamete fuses with female gamete $\rightarrow$ Seed develop inside ovary $\rightarrow$ The zygote forms an embryo in the seed.

CRITICAL THINKING

56. (C) When we sharpen a pencil using a sharpner, the sharp edges would be the first to be cut more. (i) is opposite to this while in (iii) some edges have lesser cuts. (ii) and (iv) are actually the same, just that (iv) is a slight rotated version of (ii).

57. (D)

58. (A) No. of '8's before the 50th '8' of the number = 49

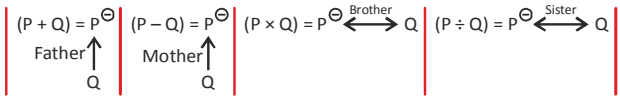
No. of '5's before the 50th '8' of the number = 1 + 2 + 3 + ... + 49

$$\left.\begin{array}{c} 1+49=50 \\ 2+48=50 \\ 3+47=50 \\ \vdots \\ 24+26=50 \\ 25 \end{array}\right\} 24 \text{ points}$$

$\therefore$ Total no. of digits before the 50th '8' = 49 + 50 × 24 + 25 = 1274

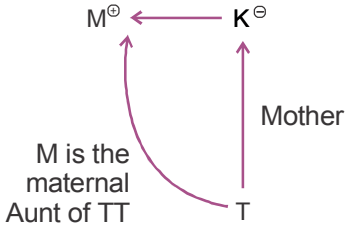
59. (C) Using both information, if 500 tickets were sold and at most 10 persons can come on a ticket, then at most 5000 persons can come on a ticket. So, at least 5600 – 5000 = 600 persons came without a ticket. Hence, question can be answered using both information.

60. (B) By decoding given information with symbols of family diagram, we get

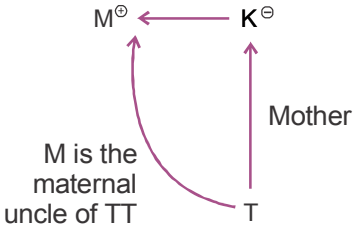


By applying above decoding method, we can check all the options for the required relationship

(A) (M ÷ K - T) = Rejected



(B) (M × K – T) = selected



Hence, there is no need to check other options.