Max Marks: 300 **JR_WEEK-7 (27-07-2026)** **Time: 180 mins**

Chemistry

1. Which of the following sets of elements follows Newland's octave rule :-

A) Be, Mg, Ca **B)** Na, K, Rb
C) F, Cl, Br **D)** B, Al, Ga

2. Atomic wt. of P is 31 and Sb is 120. What will be the atomic wt. of As, as per Dobereiners triad rule :-

A) 151 **B)** 75.5
C) 89.5 **D)** Unpredictable

3. The places that were left empty by Mendeleev's were, for:-

A) Aluminium & Silicon **B)** Galium and germinium
C) Arsenic and antimony **D)** Molybdenum and tungstun

4. Which is not anomalous pair of elements in the Medeleev's periodic table:-

A) Ar and K **B)** Co and Ni
C) Te and I **D)** Al and Si

5. IUPAC name of the element placed just after actinide series :-

A) Unniltrium **B)** Unnilpentium
C) Unnilquadium **D)** Ununbium

6. The element with atomic number $Z = 115$ will be placed in :-

A) 7th period, IA group **B)** 8th period, IVA group
C) 7th period, VA group **D)** 6th period, VB group

7. Which of the following sequence contains atomic number of only representative elements

A) 55, 12, 18, 53 **B)** 13, 33, 54, 83
C) 3, 33, 53, 87 **D)** 22, 33, 55, 66

8. Which of the following order of atomic/ionic radius is not correct :–

A) $I^- > I > I^+$ **B)** $Mg^{+2} > Na^+ > F^-$
C) $P^{+5} < P^{+3}$ **D)** $Li > Be > B$

9. The correct order of stability of Al^+, Al^{+2}, Al^{+3} is :-

A) $Al^{+3} > Al^{+2} > Al^+$ **B)** $Al^{+2} > Al^{+3} > Al^+$
C) $Al^{+2} < Al^+ > Al^{+3}$ **D)** $Al^{+3} > Al^+ > Al^{+2}$

10. Among the following elements (Whose electronic configuration is given below) the one having the highest ionisation energy is

A) $[Ne]3s^23p^3$ **B)** $[Ne]3s^23p^4$
C) $[Ne]3s^23p^5$ **D)** $[Ar]3d^{10}4s^24p^2$

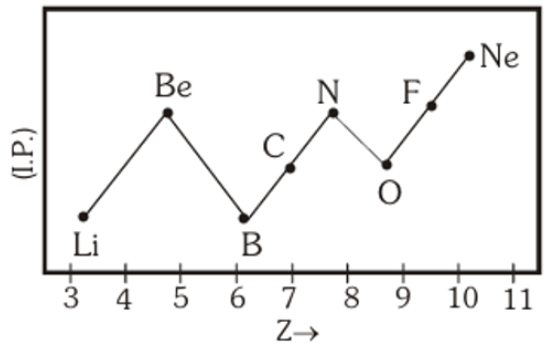
11. Successive ionisation energies of an element 'X' are given below (in K. Cal): $IP_1 = 165, IP_2 = 195, IP_3 = 556, IP_4 = 595$. Electronic configuration of 'X' is:-

A) $1s^2, 2s^22p^6, 3s^23p^2$ **B)** $1s^2, 2s^1$
C) $1s^2, 2s^22p^2$ **D)** $1s^2, 2s^22p^6, 3s^2$

12. Second IP of which of the element is maximum–

A) Lithium **B)** Oxygen
C) Nitrogen **D)** Fluorine

13. Following graph shows variation of I.P. with atomic number in second period (Li – Ne). Value of I.P. of Na(11) will be :-



A) Above Ne
B) Below Ne but above O
C) Below Li
D) Between N and O

14. Consider the following ionisation reactions: $A_{(g)} \rightarrow A^{+}_{(g)} + e^{-}$ IE in (KJ/mol) is A_1 $A^{+}_{(g)} \rightarrow A^{+2}_{(g)} + e^{-}$ IE in (KJ/mol) is A_2 $A^{+2}_{(g)} \rightarrow A^{+3}_{(g)} + e^{-}$ IE in (KJ/mol) is A_3 Then correct order of IE is :-

A) $A_1 > A_2 > A_3$
B) $A_1 = A_2 = A_3$
C) $A_1 < A_2 < A_3$
D) $A_3 = A_2 < A_1$

15. In which of the following process, least energy is required :-

A) $F^{-}_{(g)} \rightarrow F_{(g)} + e^{-}$
B) $P^{-}_{(g)} \rightarrow P_{(g)} + e^{-}$
C) $S^{-}_{(g)} \rightarrow S_{(g)} + e^{-}$
D) $Cl^{-}_{(g)} \rightarrow Cl_{(g)} + e^{-}$

16. The electronegativities of the following elements: H, O, F, S and Cl increase in the order :-

A) $H < O < F < S < Cl$
B) $Cl < H < O < F < S$
C) $H < S < O < Cl < F$
D) $H < S < Cl < O < F$

17. Which of the following does not act as an amphoteric oxide ?

A) Al_2O_3
B) ZnO
C) BeO
D) NO

18. The anomalous behaviour of 2nd period elements from rest of the members of their respective families is due to :-

A) small size
B) large charge/radius ratio
C) higher Z_{eff}
D) All

19. Amongst the elements with following electronic configurations, which one of them may have the highest ionization energy?

A) $[Ne]3s^2 3p^1$
B) $[Ne]3s^2 3p^3$
C) $[Ne]3s^2 3p^2$
D) $[Ar]3d^{10}4s^2 4p^3$

20. The formation of the oxide ion, $O^{2-}_{(g)}$, from oxygen atom requires first an exothermic and then an endothermic step as shown below:

$O_{(g)} + e^{-} \rightarrow O^{-}_{(g)}; \Delta_f H^{-} = -141 \text{ kJ mol}^{-1}$

$O^{-}_{(g)} + e^{-} \rightarrow O^{2-}_{(g)}; \Delta_f H^{-} = +780 \text{ kJ mol}^{-1}$

Thus process of formation of O^{2-} in gas phase is unfavourable even though O^{2-} is isoelectronic with neon. It is due to the fact that:

A) Oxygen is more electronegative
B) Addition of electron in oxygen results in larger size of the ion
C) Electron repulsion outweighs the stability gained by achieving noble gas configuration
D) O^{-} ion has comparatively smaller size than oxygen atom

21. How many of the following species are isoelectronic with Neon (Ne)? List:
$O^{2-}, F^{-}, Na^{+}, Mg^{2+}, Al^{3+}, N^{3-}, Cl^{-}$

22. Among the following elements, how many have a more negative electron gain enthalpy than fluorine (F)? List:
Cl, Br, I, O, S

23. For Magnesium (Mg), after the removal of how many electrons is there a large jump in ionization enthalpy?

24. How many among the following pairs show diagonal relationships? Pairs:
$Li - Mg, Be - Al, B - Si, C - P, N - S$

25. How many of the following elements have a lower first ionization enthalpy than that of the element immediately preceding them in the same period? List: Be, B, N, O, F

Maths

26. If $\sin\left(\frac{\pi}{18}\right)\sin\left(\frac{5\pi}{18}\right)\sin\left(\frac{7\pi}{18}\right) = K$, then the value of $\sin\left(\frac{10K\pi}{3}\right)$ is:

A) $\frac{\sqrt{3}+1}{2\sqrt{2}}$ **B)** $\frac{\sqrt{3}-1}{\sqrt{2}}$

C) $\frac{\sqrt{3}}{2}$ **D)** $\frac{1}{2}$

27. Let $\frac{\pi}{2} < \theta < \pi$ and $\cot\theta = -\frac{1}{2\sqrt{2}}$. Then the value of $\sin\left(\frac{15\theta}{2}\right)(\cos 8\theta + \sin 8\theta) + \cos\left(\frac{15\theta}{2}\right)(\cos 8\theta - \sin 8\theta)$ is equal to :

A) $\frac{\sqrt{2}-1}{\sqrt{3}}$ **B)** $\frac{\sqrt{2}}{\sqrt{3}}$

C) $\frac{1-\sqrt{2}}{\sqrt{3}}$ **D)** $-\frac{\sqrt{2}}{\sqrt{3}}$

28. For $\alpha, \beta \in (0, \pi/2)$, let $3\sin(\alpha+\beta) = 2\sin(\alpha-\beta)$ and a real number k be such that $\tan\alpha = k\tan\beta$. Then, the value of k is equal to:

A) 5 **B)** $-2/3$

C) -5 **D)** $2/3$

29. If $\sin x = -\frac{3}{5}$, where $\pi < x < \frac{3\pi}{2}$, then $80(\tan^2 x - \cos x)$ is equal to:

A) 109 **B)** 108

C) 19 **D)** 18

30. The value of $2\sin(12^\circ) - \sin(72^\circ)$ is:

A) $\frac{\sqrt{5}(1-\sqrt{3})}{4}$ **B)** $\frac{1-\sqrt{5}}{8}$

C) $\frac{\sqrt{3}(1-\sqrt{5})}{2}$ **D)** $\frac{\sqrt{3}(1-\sqrt{5})}{4}$

31. $16\sin(20^\circ)\sin(40^\circ)\sin(80^\circ)$ is equal to:

A) $\sqrt{3}$ **B)** $2\sqrt{3}$

C) 3 **D)** $4\sqrt{3}$

32. If $\cot\alpha = 1$ and $\sec\beta = -\frac{5}{3}$, where $\pi < \alpha < \frac{3\pi}{2}$ and $\frac{\pi}{2} < \beta < \pi$, then the value of $\tan(\alpha+\beta)$ and the quadrant in which $\alpha+\beta$ lies, respectively are:

A) $-\frac{1}{7}$ and IV^{th} quadrant **B)** 7 and I^{st} quadrant

C) -7 and IV^{th} quadrant **D)** $\frac{1}{7}$ and I^{st} quadrant

33. The value of $\cot\frac{\pi}{24}$ is:

A) $\sqrt{2}+\sqrt{3}+2-\sqrt{6}$ **B)** $\sqrt{2}+\sqrt{3}+2+\sqrt{6}$

C) $\sqrt{2}-\sqrt{3}-2+\sqrt{6}$ **D)** $3\sqrt{2}-\sqrt{3}-\sqrt{6}$

34. If $0 < x < \pi$ and $\cos x + \sin x = \frac{1}{2}$, then $\tan x$ is:

A) $\frac{(1-\sqrt{7})}{4}$ **B)** $\frac{(4-\sqrt{7})}{3}$

C) $\frac{(4+\sqrt{7})}{3}$ **D)** $\frac{(1+\sqrt{7})}{4}$

35. Period of $\cos\left(x + \frac{x}{3} + \frac{x}{3^2} + \ldots\right)$ is

A) $\frac{\pi}{3}$ **B)** $\frac{2\pi}{3}$

C) π **D)** $\frac{4\pi}{3}$

36. Period of $\cos^6 x + \sin^6 x$ is

A) $\frac{\pi}{2}$ **B)** π

C) $\frac{3\pi}{2}$ **D)** 2π

37. Period of $\sin x \sin(120^\circ - x)\sin(120^\circ + x)$ is

A) $\frac{\pi}{3}$ **B)** $\frac{2\pi}{3}$

C) π **D)** $\frac{\pi}{2}$

38. The minimum and maximum values of $8\cos 3x - 15\sin 3x$ are

A) -7, 7 **B)** -23, 23

C) -17, 17 **D)** -15, 8

39. The maximum value of $\frac{3}{5\sin x - 12\cos x + 19}$ is

A) 1 **B)** $\frac{1}{2}$

C) $\frac{1}{3}$ **D)** $\frac{1}{4}$

40. The range of $\sin^6 x + \cos^6 x$ is

A) $[\frac{-1}{4}, \frac{1}{4}]$ **B)** $[\frac{1}{4}, \frac{1}{2}]$

C) $[\frac{1}{4}, 1]$ **D)** $[\frac{-1}{2}, \frac{-1}{4}]$

41. The minimum and maximum values of $\sin^2(60^\circ - x) + \sin^2(60^\circ + x)$ are

A) $\frac{-1}{2}, \frac{1}{2}$ **B)** $1, \frac{1}{2}$

C) $\frac{1}{2}, \frac{3}{2}$ **D)** $2, \frac{2}{3}$

42. The period of $f(x) = \sin x + \{x\}$, where $\{x\}$ is fractional part of x is

A) 0 **B)** 1

C) 2π **D)** Does not exist

43. The period of $f(x) = \sin\frac{\pi x}{n!} - \cos\frac{\pi x}{(n+1)!}$ is

A) $(n+1)!$ **B)** $2(n+1)!$
C) $2(n)!$ **D)** $\frac{(n+1)}{2!}$

44. The period of the function $f(x) = [6x+7] + \cos\pi x - 6x$, where [.]denotes the greatest integer function, is

A) 3 **B)** 2π
C) 2 **D)** π

45. The function $\sin(x^2) + \cos\sqrt{x}$ is

A) Periodic with period π **B)** Periodic with period 2π
C) Periodic with period 0 **D)** Not a periodic function

46. If $A = \frac{\sin 3^\circ}{\cos 9^\circ} + \frac{\sin 9^\circ}{\cos 27^\circ} + \frac{\sin 27^\circ}{\cos 81^\circ}$ and $B = \tan 81^\circ - \tan 3^\circ$, then $\frac{B}{A}$ is equal to _____.

47. If $n \in \mathbb{N}$, and the period of $\frac{\cos nx}{\sin(x/n)}$ is 4π, then $n =$

48. The period of the function $|\sin^3\frac{x}{2}| + |\cos^5\frac{x}{5}|$ is___π

49. Period of $\tan\left(\frac{3\pi x}{4}\right) - 2\sec\left(\frac{\pi x}{3}\right) + 5\sin\left(\frac{2\pi x}{5}\right)$ is

50. If the value of $\frac{3\cos 36^\circ + 5\sin 18^\circ}{5\cos 36^\circ - 3\sin 18^\circ}$ is $\frac{a\sqrt{5}-b}{c}$, where a, b, c are natural numbers and $gcd(a,c) = 1$, then $a+b+c$ is equal to:

Physics

51. A car travels $\frac{1}{3}$ rd of the total distance with speed v_1 and the remaining $\frac{2}{3}$rd distance with speed v_2. What is the average speed of the car for the entire journey?

A) $\frac{3v_1v_2}{2v_1+v_2}$ **B)** $\frac{v_1+2v_2}{3}$
C) $\frac{2v_1v_2}{v_1+v_2}$ **D)** $\frac{3v_1v_2}{v_1+2v_2}$

52. A car travels one-third of the total distance with velocity v_0. The remaining distance is covered with velocity v_1 for half the time and with velocity v_2 for the rest half. The average velocity of the car for the whole journey is:

A) $\frac{3v_0(v_1+v_2)}{v_0+4(v_1+v_2)}$ **B)** $\frac{3v_0(v_1+v_2)}{4v_0+v_1+v_2}$
C) $\frac{v_0+v_1+v_2}{3}$ **D)** $\frac{2v_0(v_1+v_2)}{2v_0+v_1+v_2}$

53. A runner covers the first 100 meters with a speed of 5 m/s and the next 100 meters with a speed of 10 m/s. The average speed of the runner is:

A) 7.5 m/s **B)** 6.67 m/s
C) 8.0 m/s **D)** 5.5 m/s

54. A particle moves in the east direction with $6\ \mathrm{m/s}$ for $2\ \mathrm{s}$ then northwards with $8\ \mathrm{m/s}$ for $2\ \mathrm{s}$. Average velocity of the particle is

A) $4\ \mathrm{m/s}$ **B)** $5\ \mathrm{m/s}$
C) $7\ \mathrm{m/s}$ **D)** $14\ \mathrm{m/s}$

55. A cyclist travels a distance S on a straight road in 4 hours and then returns to the starting point in the next 2 hours. Its average speed and average velocity are respectively:

A) $\frac{S}{3}, 0$ **B)** $\frac{S}{6}, 0$
C) $\frac{S}{2}, \frac{S}{6}$ **D)** $0, \frac{S}{3}$

56. A car travels one-fourth of the total distance with a speed of $20\ \mathrm{km/hr}$ and the remaining distance with a speed of $60\ \mathrm{km/hr}$. The average speed of the car is:

A) $30\ \mathrm{km/hr}$ **B)** $40\ \mathrm{km/hr}$
C) $45\ \mathrm{km/hr}$ **D)** $50\ \mathrm{km/hr}$

57. A student walks on a straight road from his home to a library $3\ \mathrm{km}$ away with a speed of $6\ \mathrm{km/h}$. Finding the library closed, he instantly turns and walks back home with a speed of $9\ \mathrm{km/h}$. The average speed of the student over the interval of time 0 to $40\ \mathrm{min}$ is equal to

A) $6\ \mathrm{km/h}$ **B)** $\frac{27}{4}\ \mathrm{km/h}$
C) $7\ \mathrm{km/h}$ **D)** $\frac{15}{2}\ \mathrm{km/h}$

58. A train travels the first half of the distance between two stations at a speed of $40\ \mathrm{km/hr}$ and the second half of the distance at $60\ \mathrm{km/hr}$. The average speed of the train for the whole journey is

A) $50\ \mathrm{km/hr}$ **B)** $48\ \mathrm{km/hr}$
C) $45\ \mathrm{km/hr}$ **D)** $52\ \mathrm{km/hr}$

59. A student walks to school at a distance of 12 km with a constant speed of 3 km/hr and walks back with a constant speed of 4 km/hr. His average speed for the round trip expressed in km/hour is

A) $\frac{24}{7}$ **B)** $\frac{7}{24}$
C) 3.5 **D)** 7

60. A car travels from A to B at a speed of $30\ \mathrm{km/hr}$ and returns at a speed of $60\ \mathrm{km/hr}$. The average speed of the car for the whole journey is

A) $35\ \mathrm{km/hr}$ **B)** $40\ \mathrm{km/hr}$
C) $45\ \mathrm{km/hr}$ **D)** $50\ \mathrm{km/hr}$

61. A train travels from station P to Q at a speed of $40\ \mathrm{km/h}$ and returns at a speed of $60\ \mathrm{km/h}$. The average speed of the train for the whole journey is

A) $50\ \mathrm{km/h}$ **B)** $48\ \mathrm{km/h}$
C) $45\ \mathrm{km/h}$ **D)** $100\ \mathrm{km/h}$

62. A car travels the first half of a distance between two places at a speed of $40\ \mathrm{km/hr}$ and the second half of the distance at $60\ \mathrm{km/hr}$. The average speed of the car for the whole journey is

A) $50\ \mathrm{km/hr}$ **B)** $48\ \mathrm{km/hr}$
C) $55\ \mathrm{km/hr}$ **D)** $45\ \mathrm{km/hr}$

63. A car travels the first half of the distance between two cities at a speed of $40\ \mathrm{km/h}$ and the second half of the distance at $60\ \mathrm{km/h}$. The average speed of the car for the whole journey is

A) $50\ \mathrm{km/h}$ **B)** $48\ \mathrm{km/h}$
C) $45\ \mathrm{km/h}$ **D)** $55\ \mathrm{km/h}$

64. The position x of a particle varies with time t as $x = At^3 - Bt^2$. The acceleration of the particle will be zero at time t equal to

A) $\frac{A}{B}$ **B)** $\frac{B}{A}$
C) $\frac{B}{3A}$ **D)** $\frac{3B}{A}$

65. The displacement of a particle, moving in a straight line, is given by $s = 3t^2 + 5t + 2$ where s is in metres and t in seconds. The acceleration of the particle is

A) $3\ \mathrm{m/s^2}$ **B)** $5\ \mathrm{m/s^2}$
C) $6\ \mathrm{m/s^2}$ **D)** $10\ \mathrm{m/s^2}$

66. The motion of a particle is described by the equation $x = a + bt^2$ where $a = 20\ \mathrm{m}$ and $b = 2\ \mathrm{m/s^2}$. Its instantaneous velocity at time $3\ \mathrm{sec}$ will be

A) $6\ \mathrm{m/s}$ **B)** $12\ \mathrm{m/s}$
C) $18\ \mathrm{m/s}$ **D)** $24\ \mathrm{m/s}$

67. A man walks on a straight road from his home to a market $3\ \mathrm{km}$ away with a speed of $6\ \mathrm{km/h}$. Finding the market closed, he instantly turns and walks back home with a speed of $9\ \mathrm{km/h}$. The average speed of the man over the interval of time 0 to $40\ \mathrm{min}$ is equal to

A) $6\ \mathrm{km/h}$ **B)** $\frac{27}{4}\ \mathrm{km/h}$
C) $\frac{30}{4}\ \mathrm{km/h}$ **D)** $\frac{45}{8}\ \mathrm{km/h}$

68. If a car covers $\frac{1}{3}$rd of the total distance with speed v_1 and the remaining $\frac{2}{3}$rd distance with speed v_2, then the average speed is

A) $\frac{2v_1v_2}{v_1+v_2}$ **B)** $\frac{3v_1v_2}{2v_1+v_2}$
C) $\frac{v_1+2v_2}{3}$ **D)** $\sqrt{v_1v_2}$

69. The displacement y of a particle is given by $y = 2at^2 - bt^3$. The acceleration of the particle will be zero at time t equal to

A) $\frac{a}{b}$ **B)** $\frac{2a}{3b}$
C) $\frac{3a}{2b}$ **D)** $\frac{a}{3b}$

70. The position x of a particle varies with time t as $x = 4t^2 - 6t + 3$. The acceleration of the particle is

A) $4\ \mathrm{m/s^2}$ **B)** $-6\ \mathrm{m/s^2}$
C) $8\ \mathrm{m/s^2}$ **D)** $2\ \mathrm{m/s^2}$

71. A bus travels one-third of its total journey at a speed of 30km/hr and the remaining distance at60km/hr. What is the average speed of the bus for the entire journey_____km/hr?

72. **A particle moving in a straight line covers half the distance with a speed of $10\ \mathrm{m/s}$. The other half of the distance is covered in two equal time intervals with speeds of $20\ \mathrm{m/s}$ and $40\ \mathrm{m/s}$ respectively. The average speed of the particle during this motion is_____m/s:**

73. **A car travels one-third of the total distance with a speed of $10\ \mathrm{m/s}$. The remaining distance is covered in two equal time intervals with speeds of $30\ \mathrm{m/s}$ and $50\ \mathrm{m/s}$ respectively. The average speed of the car for the whole journey is:**

74. **A body travels one-third of the total distance with speed v, the second one-third with speed 3v, and the final one-third with speed6v. Its average speed is___v:**

75. **A car travels a distance of 60 km at a speed of 30 km/h and another 60 km at a speed of 60 km/h. The average speed for the entire trip is:**

ANSWER KEY

Chemistry

1.	**1**	8.	**1**	15.	**2**	22.	**2**
2.	**2**	9.	**4**	16.	**4**	23.	**2**
3.	**2**	10.	**3**	17.	**4**	24.	**2**
4.	**4**	11.	**4**	18.	**4**	25.	**?**
5.	**3**	12.	**1**	19.	**2**		
6.	**3**	13.	**3**	20.	**3**		
7.	**3**	14.	**3**	21.	**3**		

Maths

26.	**1**	33.	**2**	40.	**3**	47.	**2**
27.	**3**	34.	**3**	41.	**3**	48.	**10**
28.	**3**	35.	**4**	42.	**4**	49.	**60**
29.	**1**	36.	**1**	43.	**2**	50.	**52**
30.	**4**	37.	**2**	44.	**3**		
31.	**2**	38.	**3**	45.	**4**		
32.	**1**	39.	**2**	46.	**2**		

Physics

51.	**1**	58.	**2**	65.	**3**	72.	**15**
52.	**2**	59.	**1**	66.	**2**	73.	**20**
53.	**2**	60.	**2**	67.	**2**	74.	**2**
54.	**2**	61.	**2**	68.	**2**	75.	**40**
55.	**1**	62.	**2**	69.	**2**		
56.	**2**	63.	**2**	70.	**3**		
57.	**2**	64.	**3**	71.	**45**		

SOLUTIONS

Q1.

Answer: A

Explanation:
Newland's Octave rule states that when elements are arranged by increasing atomic mass, every 8th element has similar properties to the 1st. This pattern is only valid up to Calcium (Ca).

Q2.

Answer: B

Explanation:
In a Dobereiner triad, the atomic weight of the middle element is approximately equal to the arithmetic average of the weights of the first and third elements.

Q3.

Answer: B

Explanation:
Mendeleev predicted the properties and positions of then-unknown elements, leaving gaps in his table for "Eka-Aluminium" (Gallium) and "Eka-Silicon" (Germanium).

Q4.

Answer: D

Explanation:
Anomalous pairs were those placed out of atomic weight order to maintain chemical similarity. Aluminum (26.9) and Silicon (28.1) follow the correct increasing order of weights.

Q5.

Answer: C

Explanation:
The actinide series ends at atomic number Z=103. The next element is Z=104, which is named Unnilquadium (1=un, 0=nil, 4=quad) per IUPAC rules.

Q6.

Answer: C

Explanation:
Elements with Z=104 to 118belong to the 7th period. The group is determined by the last two digits (15), which corresponds to the VA group (Pnicogens).

Q7.

Answer: C

Explanation:
Representative elements are those in the s-block and p-block, excluding noble gases (group 18). Sequence C consists of Li, As, I, and Fr.

Q8.

Answer: A

Q9.

Answer: D

Explanation:
Stability is determined by ionization energy differences (ΔIE). Al^{+3} is highly stable due to its noble gas configuration, while Al^{+} is more stable than Al^{+2} because $\Delta IE_1 \text{ to } IE_2 > 11eV$.

Q10.

Answer: C

Explanation:
Ionization energy increases from left to right across a period. Halogens (configuration C) have the highest effective nuclear charge and thus the highest ionization energy in their period.

Q11.

Answer: D

Explanation:
A massive jump in IP values occurs after all valence electrons are removed. The jump between IP_2 and IP_3 ($195 \rightarrow 556$) indicates the element has 2 valence electrons.

Q12.

Answer: A

Explanation:
After losing one electron, Lithium (Li^{+}) achieves the highly stable Helium configuration ($1s^2$). Removing a second electron requires a huge amount of energy.

Q13.

Answer: C

Explanation:
Ionization potential decreases down a group because atomic size increases. Since Sodium (Na) is below Lithium (Li) in group 1, its IP is lower than that of Lithium.

Q14.

Answer: C

Explanation:
Successive ionization energies for any atom always increase ($IE_1 < IE_2 < IE_3 \ldots$) because it is increasingly difficult to remove an electron from a more positively charged ion.

Q15.

Answer: B

Explanation:
The energy to remove an electron from an anion is equal to the Electron Affinity (EA) of the neutral atom. Phosphorus (P) has a stable half-filled$3p^3$ configuration and thus the lowest EA among these.

Q16.

Answer: D

Explanation:
Electronegativity values on the Pauling scale are: $H(2.1), S(2.5), Cl(3.0), O(3.5)$, and $F(4.0)$. The increasing order is $H < S < Cl < O < F$.

Q17.

Answer: D

Explanation:
Amphoteric oxides like Al_2O_3, ZnO, and BeO react with both acids and bases. NO is classified as a neutral oxide.

Q18.

Answer: D

Explanation:
Second-period elements differ from their group members because of their unique properties: exceptionally small size, high ionization potential (linked to Z_{eff}), and high ionic potential (charge/radius ratio).

Q19.

Answer: B

Explanation:
Ionization energy is highest for half-filled p-subshells (p^3) within the same period due to increased stability. Option B represents Phosphorus, which has a stable $3p^3$ configuration.

Q20.

Answer: C

Explanation:
Adding a second electron to a negatively charged ion (O^-) requires energy to overcome the strong electrostatic repulsion between the ion and the incoming electron.

Q21.

Answer: 3

Q22.

Answer: 2

Q23.

Answer: 2

Q24.

Answer: 2

Q25.

Answer: ?

Q26.

Answer: A

Explanation:
Evaluate the product of sines using the identity $\sin\theta\sin(60^\circ-\theta)\sin(60^\circ+\theta) = \frac{1}{4}\sin 3\theta$. This determines the value of K, which is then substituted into the required sine expression.

Q27.

Answer: C

Explanation:
Simplify the trigonometric expression using the angle sum and difference formulas. Determine $\cos\frac{\theta}{2}$ and $\sin\frac{\theta}{2}$ from the given $\cot\theta$ to evaluate the final form.

Q28.

Answer: C

Explanation:
Expand the sine terms using compound angle identities and rearrange the equation to express the relationship between $\tan\alpha$ and $\tan\beta$.

Q29.

Answer: A

Explanation:
Identify that x is in the third quadrant, where $\cos x$ is negative and $\tan x$ is positive. Calculate these values from $\sin x$ and evaluate the given expression.

Q30.

Answer: D

Explanation:
Use trigonometric identities to simplify the difference of sines, eventually expressing the result in terms of $\sin 18^\circ$.

Q31.

Answer: B

Explanation:
Apply the specialized sine product identity $\sin\theta\sin(60^\circ-\theta)\sin(60^\circ+\theta) = \frac{1}{4}\sin 3\theta$ to evaluate the expression.

Q32.

Answer: A

Explanation:
Determine $\tan\alpha$ and $\tan\beta$ based on their quadrants. Use the tangent sum formula and the range of individual angles to find the final value and quadrant.

Q33.

Answer: B

Explanation:
Use the half-angle identity $\cot\frac{\theta}{2}=\frac{1+\cos\theta}{\sin\theta}$ where $\theta=\frac{\pi}{12}=15^\circ$ to find the value of $\cot 7.5^\circ$.

Q34.

Answer: C

Explanation:
Square the initial equation to find the value of $\sin 2x$. Use this to solve for $\tan x$, ensuring the solution aligns with the constraints on x.

Q35.

Answer: D

Explanation:
The argument of the cosine function is an infinite geometric progression. Summing this progression simplifies the function, allowing the period to be calculated using the formula $T=\frac{2\pi}{|a|}$.

Q36.

Answer: A

Explanation:
For a sum of equal even powers of sine and cosine, the fundamental period is $\frac{\pi}{2}$ because the functions swap values over this interval while remaining symmetric.

Q37.

Answer: B

Explanation:
This expression is a standard trigonometric identity equivalent to $\frac{1}{4}\sin 3x$. The period of $\sin(ax)$ is $\frac{2\pi}{|a|}$.

Q38.

Answer: C

Explanation:
For any function of the form $a\cos\theta+b\sin\theta$, the extreme values are given by $\pm\sqrt{a^2+b^2}$.

Q39.

Answer: B

Explanation:
To find the maximum value of a fraction with a positive numerator, one must minimize the denominator by finding the minimum value of its trigonometric part.

Q40.

Answer: C

Explanation:
Using algebraic identities, the expression is converted into a function of $\sin^2 2x$. The range is determined by applying the known bounds of the sine function.

Q41.

Answer: C

Explanation:
For the function $f(x)=\sin^2(\alpha-x)+\sin^2(\alpha+x)$, the range for $\alpha=60^\circ$ is specifically derived as $[1/2,3/2]$.

Q42.

Answer: D

Explanation:
For a sum of functions to be periodic, their periods must have a rational ratio. Here, the periods are 2π and 1, whose ratio is irrational.

Q43.

Answer: B

Explanation:
Individual periods are calculated and their LCM is determined. Since $(n+1)!$ is a multiple of n!, the larger factorial dictates the common period.

Q44.

Answer: C

Explanation:

Using the property $[x]-x=-\{x\}$, the function is transformed into a sum of two periodic components whose individual periods are then used to find the common period.

Q45.

Answer: D

Explanation:
For a function to be periodic, its argument must be a linear function of x (like $ax+b$). Non-linear arguments such as x^2 or $\sqrt{x}$ prevent a constant repeating interval.

Q46.

Answer: 2

Explanation:
The expression for A can be simplified using the trigonometric identity $\frac{\sin\theta}{\cos 3\theta}=\frac{1}{2}(\tan 3\theta-\tan\theta)$. When applied to each term, it creates a telescoping sum that reduces A to exactly half of the value of B.

Q47.

Answer: 2

Explanation:
The period of a ratio is the LCM of the numerator and denominator periods. Solving the equation for the total period yields the value of n.

Q48.

Answer: 10

Explanation:
The period of $|\sin ax|$ or $|\cos ax|$ is $\frac{\pi}{a}$. The total period is the LCM of the individual component periods.

Q49.

Answer: 60

Explanation:
The period of a sum of functions is the LCM of their individual periods. For fractional periods, $LCM = \frac{LCM(numerators)}{HCF(denominators)}$.

Q50.

Answer: 52

Explanation:
Substitute the standard trigonometric values for $\cos 36^\circ$ and $\sin 18^\circ$ into the ratio, simplify the resulting expression by rationalizing, and solve for a, b, and c.

Q51.

Answer: A

Explanation:

Let total distance be D. Time for first part ($D/3$) is $t_1 = \frac{D}{3v_1}$. Time for remaining part ($2D/3$) is $t_2 = \frac{2D}{3v_2}$. Total time $T = \frac{D}{3}(\frac{1}{v_1} + \frac{2}{v_2}) = \frac{D(2v_1+v_2)}{3v_1v_2}$. Average speed $V_{avg} = \frac{D}{T} = \frac{3v_1v_2}{2v_1+v_2}$.

Q52.

Answer: B

Explanation:

Let total distance be S. Time for first part ($S/3$) is $t_1 = \frac{S}{3v_0}$. For the remaining distance ($2S/3$), the average velocity during that segment (since time is split equally) is $\frac{v_1+v_2}{2}$. Time for remaining part is $t_2 = \frac{2S/3}{(v_1+v_2)/2} = \frac{4S}{3(v_1+v_2)}$. Total time $T = \frac{S}{3}[\frac{1}{v_0} + \frac{4}{v_1+v_2}]$. $V_{avg} = \frac{S}{T} = \frac{3v_0(v_1+v_2)}{4v_0+v_1+v_2}$.

Q53.

Answer: B

Explanation:

Using the formula for average speed over equal distances: $V_{avg} = \frac{2v_1v_2}{v_1+v_2}$. Substituting $v_1 = 5$ and $v_2 = 10$, we get $V_{avg} = \frac{2(5)(10)}{5+10} = \frac{100}{15} \approx 6.67$ m/s.

Q54.

Answer: B

Explanation:

Displacement in east: $d_1 = 6 \times 2 = 12$ m. Displacement in north: $d_2 = 8 \times 2 = 16$ m. Resultant displacement $D = \sqrt{12^2 + 16^2} = 20$ m. Total time $T = 2 + 2 = 4$ s. Average velocity $V_{avg} = \frac{20}{4} = 5$ m/s.

Q55.

Answer: A

Explanation:

Total distance covered is S (forward) + S (backward) = 2S. Total time taken is $4 + 2 = 6$ hours. Average speed = $\frac{\text{Total Distance}}{\text{Total Time}} = \frac{2S}{6} = \frac{S}{3}$. Since the cyclist returns to the starting point, the net displacement is 0, so average velocity is 0.

Q56.

Answer: B

Explanation:

Let total distance be D. Time for first part ($D/4$) is $t_1 = \frac{D/4}{20} = \frac{D}{80}$. Time for remaining part ($3D/4$) is $t_2 = \frac{3D/4}{60} = \frac{3D}{240} = \frac{D}{80}$. Total time $T = \frac{D}{80} + \frac{D}{80} = \frac{2D}{80} = \frac{D}{40}$. Average speed $V_{avg} = \frac{D}{D/40} = 40$ km/hr.

Q57.

Answer: B

Explanation:

Time to reach library (3 km at 6 km/h) is $t_1 = 0.5$ h $= 30$ min. Remaining time in the 40 min interval is 10 min $= \frac{1}{6}$ h. Distance covered returning in this time at 9 km/h is $d_{\text{return}} = 9 \times \frac{1}{6} = 1.5$ km. Total distance = $3 + 1.5 = 4.5$ km. Total time = $\frac{40}{60} = \frac{2}{3}$ h. Average speed = $\frac{4.5}{2/3} = \frac{27}{4}$ km/h.

Q58.

Answer: B

Explanation:

Since the distances are equal, we use the formula for average speed: $V_{avg} = \frac{2v_1v_2}{v_1+v_2}$. Substituting $v_1 = 40$ and $v_2 = 60$, we get $V_{avg} = \frac{2(40)(60)}{40+60} = \frac{4800}{100} = 48 \text{ km/hr}.$

Q59.

Answer: A

Explanation:

Since the distance is the same for both legs of the trip, we use the formula for average speed: $V_{avg} = \frac{2v_1v_2}{v_1+v_2}$. Substituting $v_1 = 3$ and $v_2 = 4$, we get $V_{avg} = \frac{2(3)(4)}{3+4} = \frac{24}{7}$ km/hr.

Q60.

Answer: B

Explanation:

Since distances are equal, average speed $V_{avg} = \frac{2v_1v_2}{v_1+v_2} = \frac{2(30)(60)}{30+60} = \frac{3600}{90} = 40 \text{ km/hr}.$

Q61.

Answer: B

Explanation:

Since the distance covered in both directions is the same, we use the formula for average speed: $v_{avg} = \frac{2v_1v_2}{v_1+v_2}$. Substituting $v_1 = 40$ and $v_2 = 60$, we get $v_{avg} = \frac{2(40)(60)}{40+60} = \frac{4800}{100} = 48 \text{ km/h}.$

Q62.

Answer: B

Explanation:

Since the distances are equal, the average speed is given by the harmonic mean formula: $v_{avg} = \frac{2v_1v_2}{v_1+v_2}$. Substituting $v_1 = 40$ and $v_2 = 60$, we get $v_{avg} = \frac{2(40)(60)}{40+60} = \frac{4800}{100} = 48 \text{ km/hr}.$

Q63.

Answer: B

Explanation:

Since the distances are equal, the average speed is the harmonic mean of the two speeds: $v_{avg} = \frac{2v_1v_2}{v_1+v_2}$. Substituting $v_1 = 40$ and $v_2 = 60$, we get $v_{avg} = \frac{2(40)(60)}{40+60} = \frac{4800}{100} = 48 \text{ km/h}.$

Q64.

Answer: C

Explanation:

Velocity $v = \frac{dx}{dt} = 3At^2 - 2Bt$. Acceleration $a = \frac{dv}{dt} = 6At - 2B$. Setting $a = 0$, we get $6At = 2B$, which implies $t = \frac{2B}{6A} = \frac{B}{3A}$.

Q65.

Answer: C

Explanation:

Velocity is the first derivative of displacement: $v = \frac{ds}{dt} = 6t + 5$. Acceleration is the derivative of velocity: $a = \frac{dv}{dt} = 6$. Thus, the acceleration is constant at 6 m/s^2.

Q66.

Answer: B

Explanation:

Velocity is the derivative of position with respect to time ($v = \frac{dx}{dt}$). Differentiating $x = a + bt^2$ gives $v = 2bt$. Substituting $b = 2$ and $t = 3$, we get $v = 2(2)(3) = 12 \text{ m/s}.$

Q67.

Answer: B

Explanation:

Time to reach market (3 km at 6 km/h) is $t_1 = 0.5 \text{ h} = 30 \text{ min}$. Remaining time in the 40 min interval is $10 \text{ min} = \frac{1}{6} \text{ h}$. Distance covered returning in this time at 9 km/h is $d_{\text{return}} = 9 \times \frac{1}{6} = 1.5 \text{ km}$. Total distance = $3 + 1.5 = 4.5 \text{ km}$. Total time = $\frac{40}{60} = \frac{2}{3} \text{ h}$. Average speed = $\frac{4.5}{2/3} = \frac{27}{4} \text{ km/h}$.

Q68.

Answer: B

Explanation:

Let total distance be D. Time for first part ($D/3$) is $t_1 = \frac{D}{3v_1}$. Time for remaining part ($2D/3$) is $t_2 = \frac{2D}{3v_2}$. Total time $T = \frac{D}{3}(\frac{1}{v_1} + \frac{2}{v_2}) = \frac{D(2v_1+v_2)}{3v_1v_2}$. Average speed $V_{avg} = \frac{D}{T} = \frac{3v_1v_2}{2v_1+v_2}$.

Q69.

Answer: B

Explanation:

Velocity $v = \frac{dy}{dt} = 4at - 3bt^2$. Acceleration $a_{cc} = \frac{dv}{dt} = 4a - 6bt$. Setting $a_{cc} = 0$, we get $4a = 6bt$, which implies $t = \frac{4a}{6b} = \frac{2a}{3b}$.

Q70.

Answer: C

Explanation:

Velocity $v = \frac{dx}{dt} = 8t - 6$. Acceleration $a = \frac{dv}{dt} = 8$. Therefore, the acceleration is $8\ \mathrm{m/s^2}$.

Q71.

Answer: 45

Explanation:

Let the total distance beD) The time taken for the first part is $t_1 = \frac{D/3}{30} = \frac{D}{90}$. The time for the remaining $2/3$ distance is $t_2 = \frac{2D/3}{60} = \frac{D}{90}$. Total time is $\frac{2D}{90} = \frac{D}{45}$. Average speed is $\frac{D}{D/45} = 45$ km/hr.

Q72.

Answer: 15

Explanation:

Let total distance be 2D) Time for first half (d) at $10\ \mathrm{m/s}$ is $t_1 = d/10$. For the second half (d), the motion is split into equal times with speeds 20 and 40, so the average speed for this segment is $(20 + 40)/2 = 30\ \mathrm{m/s}$. Time for second half is $t_2 = d/30$. Total time $T = d/10 + d/30 = 4d/30$. Average speed $= 2d/(4d/30) = 15\ \mathrm{m/s}$.

Q73.

Answer: 20

Explanation:

Let total distance be 3D) First part (d) at $10\ \mathrm{m/s}$ takes $t_1 = d/10$. Remaining part (2d) has equal time intervals at30 and $50\ \mathrm{m/s}$, so average speed for this part is $(30 + 50)/2 = 40\ \mathrm{m/s}$. Time for remaining part is $t_2 = 2d/40 = d/20$. Total time $T = d/10 + d/20 = 3d/20$. Average speed $= 3d/(3d/20) = 20\ \mathrm{m/s}$.

Q74.

Answer: 2

Explanation:

Let total distance beS. Time for first part (S/3) is $t_1 = \frac{S}{3v}$. Time for second part (S/3) is$t_2 = \frac{S}{9v}$. Time for third part (S/3) is$t_3 = \frac{S}{18v}$. Total time $T = \frac{S}{3v} + \frac{S}{9v} + \frac{S}{18v} = \frac{6S+2S+S}{18v} = \frac{9S}{18v} = \frac{S}{2v}$. Average speed $V_{avg} = \frac{S}{S/2v} = 2v$.

Q75.

Answer: 40

Explanation:

Since the distances are equal, we use the formula for average speed: $V_{avg} = \frac{2v_1v_2}{v_1+v_2}$. Substituting $v_1 = 30$ and $v_2 = 60$, we get $V_{avg} = \frac{2(30)(60)}{30+60} = \frac{3600}{90} = 40$ km/h.