Max Marks: 300 **JR_WEEK-12 (07-09-2026)** **Time: 180 mins**

Chemistry

1. The correct order of ONO bond angle in the given species is:

A) $NO_2^+ < NO_2 < NO_3^- < NO_2^-$

B) $NO_2^- < NO_3^- < NO_2 < NO_2^+$

C) $NO_3^- < NO_2^- < NO_2 < NO_2^+$

D) $NO_2^+ < NO_3^- < NO_2^+ < NO_2$

2. The correct order of dipole moments for the given species is:

A) $BF_3 = NH_4^+ < NF_3 < NH_3$

B) $BF_3 < NH_4^+ < NF_3 < NH_3$

C) $NH_4^+ < BF_3 < NH_3 < NF_3$

D) $BF_3 < NH_4^+ < NH_3 < NF_3$

3. Consider the following species:
$SOCl_2, XeOF_4, ClF_3, ClF_5, XeF_5^+, SO_3^{2-}, XeF_3^+, SF_4$
List-I contains different molecular shapes and List-II contains total number of species with the same molecular shapes from the given species. Match each entry in List-I with the appropriate entry in List-II and choose the correct option.

List-I	List-II
(P) See-saw	(1) one
(Q) T-Shaped	(2) two
(R) Trigonal Planar	(3) three
(S) Square Pyramidal	(4) four
	(5) zero

A) $P \to 1; Q \to 2; R \to 5; S \to 3$

B) $P \to 5; Q \to 4; R \to 2; S \to 3$

C) $P \to 3; Q \to 2; R \to 1; S \to 4$

D) $P \to 1; Q \to 3; R \to 5; S \to 4$

4. Regarding the molecular orbital (MO) energy levels for homonuclear diatomic molecules, the INCORRECT statement(s) is(are) A) Bond order of Ne_2 is zero. B) The highest occupied molecular orbital (HOMO) of F_2 is σ-type. C) Bond energy of O_2^+ is smaller than the bond energy of O_2. D) Bond length of Li_2 is larger than the bond length of B_2.

A) B, C

B) A, C

C) D, C

D) B, D

5. Statement 1: Boron always forms covalent bond. Statement 2: The small size of B^{3+} favours formation of covalent bond.

A) Statement 1 is True, Statement 2 is True, Statement 2 is a CORRECT explanation for Statement 1

B) Statement 1 is True, Statement 2 is True, Statement 2 is NOT a CORRECT explanation for Statement 1

C) Statement 1 is True, Statement 2 is False

D) Statement 1 is False, Statement 2 is True

6. Read the following Assertion and Reason and answer as per the options given below: Assertion: LiClis predominantly a covalent compound. Reason: Electronegativity difference betweenLi and Cl is too small.

A) If both assertion and reason are correct and reason is the correct explanation of the assertion

B) If both assertion and reason are correct and reason is not the correct explanation of the assertion

C) If assertion is correct but reason is incorrect

D) If assertion is incorrect but reason is correct

7. Match List - I with List - II according to shape.

List – I	List – II
A. XeO_3	I. BrF_5
B. XeF_2	II. NH_3
C. XeO_2F_2	III. $[I_3]^-$
D. $XeOF_4$	IV. SF_4

A) A-II, B-III, C-I, D-IV **B)** A-III, B-II, C-IV, D-I
C) A-II, B-III, C-IV, D-I **D)** A-II, B-I, C-III, D-IV

8. The maximum number of 90° angles between bond pair-bond pair of electrons is observed in:

A) dsp^2 hybridization **B)** sp^3d hybridization
C) dsp^3 hybridization **D)** sp^3d^2 hybridization

9. Which one of the following has the regular tetrahedral structure? (Atomic nos. : B = 5, S = 16, Ni = 28, Xe = 54)

A) BF_4^- **B)** SF_4
C) XeF_4 **D)** $[Ni(CN)_4]^{2-}$

10. The bond order in NO is 2.5 while that in NO^+ is 3. Which of the following statements is true for these two species?

A) Bond length in NO^+ is equal to that in NO **B)** Bond length in NO is greater than in NO^+
C) Bond length in NO^+ is greater than in NO **D)** Bond length is unpredictable

11. Which of the following species is diamagnetic in nature?

A) H_2^- **B)** H_2^+
C) H_2 **D)** He_2^+

12. Lattice energy of an ionic compound depends upon:

A) Charge on the ion and size of the ion **B)** Packing of ions only
C) Size of the ion only **D)** Charge on the ion only

13. The decreasing values of bond angles from NH_3 (106°) to SbH_3 (101°) down Group 15 of the periodic table is due to:

A) decreasing $lp - bp$ repulsion **B)** decreasing electronegativity
C) increasing $bp - bp$ repulsion **D)** increasing p-orbital character in sp^3

14. In which of the following molecules/ions are all the bonds not equal?

A) XeF_4 **B)** BF_4^-
C) SF_4 **D)** SiF_4

15. Bond order normally gives an idea of the stability of a molecular species. All the molecules viz. H_2, Li_2, and B_2 have the same bond order yet they are not equally stable. Their stability order is:

A) $H_2 > B_2 > Li_2$ **B)** $Li_2 > H_2 > B_2$
C) $Li_2 > B_2 > H_2$ **D)** None of the above

16. Arrange the bonds in order of increasing ionic character in the molecules: LiF, K_2O, N_2, SO_2, and ClF_3.

A) $ClF_3 < N_2 < SO_2 < K_2O < LiF$ **B)** $LiF < K_2O < ClF_3 < SO_2 <$
C) $N_2 < SO_2 < ClF_3 < K_2O < LiF$ **D)** $N_2 < ClF_3 < SO_2 < K_2O <$

17. Assuming $2s - 2p$ orbital mixing is NOT operative, the paramagnetic species among the following is:

A) Be_2 **B)** B_2
C) C_2 **D)** N_2

18. The central atom shows d-orbital participation in hybridisation in

A) A) XeF_2 **B)** B) SO_2
C) C) NH_4^+ **D)** D) CH_4

19. The hybridisation scheme for the central atom includes a d-orbital contribution in

A) A) I_3^- **B)** B) PCl_3
C) C) NO_3^- **D)** D) H_2Se

20. Which one of the following is/are linear structure? I. I_3^- II. NO_2^- III. I_3^+ IV. SO_2 V. N_3^-

A) I, II and III **B)** I and V
C) II, III and IV **D)** All of these

21. **Consider the following molecules: Br_3O_8, F_2O, $H_2S_4O_6$, $H_2S_5O_6$, and C_3O_2. Count the number of atoms existing in their zero oxidation state in each molecule. Their sum is _______.**

22. **The sum of the number of unpaired electron(s) in the highest occupied molecular orbital (HOMO) of the following species respectively: N_2, N_2^+, O_2, O_2^+?**

23. **The dipole moment of KCl is $3.336 \times 10^{-29}\ \mathrm{C \cdot m}$. The interatomic distance between $\mathrm{K^+}$ and $\mathrm{Cl^-}$ in this molecule is $2.6 \times 10^{-10}\ \mathrm{m}$. Calculate the percentage ionic character of the KCl molecule assuming complete separation of a unit fundamental charge ($1.602 \times 10^{-19}\ \mathrm{C}$).**

24. **The sum of the number of lone pairs of electrons on each central atom in the species $[\mathrm{TeBr_6}]^{2-}$, $[\mathrm{BrF_2}]^+$, $\mathrm{SNF_3}$, and $[\mathrm{XeF_3}]^-$ is: (Atomic numbers: $\mathrm{N = 7, F = 9, S = 16, Br = 35, Te = 52, Xe = 54}$)**

25. **Among $\mathrm{H_2}$, $\mathrm{He_2^+}$, $\mathrm{Li_2}$, $\mathrm{Be_2}$, $\mathrm{B_2}$, $\mathrm{C_2}$, $\mathrm{N_2}$, $\mathrm{O_2^-}$, and $\mathrm{F_2}$, the number of diamagnetic species is: (Atomic number: H=1, He=2, Li = 3, Be = 4, B 5, C = 6, N=7, O=8, F=9)**

Maths

26. **If $f(x) = \frac{9^x}{9^x+3}$ for all $x \in R$, then the sum $f\left(\frac{1}{1996}\right) + f\left(\frac{2}{1996}\right) + \cdots + f\left(\frac{1995}{1996}\right)$ is:**

A) 997.5 **B)** 997
C) 996.5 **D)** 996

27. **$f : R \to R$ is a function defined by $f(x) = \frac{e^{|x|}-e^{-x}}{e^x+e^{-x}}$, then f is:**

A) a bijection **B)** an injection only
C) a surjection only **D)** neither injection nor surjection

28. **If $f : N \to N$ is defined by $f(n) = n - (-1)^n$, then:**

A) f is one-one but not onto **B)** f is both one-one and onto
C) f is neither one-one nor onto **D)** f is onto but not one-one

29. **If $f : R \to R$ is a function satisfying the property $f(x+1) + f(x+3) = 2$ for all $x \in R$, then f is:**

A) Periodic with period 3 **B)** Periodic with period 4
C) non periodic **D)** Periodic with period 5

30. **The function $f(x) = \frac{x}{e^x-1} + \frac{x}{2} + 1$ is:**

A) an odd function **B)** an even function
C) neither an odd nor an even function **D)** a periodic function

31. **The range of $f(x) = \frac{3}{5+4\sin 3x}$ is:**

A) $[1/3, 3]$ **B)** $[1/3, 1]$
C) [1,3] **D)** $(-\infty, -1/3] \cup [3, \infty)$

32. **Range of the function $f(x) = x^2 + \frac{1}{x^2+1}$ is:**

A) $[1, \infty)$ **B)** $[2, \infty)$
C) $[3/2, \infty)$ **D)** $(-\infty, \infty)$

33. **Let $f : (2,4) \to (1,3)$ be a function defined by $f(x) = x - \left[\frac{x}{2}\right]$ (where [.] denotes the greatest integer function), then $f^{-1}(x)$ is equal to:**

A) $2x$ **B)** $x + \left[\frac{x}{2}\right]$
C) $x+1$ **D)** x-1

34. **If $f(x)f\left(\frac{1}{x}\right) = f(x) + f\left(\frac{1}{x}\right) \forall x \in r - \{0\}$, where $f(x)$ is a polynomial function and $f(5) = 126$, then $f(3) =$**

A) 28 **B)** 26
C) 27 **D)** 25

35. **The range of the function $f(x) = 2 - 3x$, $x > 0$ is:**

A) R **B)** $(-\infty, 2)$
C) $(-\infty, 2]$ **D)** $(-2, 2)$

36. **The domain of the function $f(x) = \sin^{-1}\left(\log_2\left(\frac{x^2}{2}\right)\right)$ is:**

A) $[-2, 2]$ **B)** $[-2, -1]$
C) [1,2] **D)** $[-2, -1] \cup [1, 2]$

37. **Domain of definition of the function $f(x) = \frac{3}{4-x^2} + \log_{10}(x^3 - x)$ is:**

A) $(1, 2)$ **B)** $(-1, 0) \cup (1, 2)$
C) $(1, 2) \cup (2, \infty)$ **D)** $(-1, 0) \cup (1, 2) \cup (2, \infty)$

38. The domain of the function $f(x) = \log_e(x^2 + x + 1) + \sin\sqrt{x-1}$ is:

A) $(-2, 1)$ **B)** $(-2, \infty)$
C) $[1, \infty)$ **D)** None of these

39. The domain of the function $f(x) = \sqrt{3 - 2x - x^2}$ is:

A) $[-3, 1]$ **B)** $[-1, 1]$
C) $(-3, 1)$ **D)** $(1, \infty)$

40. The domain of definition of the function $f(x) = \sqrt{\log_{10}\left(\frac{5x-x^2}{4}\right)}$ is:

A) [–3, 1] **B)** [–1, 1]
C) (–3, 1) **D)** $(1, \infty)$

41. The range of $|x-2| + |x-5|$ is:

A) $[2, \infty)$ **B)** $[3, \infty)$
C) $[4, \infty)$ **D)** $[5, \infty)$

42. The inverse of the function $f(x) = \frac{e^x - e^{-x}}{e^x + e^{-x}} + 2$ is given by:

A) $\log\left(\frac{x-2}{x-1}\right)^{1/2}$ **B)** $\log\left(\frac{x-1}{x+1}\right)^{1/2}$
C) $\log\left(\frac{x}{2-x}\right)^{1/2}$ **D)** $\log\left(\frac{x-1}{3-x}\right)^{1/2}$

43. If $f(x) = \log_e(x + \sqrt{1+x^2})$, then $f^{-1}(x)$ equals:

A) $\log(x - \sqrt{1+x^2})$ **B)** $\frac{e^x + e^{-x}}{2}$
C) $\frac{e^x - e^{-x}}{2}$ **D)** $\frac{e^x - e^{-x}}{e^x + e^{-x}}$

44. The domain of the function $f(x) = \log_2(log_3(log_4 x))$ is:

A) $(-\infty, 4)$ **B)** $(4, \infty)$
C) $(0, 4)$ **D)** $(1, \infty)$

45. If $f(x) = \frac{1}{\sqrt{|x| - x}}$, then domain of $f(x)$ is:

A) $(-\infty, 0)$ **B)** $(-\infty, 2)$
C) $(-\infty, \infty)$ **D)** $(1, \infty)$

46. $f : R \to R$ is given by $f(x) = \frac{a^x}{a^x + \sqrt{a}}\ \forall x \in R$. Then the sum $f\left(\frac{1}{11}\right) + f\left(\frac{2}{11}\right) + \cdots + f\left(\frac{10}{11}\right)$ is:

47. Find the natural number 'a' for which $\sum_{k=1}^{n} f(a+k) = 16(2^n - 1)$ where $f(x) = 2^x$.

48. If the domain of the function $f(x) = \sin^{-1}\left(\frac{5-x}{3+2x}\right) + \log_e\left(\frac{1}{10-x}\right)$ is $(-\infty, \alpha] \cup [\beta, \gamma) - \{\delta\}$, then $6(\alpha + \beta + \gamma + \delta)$ is equal to

49. If the domain of the function $f(x) = \frac{1}{\sqrt{10+3x-x^2}} + \frac{1}{\sqrt{x+|x|}}$ is (a, b), then $(1+a)^2 + b^2$ is equal to:

50. Find the domain of the function $f(x) = \log_e\left(\frac{2x-3}{5+4x}\right) + \sin^{-1}\left(\frac{4+3x}{2-x}\right)$. If the domain is $[\alpha, \beta]$, then find the value of $\alpha^2 + 4\beta$.

<u>Physics</u>

51. Two bodies are thrown with the same initial velocity at angles θ and $(90^\circ - \theta)$ respectively with the horizontal, then their maximum heights are in the ratio

A) $1 : 1$ **B)** $\sin\theta : \cos\theta$
C) $\sin^2\theta : \cos^2\theta$ **D)** $\cos\theta : \sin\theta$

52. A ball is projected with a velocity $20\ \mathrm{ms}^{-1}$ at an angle to the horizontal. In order to have the maximum range. Its velocity at the highest position must be

A) $10\ \mathrm{ms}^{-1}$ **B)** $14\ \mathrm{ms}^{-1}$
C) $18\ \mathrm{ms}^{-1}$ **D)** $16\ \mathrm{ms}^{-1}$

53. A body is projected at an angle 60° with the horizontal with kinetic energy K. When the velocity makes an angle 30° with the horizontal, the kinetic energy of the body will be

A) $K/2$ **B)** $K/3$
C) $2K/3$ **D)** $3K/4$

54. If T_1 and T_2 are the times of flight for two complementary angles, then the range of projectile R is given by

A) $R = 4gT_1T_2$ **B)** $R = 2gT_1T_2$
C) $R = \frac{1}{4}gT_1T_2$ **D)** $R = \frac{1}{2}gT_1T_2$

55. A gun is firing bullets with velocity v_0 by rotating it through 360° in the horizontal plane. The maximum area covered by the bullets is

A) $\frac{\pi v_0^2}{g}$ **B)** $\frac{\pi^2 v_0^2}{g}$
C) $\frac{\pi v_0^4}{g^2}$ **D)** $\frac{\pi^2 v_0^4}{g^2}$

56. Average velocity of a particle in projectile motion between its starting point and the highest point of its trajectory is (projection speed $= u$, angle of projection from horizontal $= \theta$)

A) $u\cos\theta$ **B)** $\frac{u}{2}\sqrt{1+3\cos^2\theta}$
C) $\frac{u}{2}\sqrt{2+\cos^2\theta}$ **D)** $\frac{u}{2}\sqrt{1+\cos^2\theta}$

57. A body is projected horizontally with a velocity $3\times10^2\ \mathrm{ms}^{-1}$ from the top of a tower of height 80 m. The distance from the point of projection at which the body will strike the ground is

A) 250 m **B)** 1200 m
C) 600 m **D)** 300 m

58. A particle starts from the origin of coordinates at time $t=0$ and moves in the xy plane with a constant acceleration α in the y-direction. Its equation of motion is $y=\beta x^2$. Its velocity component in the x-direction is

A) variable **B)** $\frac{2\alpha}{\beta}$
C) $\frac{\alpha}{\beta}$ **D)** $\sqrt{\frac{\alpha}{2\beta}}$

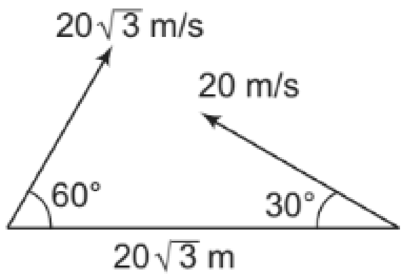
59. A projectile is projected with speed u at an angle of 60° with horizontal from the foot of an inclined plane. If the projectile hits the inclined plane horizontally, the range on inclined plane will be

A) $\frac{u^2\sqrt{21}}{2g}$ **B)** $\frac{3u^2}{4g}$
C) $\frac{u^2}{2\beta}$ **D)** $\frac{u^2\sqrt{21}}{8g}$

60. A shell fired from the base of a mountain just clears it. If α is the angle of projection, then the angular elevation of the summit β is

A) $\frac{\alpha}{2}$ **B)** $\tan^{-1}\left(\frac{1}{2\tan\alpha}\right)$
C) $\tan^{-1}\left(\frac{\tan\alpha}{2}\right)$ **D)** $\tan^{-1}(2\tan\alpha)$

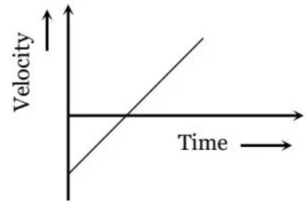
61. In the figure shown, the two projectiles are fired simultaneously. The minimum distance between them during their flight is



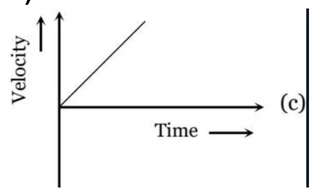
A) 20 m **B)** $10\sqrt{3}$ m
C) 10 m **D)** None of the above

62. A particle is moving in such a way that its displacement is related with time by the equation $x=(10-4t+6t^2)m$. The diagram showing variation of velocity of particle with time is

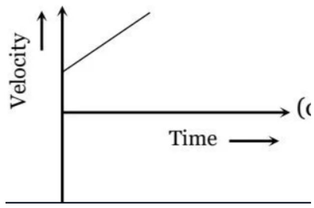
A)



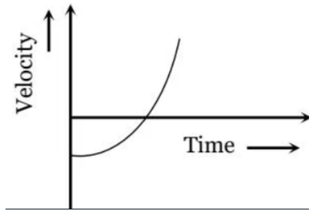
B)



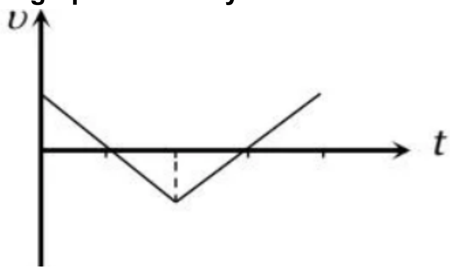
C)



D)

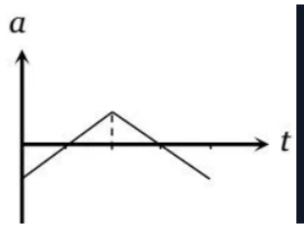


63. The graph below shows the velocity versus time graph for a body

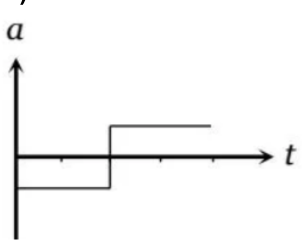


Which of the following graphs represents the corresponding acceleration versus time graphs

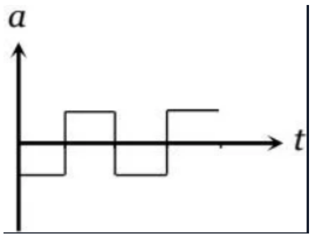
A)



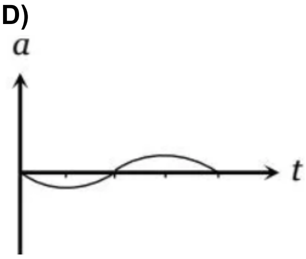
B)



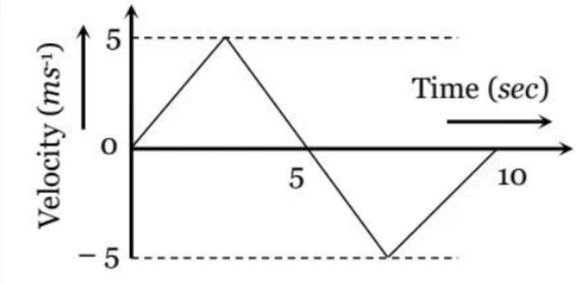
C)



D)



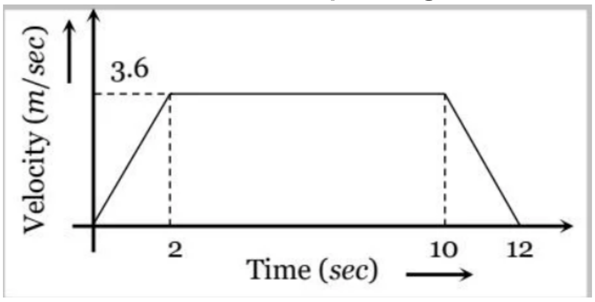
64. The v-t plot of a moving object is shown in the figure. The average velocity of the object during the first 10 seconds is



A) 0 **B)** $2.5\,ms^{-1}$

C) $5\,ms^{-1}$ **D)** $2\,ms^{-1}$

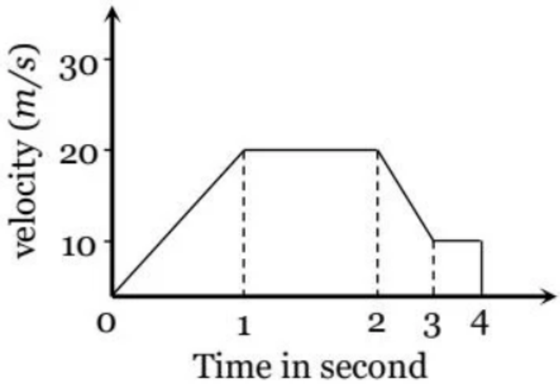
65. A lift is going up. The variation in the speed of the lift is as given in the graph. What is height to which the lift takes the passenger



A) 3.6m **B)** 28.8 m

C) 36.0 m **D)** Cannot be calculated from the above graph

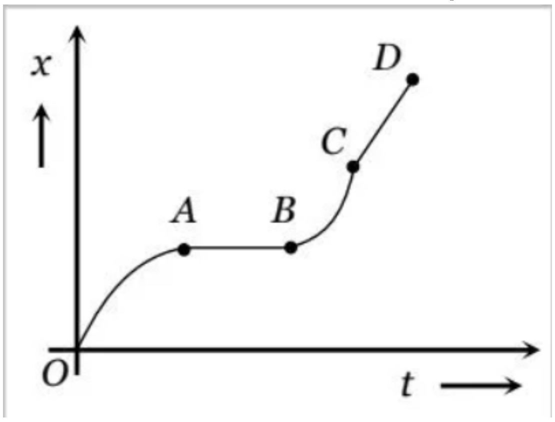
66. The variation of velocity of a particle with time moving along a straight line is illustrated in the following figure. The distance travelled by the particle in four seconds is



A) 60 m **B)** 55 m

C) 25 m **D)** 30 m

67. The graph between the displacement x and time t for a particle moving in a straight line is shown in figure. During the interval OA, AB, BC and CD, the acceleration of the particle is



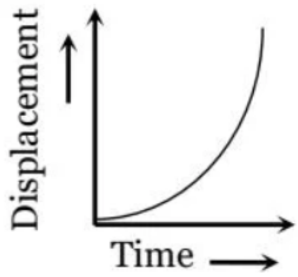
OA AB BC CD

A) OA-+, AB-○, BC-+, CD-+ **B)** OA-+, AB-○, BC-+, CD-○

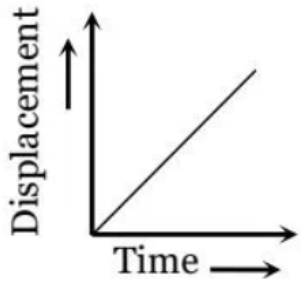
C) OA-+, AB-○, BC-−, CD-+ **D)** OA-−, AB-○, BC-−, CD-○

68. A car dealcelerates at a constant rate during a period commencing at $t = 0$. Which of the displacement time graphs represents the displacement of the car

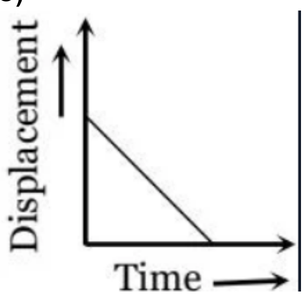
A)



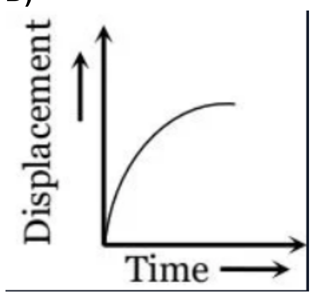
B)



C)



D)



69. A body has speed V, 2V and 3V in first 1/3 of distance S, seconds 1/3 of S and third 1/3 of S respectively. Its average speed will be

A) V **B)** 2V

C) $\frac{18}{11}$ V **D)** $\frac{11}{18}$ V

70. A car travels a distance of 2000 m. If the first half distance is covered at 40 km/hour and the second half with speed v and the average speed is 48 km/hour, then the value of v is

A) 56 km/hour **B)** 60 km/hour

C) 50 km/hour **D)** 48 km/hour

71. The range of a projectile at an angle θ is equal to half of the maximum range if thrown at the same speed. The angle of projection θ is given by___$^\circ$

72. A grasshopper can jump maximum distance 1.6 m. It spends negligible time on ground. How far can it go in $10\sqrt{2}$ s?___m

73. Two stones are projected with the same speed but making different angles with the horizontal. Their horizontal ranges are equal. The angle of projection of one is $\frac{\pi}{3}$ and the maximum height reached by it is 102 m. Then the maximum height reached by the other in metres is

74. A ball is projected upwards from the top of a tower with a velocity $50 \mathrm{~ms}^{-1}$ making an angle 30° with the horizontal. The height of tower is 70 m. After how many seconds from the instant of throwing, will the ball reach the ground? $\left(g=10 \mathrm{~ms}^{-2}\right)$ will be ___s

75. A body is projected horizontally with a velocity $3 \times 10^2 \mathrm{~ms}^{-1}$ from the top of a tower of height 80 m. The time after which the body will strike the ground is $\left(g=10 \mathrm{~ms}^{-2}\right)$will be ___s

ANSWER KEY

Chemistry

1.	**2**	8.	**4**	15.	**4**	22.	**4**
2.	**1**	9.	**1**	16.	**3**	23.	**80**
3.	**1**	10.	**2**	17.	**3**	24.	**6**
4.	**1**	11.	**3**	18.	**1**	25.	**6**
5.	**1**	12.	**1**	19.	**1**		
6.	**3**	13.	**2**	20.	**2**		
7.	**3**	14.	**3**	21.	**6**		

Maths

26.	**1**	33.	**3**	40.	**1**	47.	**3**
27.	**4**	34.	**1**	41.	**2**	48.	**70**
28.	**2**	35.	**2**	42.	**4**	49.	**26**
29.	**2**	36.	**4**	43.	**3**	50.	4
30.	**2**	37.	**4**	44.	**2**		
31.	**1**	38.	**3**	45.	**1**		
32.	**1**	39.	**1**	46.	**5**		

Physics

51.	**3**	58.	**4**	65.	**3**	72.	**40**
52.	**2**	59.	**4**	66.	**2**	73.	**34**
53.	**2**	60.	**3**	67.	**2**	74.	**7**
54.	**4**	61.	**2**	68.	**4**	75.	**4**
55.	**3**	62.	**1**	69.	**3**		
56.	**2**	63.	**2**	70.	**2**		
57.	**2**	64.	**1**	71.	**15**		

SOLUTIONS

Q1.

Answer: B

Explanation:
The bond angle depends on the hybridization of the central nitrogen atom and the repulsion caused by lone pairs or surrounding atoms. NO_2^+ is sphybridized with a linear geometry (180°). NO_2 is sp^2 hybridized with one unpaired electron ($\approx 134^\circ$). NO_3^- is sp^2 hybridized with a regular trigonal planar geometry (120°). NO_2^- is sp^2 hybridized with one lone pair, compressing the bond angle further ($\approx 115^\circ$).

Q2.

Answer: A

Explanation:
BF_3 and NH_4^+ are both symmetrical molecules with a regular geometry (D_{h3} trigonal planar and tetrahedral, respectively), resulting in a net dipole moment of zero ($\mu = 0$). NH_3 has a large dipole moment ($\approx 1.46\ \mathrm{D}$) because the orbital dipole due to the lone pair and the bond dipoles of the three $N-H$ bonds act in the same direction. NF_3 has a smaller dipole moment ($\approx 0.23\ \mathrm{D}$) than NH_3 because the bond dipoles of the three $N-F$ bonds (which are polarized towards fluorine) oppose the direction of the lone pair's orbital dipole, partially canceling it out.

Q3.

Answer: A

Explanation:
Using VSEPR theory, determine the steric number, number of bond pairs, and lone pairs for each species to find its molecular shape. Count how many species correspond to each geometry in List-I to match with List-II.

Q4.

Answer: A

Explanation:

Statements (B) and (C) are incorrect based on Molecular Orbital (MO) Theory. For F_2, the last electron enters a π^* orbital, making its HOMO π-type rather than σ-type. For O_2^+, removing an electron from an antibonding orbital increases the bond order (2.5 compared to 2 for O_2), thereby increasing the bond energy of O_2^+.

Q5.

Answer: A

Explanation:

Boron has a very high ionization enthalpy and a small atomic size, making the formation of a simple B^{3+} gaseous cation energetically unfeasible. Consequently, it shares electrons to form covalent compounds. According to Fajan's rules, a cation with a high charge and small size (B^{3+}) exhibits a high polarizing power, distorting the electron cloud of the anion and heavily favoring covalency. Thus, both statements are true and Statement 2 correctly explains Statement 1.

Q6.

Answer: C

Explanation:

Lithium chloride (LiCl) is predominantly covalent due to the high polarizing power and small size of theLi^+ion (Fajans' rules), which distorts the electron cloud of the chloride ion. However, the electronegativity difference between lithium and chlorine is actually quite large (roughly3.16 - 0.98 = 2.18), meaning the reason given is incorrect. Thus, the assertion is true and the reason is false.

Q7.

Answer: C

Explanation:

Molecules and ions that share the same hybridization and number of lone pairs on their central atoms possess identical molecular geometries (shapes). By determining the total electron pairs ($bp + lp$) for each species, we can successfully pair them up.

Q8.

Answer: D

Explanation:
The number of 90° bond angles depends on the geometry of the hybridized state . In an octahedral molecular geometry (sp^3d^2 hybridization), there are 12 such angles, which is the highest among the given options .

Q9.

Answer: A

Explanation:
A regular tetrahedral structure requires sp^3 hybridization of the central atom with four bonding pairs and zero lone pairs . Only the borofluoride ion (BF_4^-) meets these steric criteria .

Q10.

Answer: B

Explanation:
Bond length is inversely proportional to bond order . Since the nitrosonium ion (NO^+) has a higher bond order than the nitric oxide molecule (NO), it possesses a shorter bond length, meaning the bond length in NO is greater .

Q11.

Answer: C

Explanation:

A molecule or ion is diamagnetic if all of its electrons are paired in its molecular orbitals . Among the given options, only H_2 has a completely paired electron configuration .

Q12.

Answer: A

Explanation:
Lattice energy is governed by Coulombic forces of attraction between ions . It is directly proportional to the product of the ionic charges and inversely proportional to the sum of the ionic radii (sizes) .

Q13.

Answer: B

Explanation:
As the central atom becomes less electronegative down the group, the bonding electron pairs shift further away from the central atom towards the hydrogen atoms, reducing bond pair-bond pair repulsions and allowing the lone pair to compress the bond angle more .

Q14.

Answer: C

Explanation:
SF_4 has a see-saw geometry derived from a trigonal bipyramidal arrangement (sp^3d hybridization) . This geometry has both axial and equatorial bonds, which are not equal in length due to different steric repulsions .

Q15.

Answer: D

Explanation:

Though all three species have a bond order of 1, their stability decreases as the number of electrons in antibonding molecular orbitals increases. The actual stability order is $H_2 > Li_2 > B_2$, which is not listed in options A through D.

Q16.

Answer: C

Explanation:
The percentage of ionic character in a bond depends on the electronegativity difference (ΔEN) between the two bonded atoms. A larger difference results in a higher ionic character.

Q17.

Answer: C

Explanation:

Without $2s$-$2p$ mixing, the energy of the σ_{2p_z} molecular orbital is lower than that of the degenerate π_{2p_x} and π_{2p_y} orbitals, which leads to unpaired electrons in the case of the $\mathrm{C_2}$ molecule.

Q18.

Answer: A

Explanation:

In $\mathrm{XeF_2}$, Xenon is the central atom and is surrounded by 2 bond pairs and 3 lone pairs, resulting in a steric number of 5. This corresponds to sp^3d hybridisation, which involves a d-orbital. The other molecules ($\mathrm{SO_2}$, $\mathrm{NH_4^+}$, and $\mathrm{CH_4}$) involve sp^2 or sp^3 hybridisation without any d-orbital contribution.

Q19.

Answer: A

Explanation:

In $\mathrm{I_3^-}$, the central iodine atom has a steric number of 5 (2 bond pairs and 3 lone pairs), which corresponds to sp^3d hybridisation that explicitly includes a d-orbital contribution. In contrast, $\mathrm{PCl_3}$, $\mathrm{NO_3^-}$, and $\mathrm{H_2Se}$ involve sp^3 or sp^2 hybridisation schemes without d-orbital participation.

Q20.

Answer: B

Explanation:

Species like $\mathrm{I_3^-}$ and $\mathrm{N_3^-}$ adopt a linear geometry due to steric arrangements involving lone pairs or multiple bonds that cancel out dipole effects or maintain a 180° bond angle. Specifically, $\mathrm{I_3^-}$ features a central iodine atom with 3 lone pairs in equatorial positions, giving a linear shape, and $\mathrm{N_3^-}$ is linear, whereas the others ($\mathrm{NO_2^-}$, $\mathrm{I_3^+}$, and $\mathrm{SO_2}$) are bent or non-linear.

Q21.

Answer: 6

Explanation:
To find the total number of atoms in a zero oxidation state, we analyze the structure of each molecule. Terminal or bridging atoms bonded to identical atoms (like C in $\mathrm{C_3O_2}$ or internal S atoms in polythionic acids) or specific oxidation state calculations reveal how many atoms possess an oxidation number of 0. Summing these values across all specified molecules gives the final answer of 6.

Q22.

Answer: 4

Explanation:

Write the molecular orbital configurations for each diatomic species and count the number of unpaired electrons in their highest occupied molecular orbital (HOMO).

Q23.

Answer: 80

Explanation:
The percentage ionic character of a polar diatomic molecule is determined by comparing its experimental dipole moment to the theoretical dipole moment calculated for a complete (100%) electronic charge separation.

Q24.

Answer: 6

Explanation:
Calculate the lone pairs on the central atom of each individual chemical species using their valence electrons and covalent bond configurations, then sum the values together.

Q25.

Answer: 6

Explanation:

A molecular species is diamagnetic if all of its electrons are completely paired in its molecular orbitals. By writing the molecular orbital electronic configurations for all nine species, we find that exactly six of them ($\mathrm{H_2}$, $\mathrm{Li_2}$, $\mathrm{Be_2}$, $\mathrm{C_2}$, $\mathrm{N_2}$, and $\mathrm{F_2}$) contain no unpaired electrons and are diamagnetic.

Q26.

Answer: A

Explanation:
For any x, we can show that $f(x) + f(1-x) = 1$. Pairing the terms $f\left(\frac{k}{1996}\right)$ and $f\left(\frac{1996-k}{1996}\right)$ allows us to simplify the entire summation easily.

Q27.

Answer: D

Explanation:
For $x \geq 0$, $f(x) = \tanh x$. For $x < 0$, $|x| = -x$ which causes the numerator to become zero. Since the function is constant for all negative numbers and bounded, it is neither injective (one-one) nor surjective (onto).

Q28.

Answer: B

Explanation:
Evaluating $f(n)$ for odd and even positive integers shows that it maps even numbers to adjacent odd numbers and odd numbers to adjacent even numbers. This defines a perfect bijective pairing on the set of natural numbers.

Q29.

Answer: B

Explanation:
By shifting the variable in the functional equation, we can establish a relation of the form $f(x+T) = f(x)$, which proves periodicity and determines the fundamental period T.

Q30.

Answer: B

Explanation:
Substitute $-x$ for x and simplify the algebraic expression. If $f(-x) = f(x)$, the function is symmetric about the y-axis, making it an even function.

Q31.

Answer: A

Explanation:
Since the range of the sine function is $[-1, 1]$, we can find the minimum and maximum values of the denominator to determine the boundaries of $f(x)$.

Q32.

Answer: A

Explanation:
Let $t = x^2 + 1 \geq 1$. Expressing the function in terms of t allows us to analyze its behavior and find its minimum value.

Q33.

Answer: C

Explanation:

For the given domain $x \in (2, 4)$, the term inside the greatest integer bracket is bounded, simplifying the greatest integer expression to a constant.

Q34.

Answer: A

Explanation:
The functional equation for a polynomial $f(x)$ has only two solutions: $f(x) = 1 \pm x^n$. Using the given boundary condition, we find the exact polynomial and evaluate it.

Q35.

Answer: B

Explanation:
Using the domain condition $x > 0$, we apply algebraic operations to construct the function and find the inequality that defines its range.

Q36.

Answer: D

Explanation:
For the function to be defined, the argument of the arcsine must lie in the interval $[-1, 1]$ and the argument of the logarithm must be positive.

Q37.

Answer: D

Explanation:
For the rational term to be defined, the denominator must be non-zero. For the logarithm, the argument must be strictly positive. Intersecting these conditions yields the domain.

Q38.

Answer: C

Explanation:
The logarithm is defined where $x^2 + x + 1 > 0$ (which is true for all real numbers), and the square root is defined for non-negative values.

Q39.

Answer: A

Explanation:
For a real-valued square root, the radicand must be non-negative. Solving this quadratic inequality determines the domain.

Q40.

Answer: A

Explanation:
The expression inside the square root must be non-negative, and the argument of the logarithm must be strictly positive.

Q41.

Answer: B

Explanation:
This function represents the sum of the distances of x from 2 and 5 on the number line. The minimum sum of these distances occurs when x lies in the interval between the two points.

Q42.

Answer: D

Explanation:
Express the function in terms of the variable x by setting $y = f(x)$ and algebraically solving for x in terms of y.

Q43.

Answer: C

Explanation:
Set $y = f(x)$, convert the logarithmic equation to an exponential form, and solve for x.

Q44.

Answer: B

Explanation:
For nested logarithms, the arguments of each logarithm must be strictly positive, starting from the outermost function and working inward.

Q45.

Answer: A

Explanation:
The denominator must be strictly positive for the square root to yield real, non-zero values. This requires $|x| - x > 0$.

Q46.

Answer: 5

Explanation:
Similar to Question 1, we can prove that $f(x) + f(1 - x) = 1$. Pairing the complementary terms in the summation yields the final result.

Q47.

Answer: 3

Explanation:
Substitute the function definition into the summation to get a geometric progression. Solve the resulting algebraic equation to find the value of a.

Q48.

Answer: 70

Explanation:
To find the domain of the function, we determine the valid input intervals for both the inverse sine term and the logarithmic term by setting up inequality conditions. Solving these simultaneously yields the required domain set parameters α, β, γ, and δ, which are then substituted into the expression $6(\alpha + \beta + \gamma + \delta)$ to arrive at the final value of 70.

Q49.

Answer: 26

Explanation:
To find the domain of the given function, we require both terms under square roots to be well-defined and strictly positive. Solving these conditions for x gives the interval $(a, b) = (-2, 5)$, which are then substituted into the expression $(1 + a)^2 + b^2$ to obtain the final value of 26.

Q50.

Answer: 4

Explanation:
To find the domain of the given function, we need to determine the intersection of the validity conditions for both the logarithmic term and the inverse sine term. 1. For the logarithmic term, the argument must be strictly greater than zero: $\frac{2x-3}{5+4x} > 0$. 2. For the inverse sine term, the argument must lie within the closed interval $[-1, 1]$: $-1 \leq \frac{4+3x}{2-x} \leq 1$. Solving these inequalities yields the interval $[\alpha, \beta]$, from which we can calculate $\alpha^2 + 4\beta$.

Q51.

Answer: C

Explanation:

The maximum height is given by $H = \frac{u^2 \sin^2 \alpha}{2g}$. For complementary angles θ and $90^\circ - \theta$, the ratio of their maximum heights is $\frac{\sin^2 \theta}{\cos^2 \theta}$.

Q52.

Answer: B

Explanation:
For maximum range, the projection angle is $\theta = 45^\circ$. The velocity at the highest point is the horizontal component $v = u \cos 45^\circ = 20 \times \frac{1}{\sqrt{2}} \approx 14.14 \text{ ms}^{-1}$.

Q53.

Answer: B

Explanation:
The horizontal component of velocity remains constant. Using $v \cos 30^\circ = u \cos 60^\circ$, we find $v = u/\sqrt{3}$, so new $KE = K/3$.

Q54.

Answer: D

Explanation:
For complementary angles θ and $(90^\circ - \theta)$,
$T_1 \cdot T_2 = \frac{4u^2 \sin\theta \cos\theta}{g^2} = \frac{2R}{g}$, hence $R = \frac{1}{2} g T_1 T_2$.

Q55.

Answer: C

Explanation:

Maximum range $R_{\max} = \frac{v_0^2}{g}$ (at 45°). Rotating 360° sweeps a circle of radius $R_{\max}$, giving area $= \pi R_{\max}^2 = \frac{\pi v_0^4}{g^2}$.

Q56.

Answer: B

Explanation:

Average velocity $= \frac{\text{displacement}}{\text{time}}$. From start to highest point, displacement $= \sqrt{(u \cos\theta \cdot t)^2 + H^2}$ and time $= \frac{u \sin\theta}{g}$, yielding $\frac{u}{2}\sqrt{1 + 3\cos^2\theta}$.

Q57.

Answer: B

Explanation:
Horizontal distance $= v_x \times t = 300 \times 4 = 1200$ m, since horizontal velocity remains constant and time of flight is 4 s.

Q58.

Answer: D

Explanation:
Since acceleration is only in y-direction, $a_x = 0$, so v_x is constant. Differentiating $y = \beta x^2$ twice and using $a_y = \alpha$ gives $v_x = \sqrt{\frac{\alpha}{2\beta}}$.

Q59.

Answer: D

Explanation:
Hitting the incline horizontally means impact occurs at the highest point. Computing the coordinates of the highest point and finding the distance along the incline gives $R = \frac{u^2\sqrt{21}}{8g}$.

Q60.

Answer: C

Explanation:
"Just clears" means the summit is at the highest point of the trajectory, which occurs at half the horizontal range. Thus $\tan\beta = \frac{H}{R/2} = \frac{\tan\alpha}{2}$.

Q61.

Answer: B

Explanation:

Since both projectiles have the same gravitational acceleration, relative acceleration is zero. The relative motion is uniform, and the minimum distance is found by minimizing the separation using relative velocity.

Q62.

Answer: A

Q63.

Answer: B

Q64.

Answer: A

Q65.

Answer: C

Q66.

Answer: B

Q67.

Answer: B

Q68.

Answer: D

Q69.

Answer: C

Q70.

Answer: B

Q71.

Answer: 15

Explanation:

The range is $R = \frac{u^2 \sin 2\theta}{g}$ and the maximum range is $R_{\max} = \frac{u^2}{g}$. Setting $R = \frac{1}{2} R_{\max}$ yields $\sin 2\theta = 0.5$, which gives $\theta = 15^\circ$.

Q72.

Answer: 40

Explanation:

Maximum range gives $u = 4$ m/s. Horizontal speed $= u \cos 45^\circ = 2\sqrt{2}$ m/s. Distance in $10\sqrt{2}$ s $= 2\sqrt{2} \times 10\sqrt{2} = 40$ m.

Q73.

Answer: 34

Explanation:

Complementary angles give the same range. If one angle is 60°, the other is 30°. The ratio of heights is $\sin^2 60^\circ : \sin^2 30^\circ = 3 : 1$, so $H_2 = 102/3 = 34$ m.

Q74.

Answer: 7

Explanation:

Using vertical displacement equation $-70 = 25t - 5t^2$, we get $t^2 - 5t - 14 = 0$, giving $t = 7$ s.

Q75.

Answer: 4

Explanation:

For horizontal projection, initial vertical velocity is zero. Using $h = \frac{1}{2} g t^2$, we get $t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{160}{10}} = 4$ s.