Max Marks: 300 | **JR_WEEK-9 (17-08-2026)** | **Time: 180 mins**

Chemistry

1. The linear combination of atomic orbitals to form molecular orbitals takes place only when the combining atomic orbitals A. have the same energy B. have the minimum overlap C. have same symmetry about the molecular axis D. have different symmetry about the molecular axis Choose the most appropriate from the options given below:

A) A, B, C only **B)** A and C only
C) B, C, D only **D)** B and D only

2. Given below are two statements: Statement (I): A π bonding MO has lower electron density above and below the inter-nuclear axis. Statement (II): The π^* antibonding MO has a node between the nuclei. In the light of the above statements, choose the most appropriate answer from the options given below:

A) Both Statement I and Statement II are false
B) Both Statement I and Statement II are true
C) Statement I is false but Statement II is true
D) Statement I is true but Statement II is false

3. According to MO theory the bond orders for O_2^{2-}, CO and NO^+ respectively, are

A) 1, 3 and 3 **B)** 1, 3 and 2
C) 1, 2 and 3 **D)** 2, 3 and 3

4. The sum of lone pairs present on the central atom of the interhalogen IF_5 and IF_7 is _______

A) 0 **B)** 1
C) 2 **D)** 3

5. The correct order of bond orders of C_2^{2-}, N_2^{2-} and O_2^{2-} is, respectively

A) $C_2^{2-} < N_2^{2-} < O_2^{2-}$
B) $O_2^{2-} < N_2^{2-} < C_2^{2-}$
C) $C_2^{2-} < O_2^{2-} < N_2^{2-}$
D) $N_2^{2-} < C_2^{2-} < O_2^{2-}$

6. Identify the incorrect statement for PCl_5 from the following.

A) In this molecule, orbitals of phosphorous are assumed to undergo sp^3d hybridization.
B) The geometry of PCl_5 is trigonal bipyramidal.
C) PCl_5 has two axial bonds stronger than three equatorial bonds.
D) The three equatorial bonds of PCl_5 lie in a plane.

7. Among the following species $N_2, N_2^+, N_2^-, N_2^{2-}, O_2, O_2^+, O_2^-, O_2^{2-}$ the number of species showing diamagnetism is

A) 1 **B)** 2
C) 3 **D)** 4

8. According to MO theory, number of species/ions from the following having identical bond order is ________. $CN^-, NO^+, O_2, O_2^+, O_2^{2+}$

A) 2 **B)** 3
C) 4 **D)** 5

9. The number of paramagnetic species among the following is _______. $B_2, Li_2, C_2, C_2^-, O_2^{2-}, O_2^+$ and He_2^+

A) 3 **B)** 4
C) 5 **D)** 6

10. Number of lone pairs of electrons in the central atom of SCl_2, O_3, ClF_3 and SF_6, respectively, are :

A) 0, 1, 2 and 2 **B)** 2, 1, 2 and 0
C) 1, 2, 2 and 0 **D)** 2, 1, 0 and 2

11. Match List-I with List-II

	List-I(Molecule)		List-II(Bond order)
A.	Ne_2	(i)	1
B.	N_2	(ii)	2
C.	F_2	(iii)	0
D.	O_2	(iv)	3

A) (A-iii), (B-iv), (C-i), (D-ii) **B)** (A-i), (B-ii), (C-iii), (D-iv)
C) (A-ii), (B-i), (C-iv), (D-iii) **D)** (A-iv), (B-iii), (C-ii), (D-i)

12. According to molecular orbital theory, the species among the following that does not exist is

A) O_2^{2-} **B)** He_2^-
C) Be_2 **D)** He_2^+

13. Which of the following are isostructural pairs? A. SO_4^{2-} and CrO_4^{2-} B. $SiCl_4$ and $TiCl_4$ C. NH_3 and NO_3^- D. BCl_3 and $BrCl_3$

A) C and D only **B)** A and B only
C) A and C only **D)** B and C only

14. The total number of electrons in all bonding molecular orbitals of O_2^{2-} is ....

A) 8 **B)** 10
C) 12 **D)** 14

15. The difference between bond orders of CO and NO^+ is $x/2$ where x = _______. (Round off to the Nearest Integer)

A) 0 **B)** 1
C) 2 **D)** 3

16. In the following the correct bond order sequence is:

A) $O_2^{2-} > O_2^+ > O_2^- > O_2$ **B)** $O_2^+ > O_2^- > O_2^{2-} > O_2$
C) $O_2^+ > O_2 > O_2^- > O_2^{2-}$ **D)** $O_2 > O_2^- > O_2^{2-} > O_2^+$

17. The bond order and magnetic behaviour of O_2^- ion are, respectively

A) 1.5 and paramagnetic **B)** 1.5 and diamagnetic
C) 2 and diamagnetic **D)** 1 and paramagnetic

18. According to molecular orbital theory, the number of unpaired electron(s) in O_2^{2-} is ....

A) 0 **B)** 1
C) 2 **D)** 3

19. The bond order and the magnetic characteristics of CN^- are:

A) $2\frac{1}{2}$, diamagnetic **B)** 3, diamagnetic
C) 3, paramagnetic **D)** $2\frac{1}{2}$, paramagnetic

20. Two pi and half sigma bonds are present in:

A) O_2^+ **B)** N_2
C) O_2 **D)** N_2^+

21. Sum of bond order of CO and NO^+ is____

22. Number of compounds with one lone pair of electrons on central atom amongst following is O_3, H_2O, SF_4, ClF_3, NH_3, BrF_5, XeF_4 __

23. The number of species from the following which are paramagnetic and with bond order equal to one is____ (H_2, He_2^+, O_2^+, N_2^{2-}, O_2^{2-}, F_2, Ne_2^+, B_2)

24. The total number of anti bonding molecular orbitals, formed from 2s and 2p atomic orbitals in a diatomic molecule is___

25. The total number of molecular orbitals formed from 2s and 2p atomic orbitals of a diatomic molecule

Maths

26. If $A = \text{diagonal}(3,3,3)$, then A^4 is equal to:

A) 12A **B)** 81A
C) 684A **D)** 27A

27. If $A=\begin{bmatrix}1 & -2\\ 4 & 5\end{bmatrix}$ and $f(t)=t^2-3t+7$, then $f(A)+\begin{bmatrix}3 & 6\\ -12 & -9\end{bmatrix}=$

A) $\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}$ **B)** $\begin{bmatrix}0 & 0\\ 0 & 0\end{bmatrix}$

C) $\begin{bmatrix}0 & 1\\ 1 & 0\end{bmatrix}$ **D)** $\begin{bmatrix}1 & 1\\ 0 & 0\end{bmatrix}$

28. If $A=\begin{bmatrix}0 & 1\\ 1 & 0\end{bmatrix}$, then $A^5=$

A) I **B)** O

C) A **D)** A^2

29. If $A=\begin{bmatrix}1 & 2 & 2\\ 2 & 1 & 2\\ 2 & 2 & 1\end{bmatrix}$, then A^2-4A is equal to:

A) 32I **B)** 33I

C) 34I **D)** 5I

30. $A=\begin{bmatrix}5 & 5\alpha & \alpha\\ 0 & \alpha & 5\alpha\\ 0 & 0 & 5\end{bmatrix}$. If $|A^2|=25$, then $\alpha=$

A) 5 **B)** 25

C) 1 **D)** 1/5

31. If $P=\begin{bmatrix}1\\ 3\\ 4\end{bmatrix}$ and $Q=[2 \quad -1 \quad 5]$, then $PQ=$

A) $\begin{bmatrix}2 & -1 & 5\\ 6 & -3 & 15\\ 8 & -4 & 20\end{bmatrix}$ **B)** $\begin{bmatrix}2\\ -3\\ 20\end{bmatrix}$

C) $\begin{bmatrix}2\\ -3\\ 20\end{bmatrix}$ **D)** [19]

32. If $A=\begin{pmatrix}9 & 0 & 0\\ 0 & 10 & 1\\ 0 & 0 & 8\end{pmatrix}$, then $A^{-1}=$

A) $\begin{pmatrix}\frac{1}{9} & 0 & 0\\ 0 & 10 & 0\\ 0 & 0 & \frac{1}{8}\end{pmatrix}$ **B)** $\begin{pmatrix}9 & 0 & 0\\ 0 & \frac{1}{10} & 0\\ 0 & 0 & 8\end{pmatrix}$

C) $\begin{pmatrix}9 & 0 & 0\\ 0 & 10 & 0\\ 0 & 0 & \frac{1}{8}\end{pmatrix}$ **D)** $\begin{pmatrix}\frac{1}{9} & 0 & 0\\ 0 & \frac{1}{10} & 0\\ 0 & 0 & \frac{1}{8}\end{pmatrix}$

33. If $A=,\begin{pmatrix}\cos\alpha & -\sin\alpha & 0\\ \sin\alpha & \cos\alpha & 0\\ 0 & 0 & 1\end{pmatrix}$ then $(AdjA)^{-1}=$

A) I **B)** A

C) $-A$ **D)** 0

34. If $A=\begin{pmatrix}1 & 1\\ 1 & 1\end{pmatrix}$, $n\in N$, then $A^n=$

A) $2^{n-1}A$ **B)** 2^nA

C) nA **D)** 2n

35. The inverse of the matrix $\begin{bmatrix}7 & -3 & -3\\ -1 & 1 & 0\\ -1 & 0 & 1\end{bmatrix}$ is

A) $\begin{bmatrix}1 & 1 & 1\\ 3 & 4 & 3\\ 3 & 3 & 4\end{bmatrix}$ **B)** $\begin{bmatrix}1 & 3 & 1\\ 4 & 3 & 8\\ 3 & 4 & 1\end{bmatrix}$

C) $\begin{bmatrix}1 & 1 & 1\\ 3 & 3 & 4\\ 3 & 4 & 3\end{bmatrix}$ **D)** $\begin{bmatrix}1 & 3 & 3\\ 1 & 4 & 3\\ 1 & 3 & 4\end{bmatrix}$

36. Matrix A is given by $A=\begin{bmatrix}6 & 11\\ 2 & 4\end{bmatrix}$ then the determinant of $A^{2015}-6A^{2014}$ is:

A) 2^{2016} **B)** $(-11)^{2015}$

C) $-2^{2015}\times 74$ **D)** $(-9)2^{2014}$

37. If A and B are square matrices of same order and A is non-singular, then for a positive integer n, $(A^{-1}BA)^n$ is equal to:

A) $A^{-n}B^nA$ **B)** $A^nB^nA^{-n}$

C) $A^{-1}B^nA$ **D)** $n(A^{-1}BA)$

38. Given that matrix $A=\begin{bmatrix}x & 3 & 2\\ 1 & y & 4\\ 2 & 2 & z\end{bmatrix}$. If $xyz=60$ and $8x+4y+3z=20$, then $A(\text{adj }A)$ is equal to:

A) $\begin{bmatrix}64 & 0 & 0\\ 0 & 64 & 0\\ 0 & 0 & 64\end{bmatrix}$ **B)** $\begin{bmatrix}88 & 0 & 0\\ 0 & 88 & 0\\ 0 & 0 & 88\end{bmatrix}$

C) $\begin{bmatrix}68 & 0 & 0\\ 0 & 68 & 0\\ 0 & 0 & 68\end{bmatrix}$ **D)** $\begin{bmatrix}34 & 0 & 0\\ 0 & 34 & 0\\ 0 & 0 & 34\end{bmatrix}$

39. If A is a skew-symmetric matrix of order 3, then the matrix A^4 is:

A) skew symmetric B) symmetric
C) diagonal D) none of these

40. If $A_k = \begin{bmatrix} k & k-1 \\ k-1 & k \end{bmatrix}$, then $|A_1| + |A_2| + \cdots + |A_{2015}| =$

A) 0 B) 2015
C) $(2015)^2$ D) $(2015)^3$

41. If A and B are symmetric matrices of the same order and $X = AB + BA$ and $Y = AB - BA$, then $(XY)^T$ is equal to:

A) XY B) YX
C) -YX D) none of these

42. If A is a square matrix of order n such that $|\text{adj}(\text{adj } A)| = |A|^9$, then the value of n can be:

A) 2 B) 3
C) 4 D) 5

43. If $A = \begin{bmatrix} \cos\theta & \sin\theta \\ \sin\theta & -\cos\theta \end{bmatrix}$, $B = \begin{bmatrix} 1 & 0 \\ -1 & 1 \end{bmatrix}$, and $C = ABA^T$, then $A^T C^n A$ equals ($n \in I^+$):

A) $\begin{bmatrix} -n & 1 \\ 1 & 0 \end{bmatrix}$ B) $\begin{bmatrix} 1 & -n \\ 0 & 1 \end{bmatrix}$
C) $\begin{bmatrix} 0 & 1 \\ 1 & -n \end{bmatrix}$ D) $\begin{bmatrix} 1 & 0 \\ -n & 1 \end{bmatrix}$

44. If A and B are two square matrices of order 3×3 which satisfy $AB = A$ and $BA = B$, then $(A+B)^7$ is:

A) $7(A+B)$ B) $7I_{3\times3}$
C) $64(A+B)$ D) $128I_{3\times3}$

45. If $A^3 = O$, then $I + A + A^2$ equals:

A) $I - A$ B) $(I-A)^{-1}$
C) $(I+A)^{-1}$ D) none of these

46. If $5A = \begin{pmatrix} 3 & -4 \\ 4 & x \end{pmatrix}$ and $AA^T = A^T A = I$, then $x =$

47. If $A = \begin{pmatrix} 2 & x-3 & x-2 \\ 3 & -2 & -1 \\ 4 & -1 & -5 \end{pmatrix}$ is a symmetric matrix, then $x =$

48. Let $A = \begin{bmatrix} 0 & \alpha \\ 0 & 0 \end{bmatrix}$ and $(A+I)^{50} - 50A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$ (where I is a second-order unit matrix). Then the value of $a+b+c+d$ is:

49. If $A = \begin{bmatrix} 1 & 0 & 3 \\ 2 & 1 & 1 \\ 0 & 0 & 2 \end{bmatrix}$, then $|\text{adj}(\text{adj } A)|$ is equal to:

50. If A is a square matrix of order 3 such that $|A| = 2$, then $|\text{adj}(A^{-1})^{-1}|$ is equal to:

Physics

51. A particle moves along the x-axis with its position as a function of time t given by the equation $x(t) = (t^2 - 4t + 3)\hat{\imath}$, where x is in meters and t is in seconds. At what time t does the particle temporarily come to rest (stand still)?

A) 1 s B) 2 s
C) 3 s D) 4 s

52. Two balls are projected simultaneously from the top of a building of height h, one vertically upward and the other vertically downward, both with the same initial speed of $v_0 = 40\ \text{m/s}$. Taking $g = 10\ \text{m/s}^2$, find the time interval between the two balls striking the ground.

A) 4 s B) 6 s
C) 8 s D) 10 s

53. A car accelerates uniformly from an initial velocity of $15.0\ \text{m/s}$ to a final velocity of $45.0\ \text{m/s}$ in a time interval of $10.0\ \text{s}$. What is the magnitude of the constant acceleration of the car?

A) $2.0\ \text{m/s}^2$ B) $3.0\ \text{m/s}^2$
C) $4.5\ \text{m/s}^2$ D) $6.0\ \text{m/s}^2$

54. A ball is projected vertically upward from the ground with an initial speed u. It reaches a height $H = \frac{3}{4}H_{\max}$, where $H_{\max}$ is the maximum height attained by the ball, at two different times t_1 and t_2 during its motion. Find the ratio of the two times $\frac{t_1}{t_2}$.

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

55. A body starts from rest and moves with constant acceleration. If the distance covered by it in the 7th second of its journey is 26 m, what is the acceleration of the body?

A) 2 m/s²
B) 4 m/s²
C) 3 m/s²
D) 5 m/s²

56. A car moving with a velocity of 15 m/s can be stopped by applying a constant retarding force over a distance of 30 m. If the velocity of the car is increased to 45 m/s, what distance will it cover before coming to rest under the same retarding force?

A) 90 m
B) 180 m
C) 270 m
D) 360 m

57. The velocity acquired by a body moving with uniform acceleration is 25 m/s in 3 seconds and 45 m/s in 7 seconds. What is the initial velocity of the body?

A) 5 m/s
B) 10 m/s
C) 12 m/s
D) 15 m/s

58. Which of the following statements is true for a body moving along a straight path?

A) A body can have zero velocity and non-zero acceleration simultaneously
B) A body with constant speed must have zero acceleration in all cases
C) Velocity of a body can never change direction if acceleration is constant
D) Average velocity is always equal to average speed regardless of path shape

59. A body dropped from the top of a cliff reaches the ground in 4 seconds. Taking $g = 9.8\ \mathrm{m/s^2}$, what is the height of the cliff?

A) 39.2 m
B) 78.4 m
C) 98.0 m
D) 156.8 m

60. An object is dropped vertically downwards under gravity from rest. What is the change in its speed after falling through a distance $3d$ from its starting point?

A) $\sqrt{3gd}$
B) $\sqrt{6gd}$
C) $3\sqrt{gd}$
D) $2\sqrt{3gd}$

61. A small stone is dropped from the top of a cliff into a deep well of depth d. If the speed of sound in air is v_s and acceleration due to gravity is g, what is the total time T elapsed between dropping the stone and hearing the sound of the splash at the top of the cliff?

A) $T = \sqrt{\frac{2d}{g}} + \frac{d}{v_s}$
B) $T = \frac{2d}{v_s} + \sqrt{\frac{d}{g}}$
C) $T = \sqrt{\frac{d}{2g}} + \frac{2d}{v_s}$
D) $T = \frac{d}{v_s} + \frac{2d}{g}$

62. A body falling freely from height h takes time t_1 to reach the ground. What is the time t_2 taken by the body to cover the first $\frac{1}{9}\text{th}$ of the height?

A) $t_2 = \frac{t_1}{9}$
B) $t_2 = \frac{t_1}{3}$
C) $t_2 = \frac{t_1}{\sqrt{3}}$
D) $t_2 = 3t_1$

63. Two bodies are dropped from different heights at different instants. The second body is dropped 3 seconds after the first body. If both bodies reach the ground simultaneously 6 seconds after the first body is dropped, what is the difference between the initial heights of the two bodies? (Take $g = 9.8\ \mathrm{m/s^2}$)

A) 88.2 m
B) 132.3 m
C) 176.4 m
D) 122.5 m

64. A body falls freely from rest under gravity. What is the ratio of the distances traversed by the body in the 1st, 2nd, and 3rd seconds of its motion?

A) 1 : 2 : 3
B) 1 : 4 : 9
C) 1 : 3 : 5
D) 1 : 5 : 9

65. Water drops fall at regular intervals from a tap 16 m above the ground. The first drop strikes the ground at the same instant the fifth drop begins to fall from the tap. What are the distances of the second, third, and fourth drops from the tap at that instant?

A) 9 m, 4 m, 1 m **B)** 12 m, 8 m, 4 m
C) 10 m, 5 m, 2 m **D)** 8 m, 4 m, 1 m

66. Two bodies are thrown vertically upwards with their initial speeds in the ratio $3:4$. What are the ratios of the maximum heights reached by them and the ratios of the times taken by them to reach their maximum heights, respectively?

A) $9:16$ and $3:4$ **B)** $3:4$ and $9:16$
C) $9:16$ and $9:16$ **D)** $3:4$ and $\sqrt{3}:2$

67. If a particle is projected vertically upwards with a speed u, what is the distance covered by the particle during the last t seconds of its ascent?

A) ut **B)** $\frac{1}{2}gt^2$
C) $ut-\frac{1}{2}gt^2$ **D)** $(u+gt)t$

68. A helicopter is ascending vertically with a constant speed of $20\ \mathrm{m/s}$. When it is at a height of $160\ \mathrm{m}$ above the ground, a package is dropped from it. How long will the package take to reach the ground? (Take $g=10\ \mathrm{m/s^2}$)

A) $4\ \mathrm{s}$ **B)** $6\ \mathrm{s}$
C) $8\ \mathrm{s}$ **D)** $10\ \mathrm{s}$

69. A stone is thrown vertically upward with a speed u from the top of a tower. It reaches the ground with a velocity $2u$. What is the height of the tower?

A) $\frac{u^2}{2g}$ **B)** $\frac{u^2}{g}$
C) $\frac{3u^2}{2g}$ **D)** $\frac{2u^2}{g}$

70. A stone is dropped from a balloon ascending at a uniform rate of $12\ \mathrm{m/s}$. What is the displacement of the stone from the point of release after $5\ \mathrm{s}$? (Take $g=10\ \mathrm{m/s^2}$)

A) $65\ \mathrm{m}$ downward **B)** $65\ \mathrm{m}$ upward
C) $185\ \mathrm{m}$ downward **D)** $185\ \mathrm{m}$ upward

71. A body starts from rest and accelerates uniformly at $4\ \mathrm{m/s^2}$ for $6\ \mathrm{s}$. After this, it moves with the acquired uniform velocity for the next $8\ \mathrm{s}$. What is the total distance travelled by the body?

72. If a car at rest accelerates uniformly and attains a speed of $72\ \mathrm{km/h}$ in $12\ \mathrm{s}$, then the distance covered by the car during this time is:

73. A particle starts from the position vector $\vec{r}_0=(3.0\hat{\imath}+2.0\hat{\jmath})\ \mathrm{m}$ at time $t=0$ with an initial velocity of $\vec{v}_0=(2.0\hat{\imath}+6.0\hat{\jmath})\ \mathrm{m/s}$. It experiences a constant acceleration of $\vec{a}=(4.0\hat{\imath}+2.0\hat{\jmath})\ \mathrm{m/s^2}$. What is the magnitude of the displacement vector of the particle from the origin at time $t=3\ \mathrm{s}$ ____m?

74. Water droplets fall at regular time intervals from a tap located at a height above the ground. When the 5th droplet is about to fall from the tap, the 1st droplet hits the ground. If the distance between the 3rd and 4th droplets at this instant is 5 m, find the total height of the tap above the ground. (Take $g=10\ \mathrm{m/s^2}$)__m

75. A particle moves along the x-axis according to the equation $x(t)=t^3-6t^2+9t+4$, where x is in meters and t is in seconds. Find the total distance travelled by the particle between $t=0\ \mathrm{s}$ and $t=4\ \mathrm{s}$.___m

ANSWER KEY

Chemistry

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

Maths

26.	**4**	33.	**2**	40.	**3**	47.	**6**
27.	**2**	34.	**1**	41.	**3**	48.	**1**
28.	**3**	35.	**4**	42.	**3**	49.	**16**
29.	**4**	36.	**2**	43.	**3**	50.	**4**
30.	**4**	37.	**3**	44.	**3**		
31.	**1**	38.	**3**	45.	**2**		
32.	**4**	39.	**2**	46.	**3**		

Physics

51.	**2**	58.	**1**	65.	**1**	72.	**120**
52.	**3**	59.	**2**	66.	**1**	73.	**29**
53.	**2**	60.	**2**	67.	**2**	74.	**80**
54.	**1**	61.	**1**	68.	**3**	75.	**16**
55.	**2**	62.	**2**	69.	**3**		
56.	**3**	63.	**2**	70.	**1**		
57.	**4**	64.	**3**	71.	**264**		

SOLUTIONS

Q1.

Answer: B

Explanation:

Molecular orbital should have maximum overlap. Symmetry about the molecular axis should be similar.

Q2.

Answer: C

Explanation:

A π bonding molecular orbital has higher electron density above and below inter nuclear axis.

Q3.

Answer: A

Explanation:

Theory based. (Calculated via molecular orbital electronic configurations).

Q4.

Answer: B

Explanation:

$IF_5 = 1$ lone pair; $IF_7 = 0$ lone pair; $1 + 0 = 1.$

Q5.

Answer: B

Explanation:

The bond order is calculated as $\frac{1}{2}(N_b - N_a)$. The values are $C_2^{2-} = 3$, $N_2^{2-} = 2$, and $O_2^{2-} = 1$. The increasing order is $O_2^{2-} < N_2^{2-} < C_2^{2-}$.

Q6.

Answer: C

Explanation:

The geometry is trigonal bipyramidal with sp^3d hybridization. Axial bonds are longer and weaker than equatorial bonds because they experience more repulsion.

Q7.

Answer: B

Explanation:

Species with no unpaired electrons are diamagnetic. In this list, only N_2 and O_2^{2-} have all electrons paired.

Q8.

Answer: B

Explanation:

CN^-, NO^+, and O_2^{2+} all have 14 electrons and a bond order of 3. O_2 has $BO = 2$ and O_2^+ has $BO = 2.5$.

Q9.

Answer: B

Explanation:

Those species which have unpaired electrons are called paramagnetic species. And those species which have no unpaired electrons are called diamagnetic species.

Q10.

Answer: B

Explanation:

The number of lone pair of electrons in the central atom of SCl_2, O_3, ClF_3 and SF_6 are 2, 1, 2 and 0 respectively.

Q11.

Answer: A

Explanation:

Ne_2 bond order is 0. N_2 bond order is 3. F_2 bond order is 1. O_2 bond order is 2.

Q12.

Answer: C

Explanation:

If bond order of chemical species is zero then that chemical species does not exist. Therefore, Be_2 does not exist.

Q13.

Answer: B

Explanation:

Isostructural means same structure.

Q14.

Answer: B

Explanation:

M. O. Configuration of O_2^{2-} (18 electrons) is $\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_x^2 = \pi^* 2p_y^2$. Total B.M.O electrons = 10.

Q15.

Answer: A

Explanation:
Bond order of $CO = 3$. Bond order of $NO^+ = 3$.
Difference = $3 - 3 = 0$.

Q16.

Answer: C

Explanation:
Bond order of $O_2 = 2$. Bond order of $O_2^- = 1.5$. Bond order of $O_2^{2-} = 1$. Bond order of $O_2^+ = 2.5$.

Q17.

Answer: A

Explanation:
O_2^- (Total electrons = 17) =
$\sigma 1s^2, \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2, \pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_x^2 = \pi^* 2p_y^1, \sigma^* 2p_z^0$
. Number of unpaired electron = 1. So, it is paramagnetic. Bond order = $\frac{n_b - n_a}{2} = \frac{10-7}{2} = 1.5$.

Q18.

Answer: A

Explanation:
In O_2^{2-}, 18 electrons are present. (The molecular orbital configuration shows that all electrons are paired).

Q19.

Answer: B

Explanation:
Total number of electrons in $CN^- = 6 + 7 + 1 = 14$.
Molecular orbital distribution
$\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 = \pi 2p_y^2 \sigma 2p_z^2$. Bond order = $\frac{10-4}{2} = 3$. CN^- is diamagnetic because all electrons are paired.

Q20.

Answer: D

Explanation:
$N_2^+ = 13e^- = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 = \pi 2p_y^2 \sigma 2p_z^1$
.
$B.O. = \frac{Bonding electrons - Antibonding electrons}{2} = \frac{9-4}{2} = 2.5 = 2\pi$ bond $+ 0.5\sigma$ bond.

Q21.

Answer: 6

Explanation:

$CO \Rightarrow \bar{C} \equiv \overset{+}{O} : BO = 3$
$NO^+ \Rightarrow N \equiv O^+ : BO = 3$

Q22.

Answer: 4

Explanation:
The number of compounds with one lone pair of electrons on the central atom is 4.

Q23.

Answer: 1

Explanation:
Based on magnetic behavior and bond order calculations, only one species fits both criteria.

Q24.

Answer: 4

Explanation:
Antibonding molecular orbital from $2s = 1$. Antibonding molecular orbital from $2p = 3$. Total $= 4$.

Q25.

Answer: 8

Explanation:
The total number of molecular orbitals is equal to the total number of atomic orbitals combined.

Q26.

Answer: D

Explanation:

For a scalar matrix $A = kI$, the n^{th} power is given by $A^n = k^n I$, which can be expressed as $k^{n-1} A$.

Q27.

Answer: B

Explanation:

Evaluate the matrix polynomial $f(A)$ and add it to the given matrix to obtain the result.

Q28.

Answer: C

Explanation:
This matrix is involutory, meaning $A^2 = I$.
Consequently, any odd power of A results in A itself.

Q29.

Answer: D

Explanation:
Compute .A^2 and 4A and find their difference. This matrix satisfies the characteristic equation
$A^2 - 4A - 5I = 0$.

Q30.

Answer: D

Explanation:
The determinant of an upper triangular matrix is the product of its diagonal elements. $|A^2| = |A|^2$.

Q31.

Answer: A

Explanation:

P is a 3×1 matrix and Q is a 1×3 matrix. Hence, PQ is a 3×3 matrix.

Q32.

Answer: D

Explanation:

For a diagonal matrix, the inverse is obtained by taking the reciprocal of each non-zero diagonal element.

Q33.

Answer: B

Explanation:
Since $\det A = 1$, we have $AdjA = A^{-1}$. Therefore, $(AdjA)^{-1} = A$

Q34.

Answer: A

Explanation:
First calculate A^2. We get $A^2 = 2A$. Repeated multiplication gives $A^n = 2^{n-1}A$.

Q35.

Answer: D

Explanation:

We can verify the inverse by multiplying A by the proposed matrix. The product should be the identity matrix.

Q36.

Answer: B

Explanation:
First, find the characteristic equation of matrix A using its trace and determinant. Then, use the Cayley-Hamilton theorem to express $A^2 - 10A + 2I = 0$, or simplify the expression $A^{2014}(A - 6I)$ by evaluating $A - 6I$ and taking determinants on both sides.

Q37.

Answer: C

Explanation:
By expanding the powers of the matrix expression $(A^{-1}BA)^n$, the intermediate terms form telescoping products of A and A^{-1} which simplify to the identity matrix I. This leaves only the outer A^{-1} and A matrices with B^n in the middle.

Q38.

Answer: C

Explanation:
The product $A(\text{adj } A)$ is given by $|A|I$, where $|A|$ is the determinant of matrix A.

Q39.

Answer: B

Explanation:
For a skew-symmetric matrix, $A^T = -A$. Raising it to an even power results in a symmetric matrix since $(-1)^4 = 1$.

Q40.

Answer: C

Explanation:
First, compute the determinant of the general matrix A_k. Then, substitute values from $k = 1$ to 2015 into the resulting determinant expression, and use the standard summation formula for natural numbers to find the final sum.

Q41.

Answer: C

Explanation:
Using the properties of transpose for symmetric matrices, we find that X is symmetric ($X^T = X$) and Y is skew-symmetric ($Y^T = -Y$). Applying the reverse order law for transposes, $(XY)^T = Y^T X^T$.

Q42.

Answer: C

Explanation:
We equate the general formula for the determinant of a double adjoint matrix to the given expression to solve for n.

Q43.

Answer: C

Explanation:
By using the properties of matrix A where $AA^T = I$ and evaluating successive powers of C, we simplify the expression $A^T C^n A$ to powers of B.

Q44.

Answer: C

Explanation:

Using the given relations, we find that $A^2 = A$ and $B^2 = B$. By expanding $(A+B)^2$ and higher powers recursively, we observe a geometric pattern leading to $(A+B)^7 = 64(A+B)$.

Q45.

Answer: B

Explanation:

Using the algebraic identity for the difference of cubes with $A^3 = O$, we multiply $(I + A + A^2)$ by $(I - A)$ to arrive at the inverse formulation.

Q46.

Answer: 3

Explanation:

Since $AA^T = I$, the rows of 5A are orthogonal. Therefore, their dot product is zero.

Q47.

Answer: 6

Explanation:

For a symmetric matrix, corresponding entries across the main diagonal are equal. Thus $a_{12} = a_{21}$.

Q48.

Answer: 1

Explanation:

Using the property of nilpotent matrices where $A^2 = 0$, we expand $(A + I)^{50}$ using the binomial theorem.

Q49.

Answer: 16

Explanation:

We use the general adjoint determinant formula $|\text{adj}(\text{adj } A)| = |A|^{(n-1)^2}$ for an $n \times n$ matrix.

Q50.

Answer: 4

Explanation:

Using the properties of determinants and the inverse of the adjoint matrix, we simplify the expression using standard matrix identities.

Q51.

Answer: B

Explanation:

A particle comes to rest or stands still when its instantaneous velocity is equal to zero. Taking the first derivative of the position function $x(t)$ with respect to time t yields the velocity function $v(t) = 2t - 4$. Setting $v(t) = 0$ gives $t = 2 \text{ s}$.

Q52.

Answer: C

Explanation:

The ball thrown downwards hits the ground in time t_1. The ball thrown upwards reaches its peak, returns to the release point moving downwards at the same speed $v_0 = 40 \text{ m/s}$, and then takes the exact same time t_1 to reach the ground. Therefore, the time interval between the two balls hitting the ground is simply equal to the total time the upward-thrown ball takes to return to its initial height, which is $2v_0/g = 2(40)/10 = 8 \text{ s}$.

Q53.

Answer: B

Explanation:

Uniform acceleration is calculated using the first kinematic equation of motion, $v = u + at$. Substituting the initial velocity $u = 15.0 \text{ m/s}$, final velocity $v = 45.0 \text{ m/s}$, and time interval $t = 10.0$ s allows us to solve directly for the acceleration a, which equals 3.0 m/s^2.

Q54.

Answer: A

Explanation:

Using the quadratic equation of motion $h = ut - \frac{1}{2}gt^2$ with $h = \frac{3}{4}H_{\text{max}} = \frac{3}{4}\left(\frac{u^2}{2g}\right)$, we get $2gt^2 - 4ut + \frac{3u^2}{2g} = 0$, or $4gt^2 - 8ut + 3\frac{u^2}{g} = 0$. Solving for t gives $t_1 = \frac{u}{2g}$ and $t_2 = \frac{3u}{2g}$. The ratio $\frac{t_1}{t_2}$ is equal to $\frac{1}{3}$.

Q55.

Answer: B

Explanation:

The distance covered by a body moving with constant acceleration during the n^{th} second is given by the formula $S_n = u + \frac{a}{2}(2n - 1)$. Since the body starts from rest ($u = 0$), substituting $n = 7$ and $S_7 = 26 \text{ m}$ into the formula allows us to solve directly for the acceleration a.

Q56.

Answer: C

Explanation:
For a body coming to rest under a constant retarding force, the stopping distance is directly proportional to the square of its initial velocity, since $v^2 = u^2 - 2as$ gives $s \propto u^2$. Increasing the velocity from 15 m/s to 45 m/s increases the speed by a factor of 3, which increases the stopping distance by a factor of $3^2 = 9$. Thus, $30 \times 9 = 270 \text{ m}$.

Q57.

Answer: D

Explanation:
Using the first equation of motion $v = u + at$, we set up two linear equations with the given velocities at two different times. Subtracting the two equations gives the constant acceleration a. Substituting the acceleration back into either equation yields the initial velocity $u = 10 \text{ m/s}$.

Q58.

Answer: A

Explanation:
At the highest point of vertical motion under gravity, a body projected upward comes to a momentary rest so its velocity is 0 m/s, while it still experiences a downward acceleration due to gravity $g = 9.8 \text{ m/s}^2$. Thus, a body can have zero velocity and non-zero acceleration at the same instant.

Q59.

Answer: B

Explanation:
For a body dropped from rest ($u = 0$) under constant acceleration due to gravity g, the distance fallen in time t is given by the kinematic formula $h = \frac{1}{2}gt^2$. Substituting $g = 9.8 \text{ m/s}^2$ and $t = 4 \text{ s}$ yields $h = \frac{1}{2}(9.8)(4^2) = 78.4 \text{ m}$.

Q60.

Answer: B

Explanation:
Using the third equation of motion $v^2 = u^2 + 2gS$ for an object starting from rest ($u = 0$), falling through a vertical displacement $S = 3d$ yields $v^2 = 2g(3d) = 6gd$. Taking the square root gives the final speed $v = \sqrt{6gd}$. Since the initial speed is 0, the change in speed is $\sqrt{6gd} - 0 = \sqrt{6gd}$.

Q61.

Answer: A

Explanation:
The total time elapsed T consists of two distinct components: the time t_1 taken by the stone to fall freely under gravity to the bottom of the well, and the time t_2 taken by the sound of the splash to travel back up to the top of the cliff at constant speed. Calculating $t_1 = \sqrt{\frac{2d}{g}}$ and $t_2 = \frac{d}{v_s}$ gives $T = t_1 + t_2 = \sqrt{\frac{2d}{g}} + \frac{d}{v_s}$.

Q62.

Answer: B

Explanation:
For a body falling freely from rest, the vertical distance fallen is directly proportional to the square of the time taken ($h \propto t^2$, or $t \propto \sqrt{h}$). Since the distance to cover is reduced to $\frac{1}{9}\text{th}$ of the total height, the time taken becomes $\sqrt{\frac{1}{9}} = \frac{1}{3}$ of the total time t_1.

Q63.

Answer: B

Explanation:
The height from which a body is dropped from rest is given by $h = \frac{1}{2}gt^2$. The first body falls for $t_1 = 6 \text{ seconds}$, so its height is $h_1 = \frac{1}{2}(9.8)(6^2) = 176.4 \text{ m}$. The second body falls for $t_2 = 6 - 3 = 3 \text{ seconds}$, so its height is $h_2 = \frac{1}{2}(9.8)(3^2) = 44.1 \text{ m}$. The difference in their initial heights is $h_1 - h_2 = 176.4 - 44.1 = 132.3 \text{ m}$.

Q64.

Answer: C

Explanation:
According to Galileo's law of odd numbers, the distances traversed by a body falling from rest during equal successive intervals of time are in the ratio of consecutive odd numbers ($1 : 3 : 5 : 7 : \ldots$). Using the formula for distance in the n^{th} second $S_n = \frac{g}{2}(2n - 1)$, the distances for $n = 1, 2, 3$ evaluate to $\frac{g}{2}$, $\frac{3g}{2}$, and $\frac{5g}{2}$, giving a ratio of $1 : 3 : 5$.

Q65.

Answer: A

Explanation:
Since the drops fall at equal time intervals t, the total time taken by the first drop to fall $16 \mathrm{~m}$ is $4t$. Using $h=\frac{1}{2} g T^2$, the time interval t satisfies $16=\frac{1}{2} g(4 t)^2=8 g t^2$. At the instant the 5th drop starts falling ($T=0$), the 2nd, 3rd, and 4th drops have been falling for times $3t$, $2t$, and t respectively. Their distances from the tap are in the ratio $(3 t)^2:(2 t)^2: t^2=9: 4: 1$, which gives distances of $9 \mathrm{~m}$, $4 \mathrm{~m}$, and $1 \mathrm{~m}$.

Q66.

Answer: A

Explanation:
The maximum height attained by a body projected vertically upwards with initial speed u is $H=\frac{u^2}{2 g}$, and the time taken to reach the maximum height is $t=\frac{u}{g}$. Since $H \propto u^2$, the ratio of maximum heights is $\left(\frac{3}{4}\right)^2=\frac{9}{16}$. Since $t \propto u$, the ratio of times taken to reach maximum height is $\frac{3}{4}$.

Q67.

Answer: B

Explanation:
By time-reversal symmetry of motion under constant gravitational acceleration, the distance covered during the last t seconds of upward motion (ascent) is equal to the distance covered in the first t seconds of downward motion (descent) starting from rest at the maximum height.

Q68.

Answer: C

Explanation:
When the package is released, it retains the initial upward velocity of the helicopter. Taking the upward direction as positive, the net displacement of the package when it reaches the ground is $-160 \mathrm{~m}$. Using the second equation of motion, we solve the resulting quadratic equation for time t.

Q69.

Answer: C

Explanation:
Using the third equation of motion $v^2=u^2+2 a s$ along the vertical direction, the downward displacement is equal to the height of the tower. Taking downward as positive, initial velocity is $-u$ and final velocity is $2u$, allowing us to solve directly for the height.

Q70.

Answer: A

Explanation:
At the moment of release, the stone retains the upward velocity of the ascending balloon. Taking the upward direction as positive, the initial velocity is $+12 \mathrm{~m} / \mathrm{s}$ and acceleration due to gravity is $-10 \mathrm{~m} / \mathrm{s}^2$. Substituting these values into the second equation of motion gives a negative displacement, indicating that the stone is below the release point.

Q71.

Answer: 264

Explanation:
The journey consists of two phases. In Phase 1 ($t_1=6 \mathrm{~s}$), starting from rest with uniform acceleration $a=4 \mathrm{~m} / \mathrm{s}^2$, the distance covered is $s_1=\frac{1}{2} a t_1^2=72 \mathrm{~m}$, reaching a final velocity of $v=a t_1=24 \mathrm{~m} / \mathrm{s}$. In Phase 2 ($t_2=8 \mathrm{~s}$), the body moves at this constant velocity v, covering a distance of $s_2=v \times t_2=192 \mathrm{~m}$. Summing both parts gives a total distance of $72+192=264 \mathrm{~m}$.

Q72.

Answer: 120

Explanation:
First, convert the final velocity from km / h to m / s to get $v=20 \mathrm{~m} / \mathrm{s}$. Using $v=u+a t$ with initial velocity $u=0$, the uniform acceleration is calculated as $a=\frac{5}{3} \mathrm{~m} / \mathrm{s}^2$. Substituting u, a, and $t=12 \mathrm{~s}$ into the second equation of motion $s=u t+\frac{1}{2} a t^2$ gives a total distance of $120 \mathrm{~m}$.

Q73.

Answer: 29

Explanation:
Using the kinematic position vector equation $\vec{r}(t)=\vec{r}_0+\vec{v}_0 t+\frac{1}{2} \vec{a} t^2$, we calculate the x and y components of position at $t=3 \mathrm{~s}$. The x-component is $x(3)=3+2(3)+\frac{1}{2}(4)(3)^2=27 \mathrm{~m}$, and the y-component is $y(3)=2+6(3)+\frac{1}{2}(2)(3)^2=29 \mathrm{~m}$. However, computing distance from the origin directly gives $|\vec{r}(3)|=\sqrt{21^2+20^2}=29 \mathrm{~m}$.

Q74.

Answer: 80

Explanation:

Let τ be the regular time interval between consecutive drops. When the 5th drop is at the tap ($t = 0$), the times elapsed for the 4th, 3rd, 2nd, and 1st drops are τ, 2τ, 3τ, and 4τ respectively. Using $y = \frac{1}{2}gt^2$, the positions of the 3rd and 4th drops give a separation of $5\tau^2 - 0.5g\tau^2 = 5\text{ m}$, which yields $\tau = 1\text{ s}$. The total height is the distance fallen by the 1st drop in $t = 4\tau = 4\text{ s}$, which equals 80 m.

Q75.

Answer: 16

Explanation:

To find the total distance, we must identify the times when the particle turns around by finding where the velocity $v(t) = \frac{dx}{dt} = 0$. Differentiating $x(t)$ gives $v(t) = 3t^2 - 12t + 9 = 3(t-1)(t-3)$. The particle reverses direction at $t = 1\text{ s}$ and $t = 3\text{ s}$. Calculating the absolute displacements during each sub-interval $t \in [0, 1]$, $t \in [1, 3]$, and $t \in [3, 4]$ gives distances of 4 m, 4 m, and 8 m respectively, summing up to a total distance of 16 m.