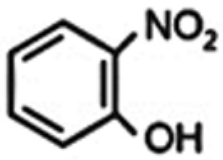
Max Marks: 300 **JR_WEEK-11 (31-08-2026)** **Time: 180 mins**

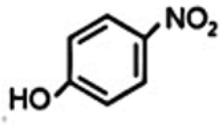
Chemistry

1. Intramolecular hydrogen bonding is present in:

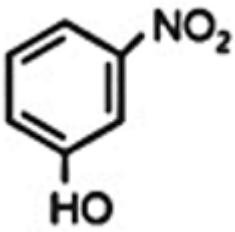
A)



B)

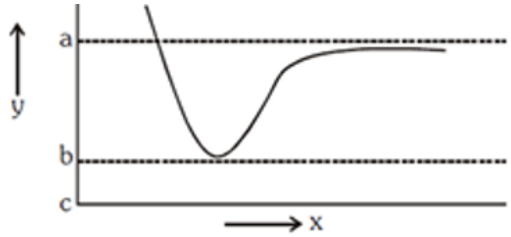


C)



D) HF

2. The potential energy (y) curve for H_2 formation as a function of internuclear distance (x) of the H atoms is shown.

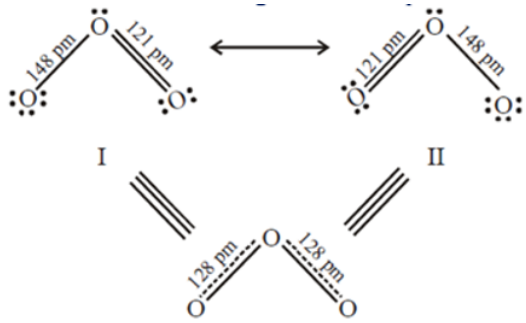


The bond energy of H_2 is:

A) $(a-b)$ **B)** $\frac{c-a}{2}$

C) $\frac{b-a}{2}$ **D)** $(c-a)$

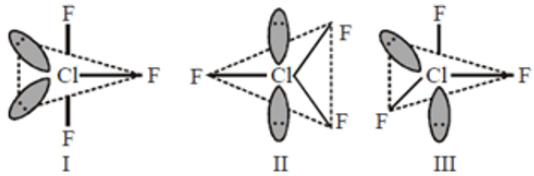
3. Which of the following structure represents structure of O_3 more accurately?



A) I and III only **B)** II and III only

C) I and II only **D)** All

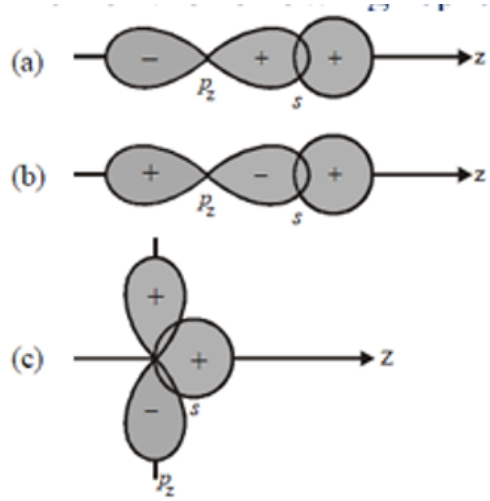
4. Which of the following structure is most stable?



A) Only I **B)** Only II

C) Only III **D)** All three have same stability

5. Which of the following represents zero overlap of atomic orbitals.



A) (a) **B)** (b)

C) (c) **D)** All of these

6. Match the List-I with List-II:

List-I: Classification of molecules based on octet rule	List-II: Example
A. Molecules obeying octet rule	I. NO, NO_2
B. Molecules with incomplete octet	II. $BCl_3, AlCl_3$
C. Molecules with incomplete octet with odd electron	III. H_2SO_4, PCl_5
D. Molecules with expanded octet	IV. CCl_4, CO_2

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

7. Match the LIST-I with LIST-II.

LIST-I: Molecule/Ion	LIST-II: Bond pair: Lone pair (on central atom)
A. ICl_2^-	I. 4:2
B. H_2O	II. 4:1
C. SO_2	III. 2:3
D. XeF_4	IV. 2:2

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

8. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R). Assertion (A): NH_3 and NF_3 molecules have pyramidal shape with a lone pair of electrons on the nitrogen atom. The resultant dipole moment of NH_3 is greater than that of NF_3. Reason (R): In NH_3, the orbital dipole due to the lone pair is in the same direction as the resultant dipole moment of the $N-H$ bonds. Fluorine is the most electronegative element.

A) Both (A) and (R) are true and (R) is the correct explanation of (A).
B) (A) is false but (R) is true.
C) (A) is true but (R) is false.
D) Both (A) and (R) are true but (R) is NOT the correct explanation of (A).

9. Match LIST-I with LIST-II.

LIST-I	Molecule/Ion	LIST-II	Shape
A	H_3O^+	I	Tetrahedral
B	Acetylide anion, C_2^{2-}	II	Linear
C	NH_4^+	III	Pyramidal
D	ClO_2^-	IV	Bent.

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

10. Given below are two statements: Statement-I: SO_2 and H_2O both possess V-shaped structure. Statement-II: The bond angle of SO_2 is less than that of H_2O. Choose the most appropriate answer.

A) Both Statement-I and Statement-II are correct
B) Statement-I is correct but Statement-II is incorrect
C) Both Statement-I and Statement-II are incorrect
D) Statement-I is incorrect but Statement-II is correct

11. Based upon VSEPR theory, match the shape (geometry) of the molecules in List-I with the molecules in List-II and select the most appropriate option:

List-I (Shape)	List-II (Molecule)
A. T-shaped	I. XeF_4
B. Trigonal planar	II. SF_4
C. Square planar	III. ClF_3
D. See-saw	IV. BF_3

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

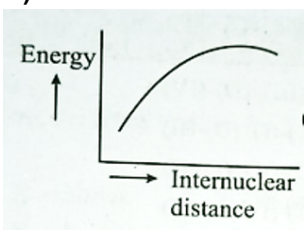
12. Match List-I with List-II:

List-I (Species)	List-II (Number of lone pairs on central atom)
A. XeF_2	I. 0
B. XeO_2F_2	II. 1
C. XeO_3F_2	III. 2
D. XeF_4	IV. 3

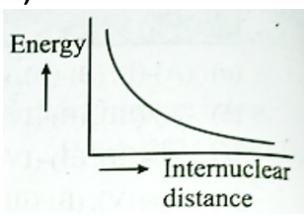
A) A)-(IV), B)-(I), C)-(II), D)-(III)
B) A)-(III), B)-(II), C)-(IV), D)-(I)
C) A)-(III), B)-(IV), C)-(II), D)-(I)
D) A)-(IV), B)-(II), C)-(I), D)-(III)

13. The potential energy curve for the H_2 molecule as a function of internuclear distance is:

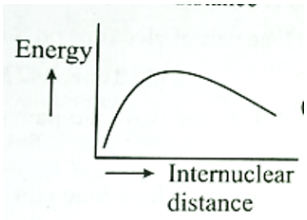
A)



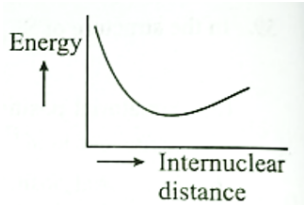
B)



C)



D)



14. When Ψ_A and Ψ_B are the wave functions of atomic orbitals, then σ^* is represented by:

A) $\Psi_A - 2\Psi_B$ **B)** $\Psi_A - \Psi_B$

C) $\Psi_A + 2\Psi_B$ **D)** $\Psi_A + \Psi_B$

15. Match List-I with List-II:

List-I	List-II
A. $\Psi_{MO} = \Psi_A - \Psi_B$	I. Dipole moment
B. $\mu = Q \times r$	II. Bonding molecular orbital
C. $\frac{N_b - N_a}{2}$	III. Anti-bonding molecular orbital
D. $\Psi_{MO} = \Psi_A + \Psi_B$	IV. Bond order

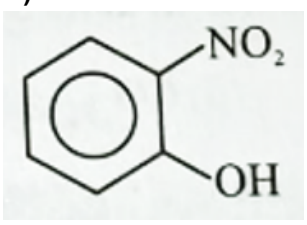
A) A)-(II), B)-(I), C)-(IV), D)-(III) **B)** A)-(III), B)-(IV), C)-(I), D)-(II)

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

16. Select the compound from the following that will show intramolecular hydrogen bonding.

A) H_2O **B)** NH_3

C) C_2H_5OH **D)**



17. The option(s) in which at least three molecules follow the Octet Rule is/are: A) CO, C_2H_4, NO and HCl B) NO_2, O_3, HCl and H_2SO_4 C) BCl_3, NO, NO_2 and H_2SO_4 D) CO_2, BCl_3, O_3 and C_2H_4

A) A, D **B)** B, C

C) C, D **D)** D, C

18. The number and type of bonds between two carbon atoms in CaC_2 are:

A) one sigma (σ) and one pi (π) bonds **B)** one sigma (σ) and two pi (π) bonds

C) one sigma (σ) and one-half pi (π) bond **D)** one sigma (σ) bond

19. Statement-I: LiCl is predominantly a covalent compound. Statement-II: The electronegativity difference between Li and Cl is too small.

A) Statement-I is correct; Statement-II is correct; Statement-II is the correct explanation of Statement-I **B)** Statement-I is correct; Statement-II is correct; Statement-II is not the correct explanation of Statement-I

C) Statement-I is correct; Statement-II is incorrect **D)** Statement-I is incorrect; Statement-II is correct

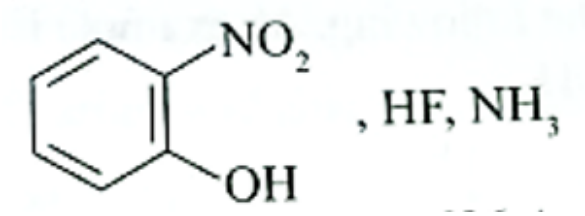
20. Arrange the following compounds in order of increasing dipole moment: toluene (I), m-dichlorobenzene (II), o-dichlorobenzene (III), p-dichlorobenzene (IV).

A) $I < IV < II < III$ **B)** $IV < I < II < III$

C) $IV < I < III < II$ **D)** $IV < II < I < III$

21. Number of molecules from the following which can exhibit hydrogen bonding is _____ (nearest integer):

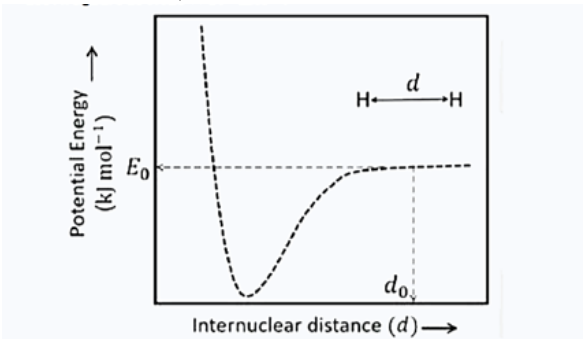
$CH_3OH, H_2O, C_2H_6, C_6H_6,$



22. Among B_2H_6, $B_3N_3H_6$, N_2O, N_2O_4, $H_2S_2O_3$, and $H_2S_2O_8$, the total number of molecules containing a covalent bond between two atoms of the same kind is:

23. Based on VSEPR theory, the number of 90° F–Br–F angles in $\mathrm{BrF_5}$ is _____

24. The figure is the plot potential energy versus internuclear distance (d) of H_2 molecule in the electronic ground state. What is the value of the net potential energy E_0 (as indicated in the figure) in $\mathrm{k.Calmol^{-1}}$ for $d = d_0$ at which the electron–electron repulsion and the nucleus–nucleus repulsion energies are absent? As reference, the potential energy of H atom is taken as zero when its electron and the nucleus are infinitely far apart. Use Avogadro's number as $6.023 \times 10^{23}, \mathrm{mol^{-1}}$.



25. Among N_2H_4, H_2O_2, C_2H_6, S_2Cl_2, $H_2S_2O_7$, and P_2H_4, 100 molecules of each compound are taken. The total number of molecules containing at least one covalent bond between two atoms of the same kind is:

Maths

26. 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)** $(1, \infty)$

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

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

28. The domain of definition of the function $f(x) = \sqrt{1 + \log_e(1-x)}$ is

A) $-\infty < x \leq 0$ **B)** $-\infty < x \leq \frac{e-1}{e}$
C) $-\infty < x \leq 1$ **D)** $x \geq 1 - e$

29. The domain of function $f(x) = \sqrt{x-1} + \ln[(2-x)(x-3)]$ is:

A) $(2, 3)$ **B)** $(-\infty, 2) \cup (3, \infty)$
C) $(-\infty, 1) \cup (1, 2) \cup (3, \infty)$ **D)** None of these

30. The domain of the function $f(x) = \sqrt{x} + \frac{1}{x-1} + \ln\left(x - \frac{1}{2}\right)$ is:

A) $[0, \infty)$ **B)** $\left(\frac{1}{2}, 1\right) \cup (1, \infty)$
C) $(0, 1) \cup (1, \infty)$ **D)** $\left(\frac{1}{2}, \infty\right)$

31. The range of the function $f(x) = \frac{x^2-x+1}{x^2+x+1}$ is:

A) $\left[\frac{1}{3}, 3\right]$ **B)** $\left[\frac{1}{3}, 1\right]$
C) [1, 3] **D)** $(-\infty, \frac{1}{3}] \cup [3, \infty)$

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

A) $[1, \infty)$ **B)** $[2, \infty)$
C) $\left[\frac{3}{2}, \infty\right)$ **D)** [1, 2]

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

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

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

A) [1, 4] **B)** [1, 0]
C) [0, 5] **D)** [5, 0]

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

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

36. 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

37. Let $f(x) = [x]\cos\left(\frac{\pi}{[x+2]}\right)$, where $[]$ denotes the greatest integer function. Then the domain of f is:

A) $x \in R, x$ not an integer **B)** $(-\infty, -2) \cup [-1, \infty)$
C) $x \in R, x \neq -2$ **D)** $(-\infty, -1]$

38. Find the domain of the function
$f(x) = \log_{10}\{1 - \log_{10}(x^2 - 5x + 10)\}$.

A) $(0, \infty)$ **B)** $(0, 5)$
C) $(-\infty, 0)$ **D)** None of these

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

A) $[-1, 1] \setminus \{0\}$ **B)** $[-1, 1]$
C) $(-1, 0)$ **D)** ϕ

40. The domain of
$f(x) = \frac{3}{4-x^2} + \log_{10}(x^3 - x)$ **is:**

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

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

A) $(0, 5)$ **B)** $(1, 4)$
C) [0, 5] **D)** [1, 4]

42. The domain of the function
$f(x) = \sqrt{\sin(\cos x)}$ **is:**

A) $\left[2n\pi, 2n\pi + \frac{\pi}{2}\right], n \in I$ **B)** $\left[2n\pi + \frac{\pi}{2}, 2n\pi + \pi\right], n \in I$
C) $\left[2n\pi + \pi, 2n\pi + \frac{3\pi}{2}\right], n \in I$ **D)** $\left[2n\pi - \frac{\pi}{2}, 2n\pi + \frac{\pi}{2}\right], n \in I$

43. The function $f(x) = \log(x + \sqrt{x^2 + 1})$ **is:**

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

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

A) $\left[\frac{1}{3}, 3\right]$ **B)** $\left[\frac{1}{3}, 1\right]$
C) [1, 3] **D)** $\left(-\infty, \frac{1}{3}\right) \cup (3, \infty)$

45. If $f : R \to R$ **is defined by** $f(x) = \frac{\sin([x]\pi) + \tan([x]\pi)}{1 + [x]^2}$**, then the range of** f **= (where [x]denotes the greatest integer function)**

A) [-1, 1] **B)** $\{-1, 1\}$
C) $\{1\}$ **D)** $\{0\}$

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

47. 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:**

48. If the domain of the function $f(x) = \sin^{-1}\left(\frac{x-1}{2x+3}\right)$ **is** $R - (\alpha, \beta)$**, then** $12\alpha\beta$ **is equal to:**

49. If the domain of the function $f(x) = \log_e\left(\frac{2x-3}{5+4x}\right) + \sin^{-1}\left(\frac{4+3x}{2-x}\right)$ **is** $[\alpha, \beta)$**, then** $\alpha^2 + 4\beta$ **is equal to:**

50. The Domain of function $f(x) = \frac{1}{\sqrt{\sin^{-1} x}} + \log_{10}\left(\cos^{-1} x\right)$ **is** $(\alpha + \beta)$**then** $\alpha + \beta =$___

Physics

51. A man is walking along the east direction with a speed of $5\ \mathrm{m/s}$ **and rain is falling vertically downwards with a speed of** $5\sqrt{3}\ \mathrm{m/s}$**. At what angle with the vertical and in which direction should he hold his umbrella?**

A) 30° with vertical towards east **B)** 60° with vertical towards east
C) 30° with horizontal towards east **D)** 45° with vertical towards east

52. A car is moving towards the north with a speed of $15\ \mathrm{m/s}$**, and a person walking on the ground observes a bus moving towards the east with a speed of** $20\ \mathrm{m/s}$**. Find the magnitude and direction of the velocity of the bus as observed by a passenger in the car.**

A) $25\ \mathrm{m/s}$ (53° south of east) **B)** $25\ \mathrm{m/s}$ (37° south of east)
C) $25\ \mathrm{m/s}$ (53° east of south) **D)** $35\ \mathrm{m/s}$ (37° east of south)

53. A man is moving along the +x-axis (east) with a speed of $15\ \mathrm{m/s}$, and rain is falling vertically downward with a speed of $15\sqrt{3}\ \mathrm{m/s}$. In which direction should the man hold his umbrella to protect himself?

A) 30° with vertical towards east
B) 60° with vertical towards east
C) 30° with horizontal towards east
D) 45° with vertical towards east

54. Rain is falling vertically downwards with a speed of $20\ \mathrm{m/s}$. A person is running due east with a speed of $20\ \mathrm{m/s}$. In which direction should the person hold their umbrella to protect themselves from the rain?

A) 30° with vertical towards east
B) 45° with vertical towards east
C) 60° with vertical towards east
D) 90° with vertical towards east

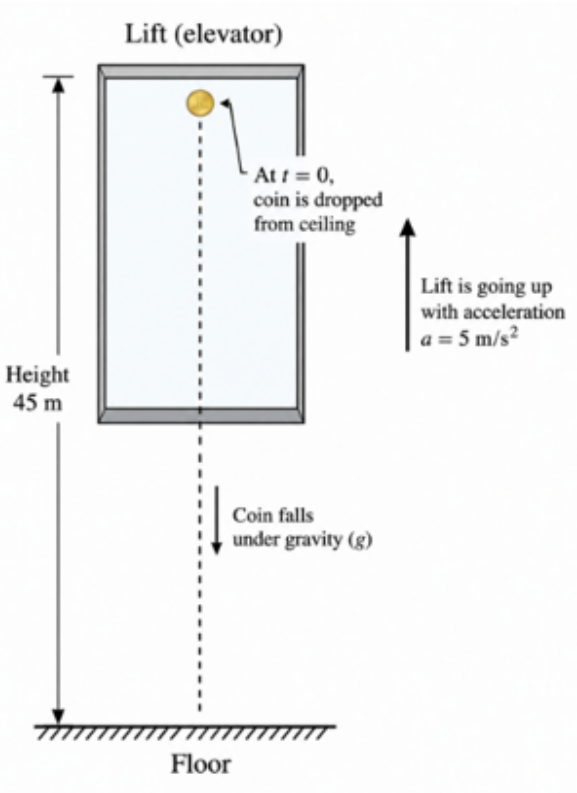
55. Rain is falling with a speed of $20\ \mathrm{m/s}$ at an angle of 37° with the vertical, and a man is moving along the east direction. What should be the velocity of the man so that the rain appears to be falling vertically downward to him?

A) $10\ \mathrm{m/s}$
B) $12\ \mathrm{m/s}$
C) $16\ \mathrm{m/s}$
D) $20\ \mathrm{m/s}$

56. A boy carrying a flag is running with a speed of $5\ \mathrm{m/s}$ along the north direction. If the wind is blowing with a speed of $5\sqrt{3}\ \mathrm{m/s}$ along the east direction, in which direction will the flag flutter?

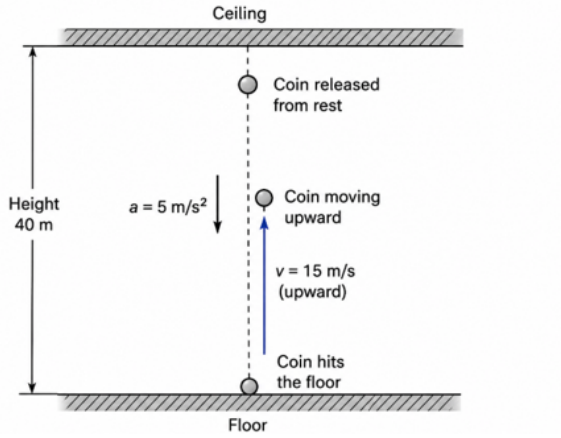
A) 60° north of west
B) 30° north of west
C) 45° north of west
D) 60° south of east

57. From the image given below, a lift of height 45 m is going up with acceleration $a = 5\ \mathrm{m/s^2}$. When the velocity of the lift is $10\ \mathrm{m/s}$ upward, a coin is dropped from the ceiling at $t = 0$. Find the time when the coin will hit the floor.



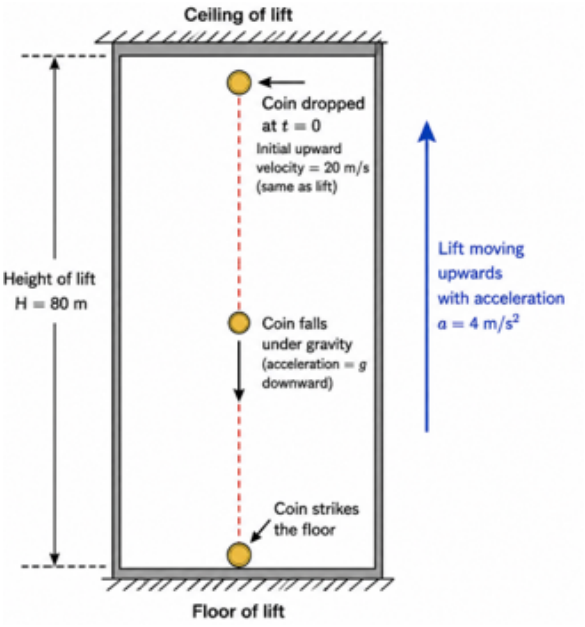
A) $3\ \mathrm{sec}$
B) $2\ \mathrm{sec}$
C) $4\ \mathrm{sec}$
D) $5\ \mathrm{sec}$

58. A coin is dropped from the ceiling of a lift of height $40\ \mathrm{m}$ which is moving upwards with an acceleration $a = 5\ \mathrm{m/s^2}$ and an upward velocity $v = 15\ \mathrm{m/s}$. Find the time when the coin will hit the floor.



A) $2\ \mathrm{sec}$
B) $4\ \mathrm{sec}$
C) $3\ \mathrm{sec}$
D) $5\ \mathrm{sec}$

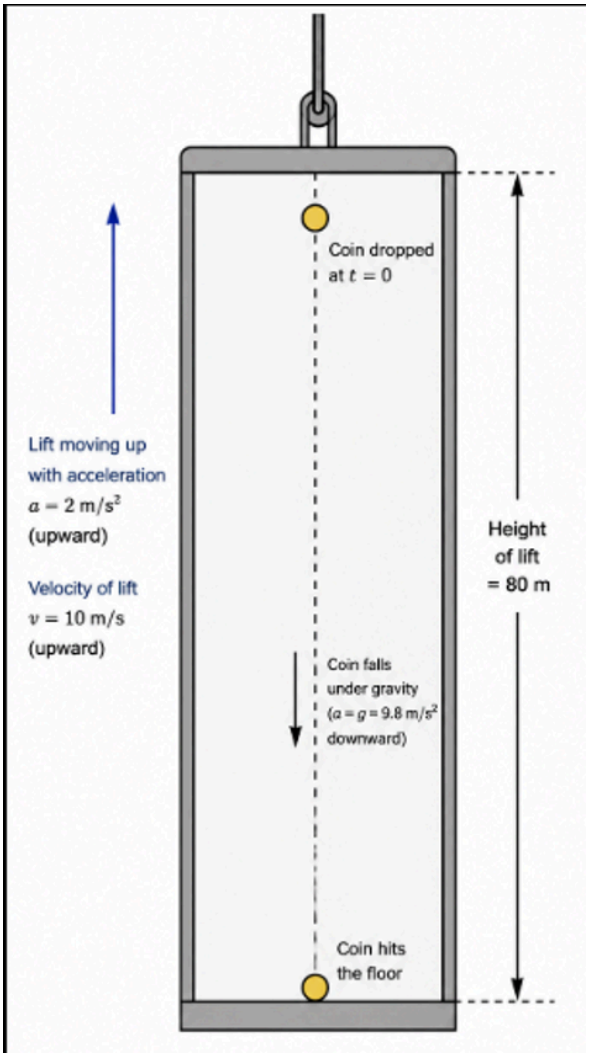
59. From the ceiling of a lift of height 80 m, which is moving upwards with an acceleration $a = 4\ \mathrm{m/s^2}$ and an initial upward velocity $v = 20\ \mathrm{m/s}$, a coin is dropped at $t = 0$. When will the coin strike the floor?



A) 2 sec **B)** 3sec

C) 5 sec **D)** 8 sec

60. From the image given below, a lift of height 80 m is going up with an acceleration $a = 2\ \mathrm{m/s^2}$. When the velocity of the lift is $10\ \mathrm{m/s}$ upward, a coin is dropped from the ceiling at $t = 0$. Find the time when the coin will hit the floor.



A) 4 sec **B)** 5 sec

C) 6 sec **D)** 8 sec

61. A boat is sent across a river with a velocity of $12\ \mathrm{km/hr}$. If the resultant velocity of the boat is $15\ \mathrm{km/hr}$, then what is the velocity of the river?

A) $3\ \mathrm{km/hr}$ **B)** $6\ \mathrm{km/hr}$

C) $9\ \mathrm{km/hr}$ **D)** $12\ \mathrm{km/hr}$

62. Question: A particle is moving with a velocity of $3\hat{i} + 4\hat{j}\ \mathrm{m/s}$ in a reference frame, and another object is moving with a velocity of $1\hat{i} - 2\hat{j}\ \mathrm{m/s}$ in the same reference frame. Find the relative velocity of the first object with respect to the second object.

A) $2\hat{i} + 6\hat{j}$ **B)** $-2\hat{i} - 6\hat{j}$

C) $4\hat{i} + 2\hat{j}$ **D)** $-4\hat{i} - 2\hat{j}$

63. Question: A swimmer can swim in still water with a speed of $3\ \mathrm{m/s}$. While crossing a river in the shortest possible time, his average speed is $2.5\ \mathrm{m/s}$. What is the speed of flow of water?

A) $2\ \mathrm{m/s}$ **B)** $3\ \mathrm{m/s}$
C) $4\ \mathrm{m/s}$ **D)** $5\ \mathrm{m/s}$

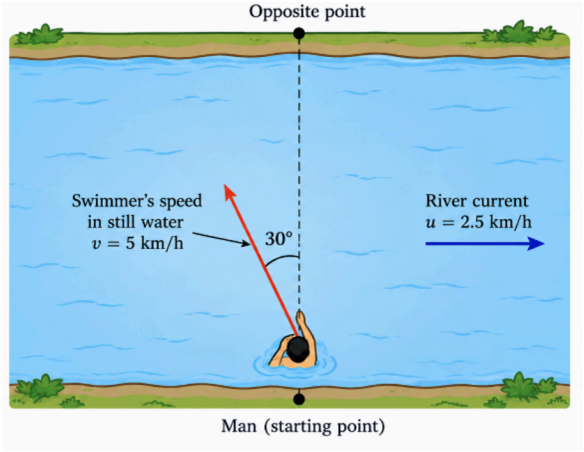
64. A river is flowing from West to East with a speed of $3\ \mathrm{m/min}$. A man can swim in still water with a velocity of $6\ \mathrm{m/min}$. In which direction should the man swim so as to take the shortest possible path to go to the south?

A) 30° with downstream **B)** 60° with downstream
C) 120° with downstream **D)** South

65. A river flows from West to East with a speed of $5\ \mathrm{m/min}$. A swimmer has a speed of $10\ \mathrm{m/min}$ in still water. Find the angle with the downstream direction the swimmer must choose to cross the river along the shortest possible path.

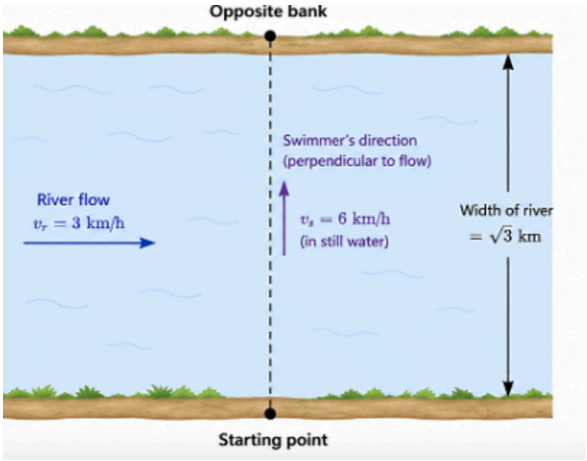
A) 60° with downstream **B)** 90° with downstream
C) 120° with downstream **D)** 135° with downstream

66. A man can swim in still water at $5\ \mathrm{km/h}$. He wants to reach a point just opposite his starting point across a river flowing at $2.5\ \mathrm{km/h}$. In which direction should he swim?



A) 30° against the current from normal to the direction of flow **B)** 45° against the current from normal to the direction of flow
C) 60° against the current from normal to the direction of flow **D)** 90° against the current from normal to the direction of flow

67. A man can swim in still water at a speed of $6\ \mathrm{km/h}$. He wants to cross a river of width $\sqrt{3}\ \mathrm{km}$ flowing at a speed of $3\ \mathrm{km/h}$ in the shortest possible time. Find the time taken by the man to cross the river.



A) $10\ \mathrm{minutes}$ **B)** $20\ \mathrm{minutes}$
C) $30\ \mathrm{minutes}$ **D)** $40\ \mathrm{minutes}$

68. Question: A motorboat is traveling with a velocity of $5\hat{i} + 12\hat{j}\ \mathrm{km/hr}$ with respect to the ground, and a water current flows with a velocity of $2\hat{i} - 3\hat{j}\ \mathrm{km/hr}$ with respect to the ground. Determine the relative velocity of the boat with respect to the water current.

A) $7\hat{i} + 9\hat{j}$ **B)** $3\hat{i} + 15\hat{j}$
C) $-3\hat{i} - 15\hat{j}$ **D)** $7\hat{i} - 9\hat{j}$

69. A cyclist is moving due east with a speed of $12\ \mathrm{m/s}$. To him, the wind appears to blow from the south with a speed of $12\ \mathrm{m/s}$. Find the actual speed and direction of the wind.

A) $12\sqrt{2}\ \mathrm{m/s}$ directed 45° east of north **B)** $12\ \mathrm{m/s}$ directed due north
C) $12\sqrt{2}\ \mathrm{m/s}$ directed 45° west of south **D)** $24\ \mathrm{m/s}$ directed due east

70. To a stationary man, rain appears to fall vertically downwards with a certain speed. When the man starts running towards the west with a speed of $8\ \mathrm{m/s}$, the rain appears to hit him at an angle of 30° with the vertical. Find the actual speed of the rain.

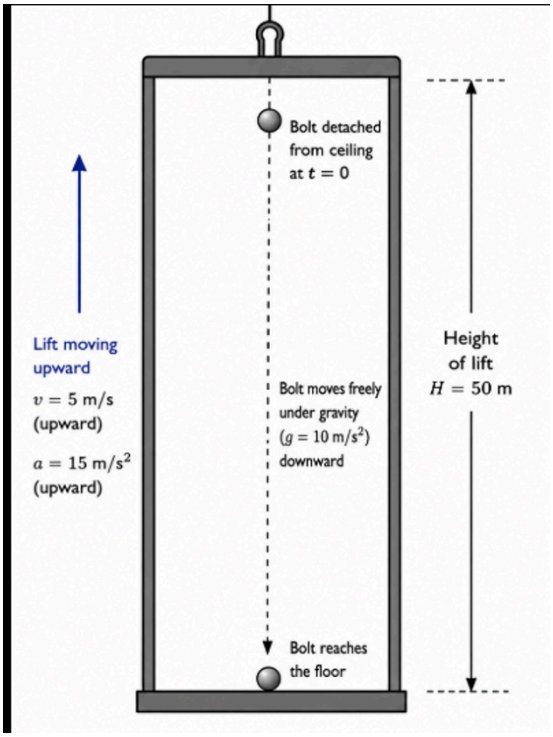
A) $8\sqrt{3}\ \mathrm{m/s}$ **B)** $\frac{8}{\sqrt{3}}\ \mathrm{m/s}$
C) $16\ \mathrm{m/s}$ **D)** $4\sqrt{3}\ \mathrm{m/s}$

71. **A man is moving along the east direction with a speed of $4\ \mathrm{m/s}$, and rain appears to him to fall vertically downwards. If the actual vertical component of the rain's velocity is $3\ \mathrm{m/s}$, what is the actual speed of the rain? ___ m/s**

72. **A car is moving towards the east with a speed of $20\ \mathrm{m/s}$, and rain is falling vertically downwards. A person inside the car observes that the rain falls at an angle of 45° to the vertical. What is the speed of the rain?_____m/s**

73. **A man is running along the east direction with a speed of $5\ \mathrm{m/s}$, and the rain appears to fall towards him at an angle of 45° with the vertical. If the actual speed of the rain is $5\sqrt{2}\ \mathrm{m/s}$, find the angle that the rain actually makes with the vertical._____$^\circ$**

74. **Question: A coin is dropped from the ceiling of a lift of height 20 m which is accelerating upwards at $a = 10\ \mathrm{m/s^2}$. Taking the acceleration due to gravity as $10\ \mathrm{m/s^2}$, find the time taken by the coin to hit the floor.____ sec**



75. **To a stationary man, rain appears to be falling at an angle of 30° with the vertical. As he starts moving with a speed of $10\ \mathrm{m/s}$, he feels that the rain is falling at an angle of 30° with the vertical in the opposite direction. Find the speed of the rain.$10\sqrt{x}\ \mathrm{m/s}$ What is the x value**

ANSWER KEY

Chemistry

1.	**1**	8.	**1**	15.	**3**	22.	**400**
2.	**1**	9.	**1**	16.	**4**	23.	**0**
3.	**3**	10.	**2**	17.	**1**	24.	**1255**
4.	**1**	11.	**2**	18.	**2**	25.	**500**
5.	**3**	12.	**4**	19.	**3**		
6.	**1**	13.	**4**	20.	**2**		
7.	**2**	14.	**2**	21.	**5**		

Maths

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

Physics

51.	**1**	58.	**1**	65.	**3**	72.	**20**
52.	**2**	59.	**2**	66.	**1**	73.	**0**
53.	**1**	60.	**1**	67.	**1**	74.	**1**
54.	**2**	61.	**3**	68.	**2**	75.	**3**
55.	**2**	62.	**1**	69.	**1**		
56.	**1**	63.	**3**	70.	**1**		
57.	**1**	64.	**3**	71.	**5**		

SOLUTIONS

Q1.

Answer: A

Explanation:
In o-nitrophenol, the $-OH$ and $-NO_2$ groups are on adjacent carbon atoms, allowing hydrogen bonding to occur within the same molecule.

Q2.

Answer: A

Explanation:

Bond energy is the difference in potential energy between the completely separated atoms (energy level a) and the minimum energy state at equilibrium distance (energy level b).

Q3.

Answer: C

Explanation:

According to the source answer key, the structures representing ozone are the resonance forms I and II, which are standard Lewis representations.

Q4.

Answer: A

Explanation:

In Structure I of ClF_3, both lone pairs are placed in equatorial positions (120° apart), which minimizes the strong lone pair-lone pair repulsions at 90°.

Q5.

Answer: C

Explanation:

In (c), the positive lobe of the s-orbital overlaps equally with the positive and negative lobes of the perpendicular p-orbital, resulting in net zero overlap due to cancellation.

Q6.

Answer: A

Explanation:

CCl_4 and CO_2 obey the octet rule. BCl_3 and $AlCl_3$ have an incomplete octet around the central atom. NO and NO_2 contain an odd number of valence electrons. H_2SO_4 and PCl_5 have expanded octets around the central atom.

Q7.

Answer: B

Explanation:

The bond pair and lone pair count is determined from the Lewis structure of the central atom.

Q8.

Answer: A

Q9.

Answer: A

Explanation:

The shapes are determined using the number of bond pairs and lone pairs around the central atom.

Q10.

Answer: B

Explanation:

Both SO_2 and H_2O have bent (V-shaped) molecular geometries. However, the bond angle of SO_2 is approximately 119°, while that of H_2O is approximately 104.5°.Thus,$\angle SO_2 > \angle H_2O$

Q11.

Answer: B

Explanation:
Using VSEPR theory, determine the steric number and lone pairs for each molecule to find its molecular geometry: ClF_3 has 3 bond pairs and 2 lone pairs (T-shaped), BF_3 has 3 bond pairs and 0 lone pairs (Trigonal planar), XeF_4 has 4 bond pairs and 2 lone pairs (Square planar), and SF_4 has 4 bond pairs and 1 lone pair (See-saw).

Q12.

Answer: D

Explanation:

Determine the number of lone pairs on the central xenon atom for each species by calculating its steric number and subtracting the number of bond pairs. Xenon has 8 valence electrons. Using VSEPR theory, $\mathrm{XeF_2}$ has 3 lone pairs, $\mathrm{XeO_2F_2}$ has 1 lone pair, $\mathrm{XeO_3F_2}$ has 0 lone pairs, and $\mathrm{XeF_4}$ has 2 lone pairs.

Q13.

Answer: D

Explanation:
The potential energy of a diatomic molecule like H_2 varies with the internuclear distance. As two hydrogen atoms approach each other, attractive forces dominate and energy decreases until a stable bond length (minimum energy) is reached. At very distances, strong repulsive forces between the nuclei cause the potential energy to rise sharply. This characteristic potential energy well is represented by curve D).

Q14.

Answer: B

Explanation:
According to molecular orbital theory, an anti-bonding molecular orbital (σ^*) is formed by the destructive interference of atomic orbital wave functions, which is represented mathematically by the subtraction of the wave functions, i.e., $\Psi_A - \Psi_B$.

Q15.

Answer: C

Explanation:

Match each scientific expression or formula in List-I with its corresponding definition or concept in List-II. $\Psi_{\mathrm{MO}} = \Psi_A - \Psi_B$ represents an anti-bonding molecular orbital (III), $\mu = Q \times r$ represents the dipole moment (I), $\frac{N_b - N_a}{2}$ is the formula for bond order (IV), and $\Psi_{\mathrm{MO}} = \Psi_A + \Psi_B$ represents a bonding molecular orbital (II). This gives the correct matching: A)-(III), B)-(I), C)-(IV), D)-(II).

Q16.

Answer: D

Explanation:
Intramolecular hydrogen bonding occurs when hydrogen bonding takes place within the same molecule, typically when a hydrogen atom is bonded to an electronegative atom and is in close proximity to another electronegative atom capable of forming a hydrogen bond (such as within 2-nitrophenol, between the $-\mathrm{OH}$ and $-\mathrm{NO_2}$ groups).

Q17.

Answer: A

Q18.

Answer: B

Explanation:
Calcium carbide (CaC_2) contains the acetylide ion (C_2^{2-}), in which the two carbon atoms are bonded together by a triple bond consisting of one sigma bond and two pi bonds.

Q19.

Answer: C

Explanation:

Lithium chloride (LiCl) is predominantly covalent due to the high polarising power of the small Li^+ ion which distorts the electron cloud of the larger Cl^- anion (Fajans' rule). Therefore, Statement-I is correct. However, Statement-II is incorrect because the electronegativity difference between lithium and chlorine is actually quite large (around $3.16 - 0.98 = 2.18$), not small.

Q20.

Answer: B

Explanation:
The dipole moment depends on the vector sum of individual bond dipoles, which is determined by the angle between them ($\cos\theta$). p-Dichlorobenzene (IV) is symmetrical, so the two C-Cl dipole moments cancel out completely, giving a dipole moment of 0. Toluene (I) has a small dipole moment due to the slight inductive effect of the methyl group. m-Dichlorobenzene (II) has an angle of 120° between the chlorine substituents, resulting in a net dipole moment vector. o-Dichlorobenzene (III) has an angle of 60° between the substituents, leading to the largest vector sum and highest dipole moment.

Q21.

Answer: 5

Explanation:
Hydrogen bonding occurs when hydrogen is directly bonded to highly electronegative atoms like fluorine, oxygen, or nitrogen ($\mathrm{F}, \mathrm{O}, \mathrm{N}$). Out of the given substances, those capable of intermolecular or intramolecular hydrogen bonding are identified and counted.

Q22.

Answer: 400

Q23.

Answer: 0

Q24.

Answer: 1255

Q25.

Answer: 500

Q26.

Answer: B

Explanation:
To find the domain of the given logarithmic function, the argument of each logarithm must be strictly greater than zero, proceeding from the outermost logarithm to the innermost one.

Q27.

Answer: A

Explanation:
For the function $f(x)$ to be defined, the expression inside the square root must be strictly greater than zero (since it is in the denominator). This leads to the inequality $|x| - x > 0$, which holds true when x is negative.

Q28.

Answer: B

Explanation:
For the function involving a square root and a logarithm to be defined, the expression inside the logarithm must be strictly positive, and the expression under the square root must be non-negative. Solving these simultaneous inequalities yields the final domain.

Q29.

Answer: A

Explanation:
For the function to be defined, all component parts must be valid simultaneously. The square root requires $x \geq 1$, while the logarithmic term requires $(2-x)(x-3) > 0$, which simplifies to $2 < x < 3$. Combining these conditions, we need $x \geq 1$ and $2 < x < 3$, which results in the interval $(2, 3)$. However, substituting any value from $(2, 3)$ into the square root expression $\sqrt{x-1}$ yields a positive number, but let's check the log condition carefully: $(2-x)(x-3) > 0 \implies (x-2)(x-3) < 0 \implies 2 < x < 3$. Since any $x \in (2, 3)$ satisfies $x \geq 1$ as well, the domain should ideally be $(2, 3)$. However, if the first term is written as $\sqrt{x-1}$ and the second as $\ln[(2-x)(x-3)]$, wait, let's re-verify the intersection.)

Q30.

Answer: B

Explanation:
To find the domain, we need to determine the set of all x values for which every part of the function is defined simultaneously: 1. The square root term $\sqrt{x}$ requires $x \geq 0$. 2. The denominator in the rational term $\frac{1}{x-1}$ requires $x \neq 1$. 3. The logarithmic term $\ln\left(x - \frac{1}{2}\right)$ requires $x - \frac{1}{2} > 0$, which simplifies to $x > \frac{1}{2}$. Taking the intersection of all these conditions gives $x > \frac{1}{2}$ excluding $x = 1$, which corresponds to the interval $\left(\frac{1}{2}, 1\right) \cup (1, \infty)$.

Q31.

Answer: A

Explanation:
To find the range of the rational function $f(x) = \frac{x^2-x+1}{x^2+x+1}$, we set $y = f(x)$ and rearrange it into a quadratic equation in terms of x. Since x is a real number, the discriminant (Δ) of this quadratic equation must be greater than or equal to zero ($\Delta \geq 0$). Solving this inequality yields the valid output values for y, which form the range $\left[\frac{1}{3}, 3\right]$.

Q32.

Answer: A

Explanation:
To find the range of the function $f(x) = x^2 + \frac{1}{x^2+1}$, we can rewrite the expression by adding and subtracting 1 to the term involving x^2: $f(x) = (x^2+1) + \frac{1}{x^2+1} - 1$Using the AM-GM inequality ($a + \frac{1}{a} \geq 2$ for $a > 0$) with $a = x^2 + 1 \geq 1$, we find that $(x^2+1) + \frac{1}{x^2+1} \geq 2$. Subtracting 1 gives $f(x) \geq 1$. Hence, the range is $[1, \infty)$.

Q33.

Answer: A

Explanation:
To find the domain of the function $f(x) = \sqrt{3 - 2x - x^2}$, the expression inside the square root must be greater than or equal to zero: $3 - 2x - x^2 \geq 0$Multiplying by -1 and reversing the inequality gives $x^2 + 2x - 3 \leq 0$. Factoring this quadratic inequality yields $(x+3)(x-1) \leq 0$, which gives the closed interval $[-3, 1]$.

Q34.

Answer: A

Explanation:

1. The expression inside the logarithm must be strictly positive: $\frac{5x-x^2}{4} > 0$.

2. The expression inside the square root (which includes the logarithm) must be non-negative: $\log_{10}\left(\frac{5x-x^2}{4}\right) \geq 0$.

Q35.

Answer: B

Explanation:
The expression represents the sum of distances from a variable point x to the fixed points 2 and 5 on the number line. The minimum distance is achieved when x lies between 2 and 5, yielding a constant minimum value equal to the distance between the two points. As x moves outside this interval, the value increases without bound toward infinity.

Q36.

Answer: C

Explanation:
To find the domain of $f(x) = \log_e(x^2 + x + 1) + \sin\sqrt{x-1}$, we must satisfy the conditions for each term to be defined: 1. The argument of the logarithmic function must be strictly positive: $x^2 + x + 1 > 0$. 2. The expression inside the square root must be non-negative: $x - 1 \geq 0$.

Q37.

Answer: B

Explanation:

For the function $f(x) = [x]\cos\left(\frac{\pi}{[x+2]}\right)$ to be defined, the denominator inside the cosine argument must not be zero: $[x+2] \neq 0$. This condition restricts the value of $x+2$ to intervals that exclude 0, translating directly to the domain $(-\infty, -2) \cup [-1, \infty)$.

Q38.

Answer: B

Explanation:
For the function to be defined, the arguments of both logarithmic terms must be strictly positive, and the argument inside the outer logarithm's outer function must satisfy the logarithmic condition. By solving these inequality constraints simultaneously, we determine the valid interval of x values.

Q39.

Answer: D

Explanation:
To find the domain of the function, we must determine the set of all x values for which every component of the function is simultaneously defined. By analyzing the individual restrictions imposed by each term, we find that the required intervals do not overlap, resulting in an empty domain.

Q40.

Answer: D

Explanation:
For the function $f(x)$ to be defined, the denominator of the rational expression must not be zero, and the argument of the logarithmic function must be strictly positive. By combining these conditions, we find the intervals that satisfy all requirements simultaneously.

Q41.

Answer: D

Explanation:
To find the domain of the function, we must ensure that the expression inside the square root is non-negative and that the argument of the logarithm is strictly positive. Solving these inequalities simultaneously yields the closed interval [1, 4].

Q42.

Answer: D

Explanation:

For the square root function $\sqrt{\sin(\cos x)}$ to be defined, the expression inside the radical must be greater than or equal to zero. This requires $\sin(\cos x) \geq 0$, which occurs when the argument of the sine function lies within the standard non-negative intervals for sine. Solving the corresponding inequality for x provides the general solution for the domain.

Q43.

Answer: C

Explanation:
To determine whether the function is even, odd, or neither, we evaluate $f(-x)$ and simplify the expression by rationalizing the argument inside the logarithm.

Q44.

Answer: A

Explanation:
To find the range of the given function, we determine the maximum and minimum values of the denominator $5 + 4\sin 3x$ by using the standard range of the sine function, and then take the reciprocal to find the bounds of $f(x)$.

Q45.

Answer: D

Explanation:

For any real number x, the greatest integer part [x] is always an integer ($n \in \mathbb{Z}$). Since the sine and tangent of any integer multiple of $\pi$are both equal to zero, the numerator of the function evaluates to zero for all x, making the entire function identically equal to zero.

Q46.

Answer: 70

Explanation:
To find the domain of the function, we must satisfy two conditions simultaneously: the input of the inverse sine function must lie within $[-1, 1]$, and the argument of the logarithm must be strictly positive while its value is non-zero (since it appears in the denominator). Solving these inequalities gives the values of α, β, γ, and δ.

Q47.

Answer: 26

Explanation:
To find the domain of the function $f(x)$, we must ensure that the expressions inside the square roots are strictly positive (since they are in the denominators): 1. For the first term, $10 + 3x - x^2 > 0$. 2. For the second term, $x + |x| > 0$. Intersection of these conditions gives the domain (a, b), from which we identify a and b to calculate $(1 + a)^2 + b^2$.

Q48.

Answer: 32

Explanation:
To find the domain of the function $f(x) = \sin^{-1}\left(\frac{x-1}{2x+3}\right)$, the argument of the inverse sine function must lie between -1 and 1, and the denominator must be non-zero. Solving the resulting compound inequality gives the valid intervals for x, which can be expressed in the form $\mathbb{R} - (\alpha, \beta)$ to find α and β.

Q49.

Answer: 4

Explanation:
To find the domain of the function $f(x)$, we must satisfy two conditions simultaneously: 1. The argument of the logarithmic function must be strictly positive: $\frac{2x-3}{5+4x} > 0$. 2. The argument of the inverse sine function must lie between -1 and 1: $-1 \leq \frac{4+3x}{2-x} \leq 1$. Taking the intersection of all valid intervals yields the domain $[\alpha, \beta)$, allowing us to find α and β and evaluate $\alpha^2 + 4\beta$.

Q50.

Answer: 1

Q51.

Answer: A

Explanation:
The man experiences the relative velocity of rain, which vectorially combines his reversed velocity with the velocity of the falling rain. The angle with the vertical is found using the ratio of the horizontal speed of the man to the vertical speed of the rain.

Q52.

Answer: B

Explanation:
To find the relative velocity of the bus with respect to the car, we subtract the velocity vector of the car from the velocity vector of the bus. The magnitude is found using the Pythagorean theorem, and the direction is determined using trigonometric ratios with respect to the coordinate axes.

Q53.

Answer: A

Explanation:
To protect himself from the rain, the man must hold his umbrella in the direction of the relative velocity of the rain with respect to the man. By resolving the velocity vectors into components, the angle with the vertical can be found using trigonometry.

Q54.

Answer: B

Explanation:
The umbrella must be held along the direction of the relative velocity of rain with respect to the man. The angle is determined by taking the inverse tangent of the ratio of the man's speed to the vertical speed of the rain.

Q55.

Answer: B

Explanation:

For the rain to appear falling vertically downward to a moving observer, the man's horizontal velocity must exactly equal the horizontal component of the rain's velocity.

Q56.

Answer: A

Explanation:
The flag flutters opposite to the direction of the relative velocity of the wind with respect to the running boy. By finding the vector difference between the wind velocity and the boy's velocity, we determine the angle made with the reference axis.

Q57.

Answer: A

Explanation:

Working in the non-inertial reference frame of the accelerating lift, the initial relative velocity of the coin is zero, the relative acceleration accounts for both gravity and the lift's upward acceleration, and the relative displacement is equal to the negative of the lift's height.

Q58.

Answer: A

Explanation:

In the frame of reference of the accelerating lift, the initial relative velocity of the coin is zero, and it experiences a downward relative acceleration equal to the sum of acceleration due to gravity and the lift's upward acceleration. Using the kinematic equation for relative motion, the time taken to cover the height of the lift is calculated.

Q59.

Answer: B

Explanation:

We solve this by working in the non-inertial frame of the lift. The relative initial velocity of the coin is zero, and the relative acceleration is the difference between the acceleration due to gravity and the lift's upward acceleration. Using the kinematic equation for displacement gives the time of impact.

Q60.

Answer: A

Explanation:

In the frame of reference of the accelerating lift, the initial relative velocity of the coin is zero, and the effective downward acceleration experienced by the coin is the sum of acceleration due to gravity and the lift's upward acceleration. Using the kinematic equation of motion under constant relative acceleration, we find the time taken to cover the height of the lift.

Q61.

Answer: C

Explanation:
The velocity of the boat in still water and the velocity of the river flow act perpendicular to each other, forming a right-angled triangle where the resultant velocity is the hypotenuse. Using the Pythagorean theorem, the river velocity can be determined from the boat and resultant speeds.

Q62.

Answer: A

Explanation:
The relative velocity of the first object with respect to the second object is calculated by subtracting the velocity vector of the second object from the velocity vector of the first object using vector subtraction component by component.

Q63.

Answer: C

Explanation:
Using the relation between the average speed in the shortest time path, the swimmer's speed in still water, and the river velocity, we set up the equation and solve for the river's flow speed.

Q64.

Answer: C

Explanation:
To cross the river via the shortest possible path (perpendicular to the flow), the man must swim upstream at an angle such that the horizontal component of his velocity cancels the river's flow velocity.

Q65.

Answer: C

Explanation:
By vectorially balancing the eastward river velocity with the westward component of the swimmer's velocity, the swimmer achieves a straight-crossing path towards the south.

Q66.

Answer: A

Explanation:

To cross the river perpendicularly and reach the exact opposite point, the component of the swimmer's velocity opposing the river flow must exactly cancel the river's speed. Using the sine relation of the angle with the normal, we find the required direction.

Q67.

Answer: A

Explanation:

To cross the river in the shortest possible time, the man must swim perpendicular to the flow of the river. The effective velocity component across the river is his speed in still water.

Q68.

Answer: B

Explanation:
The relative velocity of the boat with respect to the water is obtained by subtracting the velocity vector of the water from the velocity vector of the boat.

Q69.

Answer: A

Explanation:
The true wind velocity is the vector sum of the cyclist's velocity and the apparent wind velocity observed by the cyclist.

Q70.

Answer: A

Explanation:
When the man moves, the apparent direction of the rain changes due to relative velocity. Using trigonometric ratios involving the man's running speed and the vertical velocity component of the rain yields the exact rain speed.

Q71.

Answer: 5

Explanation:
The actual speed of the rain is the vector magnitude of its horizontal and vertical components, where the horizontal component equals the man's speed.

Q72.

Answer: 20

Explanation:
The apparent angle of the rain is given relative to the vertical, meaning the magnitude of the horizontal relative velocity component equals the vertical falling speed component.

Q73.

Answer: 0

Explanation:
By resolving the actual velocity of the rain into horizontal and vertical components using its given magnitude and apparent behavior when the man is in motion, we can determine its true directional angle with the vertical.

Q74.

Answer: 1

Explanation:

Transforming into the accelerating frame of the lift, the initial relative velocity is zero. The total downward acceleration relative to the lift is the sum of the gravitational deceleration and the upward acceleration of the lift, yielding a simple time calculation using standard kinematics.

Q75.

Answer: 3

Explanation:
When the man is stationary, the horizontal component of the rain's velocity balances the apparent horizontal velocity when he moves. By setting up simultaneous equations using the horizontal and vertical components of the rain's velocity in both cases, we can determine the actual speed of the rain.