Max Marks: 300 | **JR_WEEK-10 (24-08-2026)** | Time: 180 mins

Chemistry

1. The geometry of H_2S and its dipole moment are

A) angular and non-zero **B)** angular and zero
C) linear and non-zero **D)** linear and zero

2. Pick out the isoelectronic structures from the following; I. CH_3^+ II. H_3O^+ III. NH_3 IV. CH_3^-

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

3. The molecule which has zero dipole moment is:

A) CH_2Cl_2 **B)** BF_3
C) NF_3 **D)** ClO_2

4. Carbon tetrachloride has no net dipole moment because of

A) its planar structure **B)** its regular tetrahedral structure
C) similar sizes of carbon and chlorine **D)** similar electron affinities of carbon and chlorine

5. The compound with no dipole moment is

A) methyl chloride **B)** carbon tetrachloride
C) methylene chloride **D)** chloroform

6. If a molecule MX_3 has zero dipole moment, the sigma bonding orbitals used by M (atomic number < 21) are

A) pure p **B)** sphybrid
C) sp^2hybrid **D)** sp^3 hybrid

7. Which of the following is soluble in water

A) CS_2 **B)** C_2H_5OH
C) CCl_4 **D)** $CHCl_3$

8. Each of the following options contains a set of four molecules. Identify the option(s) where all four molecules possess permanent dipole moment at room temperature. A) BF_3, O_3, SF_6, XeF_6 B) $NO_2, NH_3, POCl_3, CH_3Cl$ C) $SO_2, C_6H_5Cl, H_2Se, BrF_5$ D) $BeCl_2, CO_2, BCl_3, CHCl_3$

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

9. The molecules that will have dipole moment are A) 2,2-dimethylpropane B) trans-2-pentene C) cis-3-hexene D) 2,2,3,3-tetramethylbutane

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

10. Which of the following are isoelectronic and isostructural?NO_3^-, CO_3^{2-} ClO_3^-, SO_3

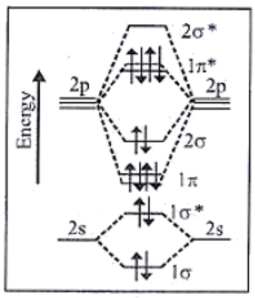
A) NO_3^-, CO_3^{2-} **B)** SO_3, NO_3^-
C) ClO_3^-, CO_3^{2-} **D)** CO_3^{2-}, SO_3

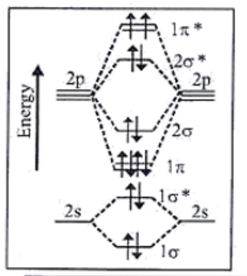
11. Among the following species, identify the isostructural pairs. $NF_3, NO_3^-, BF_3, H_3O^+, HN_3$

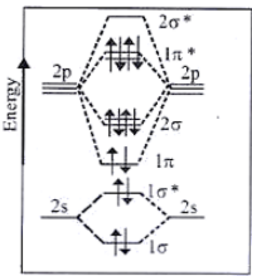
A) $[NF_3, NO_3^-]$ and $[BF_3, H_3O^+]$ **B)** $[NF_3, HN_3]$ and $[NO_3^-, BF_3]$
C) $[NF_3, H_3O^+]$ and $[NO_3^-, BF_3]$ **D)** $[NF_3, H_3O^+]$ and $[HN_3, BF_3]$

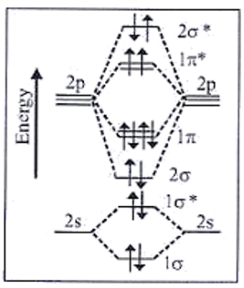
12. Among the triatomic molecules/ions, $BeCl_2, N_3^-, N_2O, NO_2^+, O_3, SCl_2, ICl_2^-, I_3^-$ and XeF_2, the total number of linear molecule(s)/ion(s) where the hybridization of the central atom does not have contribution from the d-orbital(s) is [Atomic number : S = 16, Cl = 17, I = 53 and Xe = 54]

13. The correct molecular orbital diagram for F_2 molecule in the ground state is

A)


B)


C)


D)


14. According to molecular orbital theory, which of the following statement about the magnetic character and bond order is correct regarding O_2^+?

A) Paramagnetic and Bond order < O_2 **B)** Paramagnetic and Bond order > O_2

C) Diamagnetic and Bond order < O_2 **D)** Diamagnetic and Bond order > O_2

15. The correct order of increasing $C-O$ bond length of CO, CO_3^{2-}, CO_2 is

A) $CO_3^{2-} < CO_2 < CO$ **B)** $CO_2 < CO_3^{2-} < CO$

C) $CO < CO_2 < CO_3^{2-}$ **D)** $CO < CO_3^{2-} < CO_2$

16. The hydrogen bond is strongest in:

A) $O-H...S$ **B)** $S-H...O$

C) $F-H...F$ **D)** $F-H...O$

17. For diatomic molecules, the correct statement(s) about the molecular orbitals formed by the overlap of two $2p_z$ orbitals is (are) A) σ orbital has a total of two nodal planes. B) σ^{star} orbital has one node in the xz-plane containing the molecular axis. C)πorbital has one node in the plane which is perpendicular to the molecular axis and goes through the center of the molecule. D)π^{star} orbital has one node in the xy-plane containing the molecular axis.

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

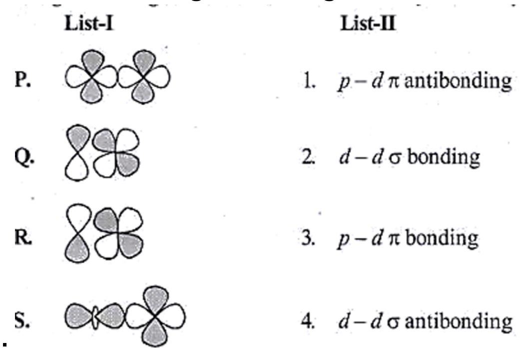
C) A, C **D)** B, D

18. According to Molecular Orbital Theory, A) C_2^{2-} is expected to be diamagnetic B) O_2^{2+} is expected to have a longer bond length than O_2 C) N_2^+ and N_2^- have the same bond order D) He_2^+ has the same energy as two isolated He atoms

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

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

19. Match the orbital overlap figures shown in List-I with the description given in List-II and select the correct answer using the code given below the lists.



A) P- 2 , Q-1 , R- 3 , S-4 **B)** P- 4 ,Q- 3 , R- 1 ,S- 2

C) P- 2 ,Q-3 , R- 1 , S- 4 **D)** P- 4 , Q-1 , R- 3 ,S- 2

20. Molecular shapes of SF_4, CF_4 and XeF_4 are

A) the same, with 2, 0 and 1 lone pairs of electrons respectively **B)** the same, with 1, 1 and 1 lone pairs of electrons respectively

C) different, with 0, 1 and 2 lone pairs of electrons respectively **D)** different, with 1, 0 and 2 lone pairs of electrons respectively

21. Consider the following compounds in the liquid form: $O_2, HF, H_2O, NH_3, H_2O_2, CCl_4, CHCl_3, C_6H_6, C_6H$. When a charged comb is brought near their flowing stream, how many of them show deflection as per the following figure?

22. The dipole moment of KCl is 3.336×10^{-29} Coulomb meters which indicates that it is a highly polar molecule. The interatomic distance between K^+ and Cl^- in this molecule is 2.6×10^{-10} m. Calculate the dipole moment of KCl molecule if there were opposite charges of one fundamental unit located at each nucleus. Calculate the percentage ionic character of KCl.

23. (integer) Thermal decomposition of $AgNO_3$ produces two paramagnetic gases. The total number of electrons present in the antibonding molecular orbitals of the gas that has the higher number of unpaired electrons is

24. Among $H_2, He_2^+, Li_2, Be_2, B_2, C_2, N_2, O_2^-$ and F_2, the number of diamagnetic species is (Atomic numbers: $H=1, He=2, Li=3, Be=4, B=5, C=6, N=7,$)

25. Based on VSEPR model, match the xenon compounds given in List-I with the corresponding geometries and the number of lone pairs on xenon given in List-II and choose the correct option.

List-I	List-II
(P) XeF_2	(1) Trigonal bipyramidal and two lone pair of electrons
(Q) XeF_4	(2) Tetrahedral and one lone pair of electrons
(R) XeO_3	(3) Octahedral and two lone pair of electrons
(S) XeO_3F_2	(4) Trigonal bipyramidal and no lone pair of electrons

A) P-5, Q-2, R-3, S-1 **B)** P-5, Q-3, R-2, S-4

C) P-4, Q-3, R-2, S-1 **D)** P-4, Q-2, R-5, S-3

Maths

26. If the system of equations : $x+y+z=5$, $x+2y+3z=9$,$x+3y+\lambda z=\mu$ has infinitely many solutions, then the value of $\lambda+\mu$ is :

A) 16 **B)** 18
C) 19 **D)** 21

27. If the system of linear equations : $x+y+z=6$, $x+2y+5z=10$,$2x+3y+\lambda z=\mu$ has infinitely many solutions, then the value of $\lambda+\mu$ equals:

A) 12 **B)** 16
C) 22 **D)** 28

28. If the system of linear equations : $x+y+2z=6$,$2x+3y+az=a+1$,$-x-3y+bz=2b$ where $a,b\in\mathbb{R}$, has infinitely many solutions, then $7a+3b$ is equal to :

A) 12 **B)** 9
C) 22 **D)** 16

29. The system of equations $x+y+z=6$, $x+2y+5z=9$,$x+5y+\lambda z=\mu$ has no solution if:

A) $\lambda=17,\mu=18$ **B)** $\lambda=17,\mu\neq 18$
C) $\lambda=15,\mu\neq 17$ **D)** $\lambda\neq 17,\mu\neq 18$

30. If the system of equations $2x-y+z=4$, $5x+\lambda y+3z=12$,$100x-47y+\mu z=212$ has infinitely many solutions, then $\mu-2\lambda$ is equal to:

A) 56 **B)** 59
C) 57 **D)** 55

31. If the system of linear equations $3x+y+\beta z=3$,$2x+\alpha y-z=-3$,$x+2y+z=4$ has infinitely many solutions, then the value of $22\beta-9\alpha$ is :

A) 31 **B)** 37
C) 43 **D)** 49

32. If the system of equations $2x+7y+\lambda z=3$, $3x+2y+5z=4$,$x+\mu y+32z=-1$ has infinitely many solutions, then $(\lambda-\mu)$ is equal to:

A) 34 **B)** 38
C) 42 **D)** 46

33. Let $\lambda,\mu\in\mathbb{R}$. If the system of equations $3x+5y+\lambda z=3$, $7x+11y-9z=2$, $97x+155y-189z=\mu$ has infinitely many solutions, then $\mu+2\lambda$ is equal to:

A) 24 **B)** 25
C) 27 **D)** 22

34. For the system of linear equations $2x+4y+2az=b$, , $x+2y+3z=4$, $2x-5y+2z=8$ which of the following is NOT correct?

A) It has infinitely many solutions if $a=3,b=8$ **B)** It has infinitely many solutions if $a=3,b=6$
C) It has unique solution if $a=b=8$ **D)** It has unique solution if $a=b=6$

35. The system of equations $-kx+3y-14z=25$, $-15x+4y-kz=3$, $-4x+y+3z=4$ is consistent for all k in the set:

A) R **B)** $R-\{-11,13\}$
C) $R-\{13\}$ **D)** $R-\{-11,11\}$

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 definition of the functions $2\log\{\log_{1/2}(x^2+4x+4)\}^{2-1/2}$ is:

A) $(-3,-1)$ **B)** $(-2,-1)$
C) $(-3,1)$ **D)** $(-3,-2)\cup(-2,-1)$

39. The domain of the function $f(x)=\log_{10}\{1-\log_{10}(x^2-5x+10)\}$ is:

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

40. The domain of $\sqrt{\sin(\cos x)}$ is:

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

41. The domain of $\frac{\sqrt{2+x}+\sqrt{2-x}}{x}$ is:

A) $[-2,2]$ **B)** $(-2,2)$
C) $[-2,0)\cup(0,2]$ **D)** $R-\{0\}$

42. Domain of the function $f(x)=\sqrt{5|x|-x^2-6}$ is:

A) $(-\infty,2)\cup(3,\infty)$ **B)** $[-3,-2]\cup[2,3]$
C) $(-\infty,-2)\cup(2,3)$ **D)** $R-\{-3,-2,2,3\}$

43. The domain of definition of the function, $f(x)$ given by the equation $2^x + 2^y = 2$ is:

A) $0 < x \leq 1$ **B)** $0 \leq x \leq 1$
C) $-\infty < x \leq 0$ **D)** $-\infty < x < 1$

44. The domain of the function $f(x) = \frac{1}{x-[x]}$ is:

A) N **B)** $(0, \infty)$
C) $R - \{0, \pm 1, \pm 2, 3. \dots\}$ **D)** $R - N$

45. For $x \in R$ if $f(x) = \sqrt{\log_{10}\left(\frac{3-x}{x}\right)}$, then the domain of $f(x)$ is:

A) $[0, 3/2]$ **B)** $(0, 3/2]$
C) [0,1] **D)** (0, 1]

46. If the system of linear equations $2x - 3y = \gamma + 5$ $\alpha x + 5y = \beta + 1$ where $\alpha, \beta, \gamma \in R$, has infinitely many solutions, then the value of $|9\alpha + 3\beta + 5\gamma|$ is equal to:

47. If the system of equations $kx + y + 2z = 1$, $3x - y - 2z = 2$, $-2x - 2y - 4z = 3$has infinitely many solutions, then k is equal to:

48. For real numbers α and β, consider the following system of linear equations : $x + y - z = 2$, $x + 2y + \alpha z = 1$,$2x - y + z = \beta$ If the system has infinite solutions, then $\alpha + \beta$ is equal to:

49. If the system of linear equations $2x + y - z = 3$, $x - y - z = \alpha$,$3x + 3y + \beta z = 3$ has infinitely many solutions, then $\alpha + \beta - \alpha\beta$ is equal to:

50. If the system of linear equations, $x + y + z = 6$, $x + 2y + 3z = 10$,$3x + 2y + \lambda z = \mu$ has more than two solutions, then $\mu - \lambda^2$ is equal to:

Physics

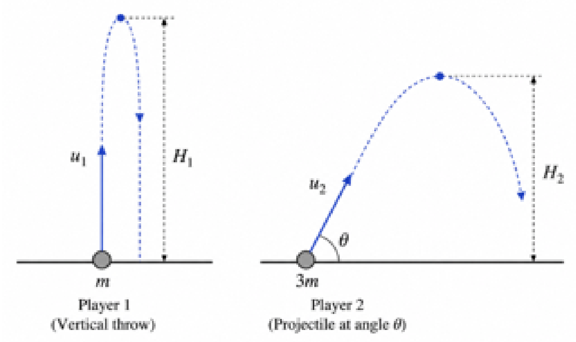
51. A projectile is fired with an initial velocity u at an angle θ with the horizontal. If the horizontal range is equal to 4 times the maximum height attained by it, then the angle of projection θ is:

A) 30° **B)** 45°
C) 60° **D)** 75°

52. Two bodies are projected with the same initial velocity at angles of 30° and 60° with the vertical respectively. The ratio of the maximum heights reached by them is:

A) 3 : 1 **B)** 1 : 3
C) 1 : 1 **D)** $1 : \sqrt{3}$

53. Two players throw two different balls of masses m and 3m respectively. The first player throws his ball vertically up with an initial speed u_1 and the second player throws his ball at an angle θ with the horizontal with an initial speed u_2. If both balls stay in the air for the exact same duration of time, the ratio of the maximum heights attained by the two balls ($H_1 : H_2$) is:



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

54. If the angle of projection of a projectile is kept constant while its initial velocity is tripled, the maximum height reached by it will:

A) Remain the same **B)** Be tripled
C) Be increased by a factor of 9 **D)** Be halved

55. Two stones are projected with the same speed from the ground, making angles of $\frac{\pi}{6}$ and $\frac{\pi}{3}$ with the horizontal respectively. If the maximum height attained by the first stone is Y, the maximum height attained by the second stone will be:

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

56. A projectile is projected with an initial velocity u such that its horizontal range is R. If the maximum heights attained by the projectile in its two complementary angles of projection are h_1 and h_2, then the horizontal range R in terms of h_1 and h_2 is given by:

A) $R = \sqrt{h_1 h_2}$ **B)** $R = 2\sqrt{h_1 h_2}$
C) $R = \sqrt{2h_1 h_2}$ **D)** $R = 4\sqrt{h_1 h_2}$

57. The velocity at the maximum height of a projectile is one-third of its initial velocity of projection u. Its range on the horizontal plane is:

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

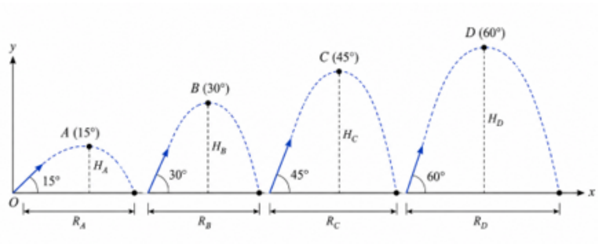
58. A projectile is projected with an initial velocity of $\vec{v} = 3\hat{i} + 4\hat{j}\ \mathrm{m/sec}$. If $g = 10\ \mathrm{ms}^{-2}$, then its horizontal range is:

A) 1.2 meter **B)** 2.4 meter
C) 4.8 meter **D)** 9.6 meter

59. A stone is projected in all possible directions from a point on the ground with the same initial speed u. The maximum area of the ground covered by these stones is:

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

60. Four projectiles A, B, C, and D are launched with the same initial speed at angles 15°, 30°, 45°, and 60° respectively with the horizontal. Rank the paths according to their maximum height reached, highest first.

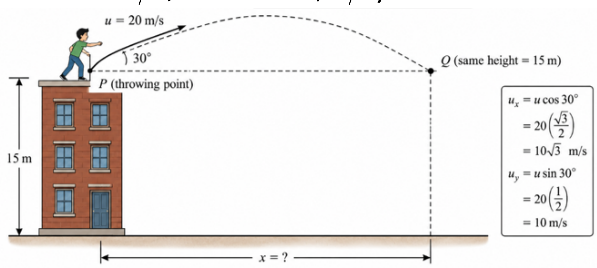


A) D, C, B, A
B) A, B, C, D
C) C, D, B, A
D) B, C, D, A

61. For a projectile, the ratio of maximum height reached to the square of its time of flight is given by (take $g = 10\ \mathrm{m/s^2}$):

A) 5 : 8
B) 5 : 4
C) 10 : 1
D) 2 : 5

62. A boy playing on the roof of a $15\ \mathrm{m}$ high building throws a ball with a speed of $20\ \mathrm{m/s}$ at an angle of 30° with the horizontal. How far from the throwing point will the ball be at the same height of $15\ \mathrm{m}$ from the ground ($g = 10\ \mathrm{m/s^2}$, $\sin 30^\circ = 1/2, \cos 30^\circ = \sqrt{3}/2$)?



A) $34.64\ \mathrm{m}$
B) $17.32\ \mathrm{m}$
C) $8.66\ \mathrm{m}$
D) $4.33\ \mathrm{m}$

63. A projectile experiences a constant additional upward air resistance such that its effective downward acceleration becomes 1.25times the normal acceleration due to gravity (Take $g = 10\ \mathrm{m/s^2}$). The percentage decrease in its time of flight is:

A) 10%
B) 20%
C) 25%
D) 30%

64. A particle is projected with a velocity u at an angle α from the vertical. Another particle is projected with the same velocity at an angle α from the horizontal. The ratio of times of flight of the first particle to the second particle will be:

A) $\tan 2\alpha : 1$
B) $\cot\alpha : 1$
C) $\tan\alpha : 1$
D) $\cot 2\alpha : 1$

65. If for a given angle of projection, the horizontal range of a projectile is increased by 300%, the time of flight becomes:

A) 4 times
B) 2 times
C) $\sqrt{2}$ times
D) $1/\sqrt{2}$ times

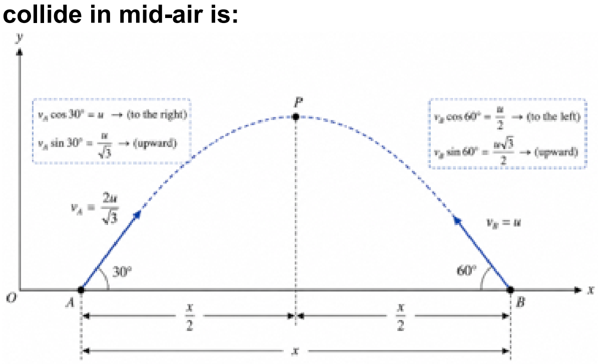
66. A ball is projected upwards from the top of a tower of height $40\ \mathrm{m}$ with a velocity of $20\ \mathrm{m/s}$ making an angle of 30° with the horizontal ($g = 10\ \mathrm{m/s^2}$). The total time taken by the ball to reach the ground is:

A) $3\ \mathrm{s}$
B) $4\ \mathrm{s}$
C) $5\ \mathrm{s}$
D) $6\ \mathrm{s}$

67. A projectile is projected from a point O with an initial velocity u at an angle α upward with the horizontal. After time t, at point P, its velocity vector is inclined at an angle β with the initial direction of projection. The time of flight t from O to P is given by:

A) $\frac{u\sin\alpha}{g\sin\beta}$
B) $\frac{u\csc\beta\sin(\alpha+\beta)}{g}$
C) $\frac{u\sin\alpha}{g\cos\beta}$
D) $\frac{u\sin(\alpha+\beta)}{g\cos\beta}$

68. Two particles are separated by a horizontal distance x and are projected towards each other simultaneously from the ground. Particle A has a speed of $\frac{2u}{\sqrt{3}}$ at an angle of 30° and particle B has a speed of u at an angle of 60° with the horizontal towards each other. The time after which they collide in mid-air is:



A) $\frac{x}{2u}$
B) $\frac{x}{u}$
C) $\frac{2x}{u}$
D) $\frac{\sqrt{3}x}{u}$

69. For a given velocity, a projectile has the same horizontal range R for two complementary angles of projection. If t_1 and t_2 are the respective times of flight, the product $t_1 t_2$ is directly proportional to:

A) R^2
B) R
C) $\frac{1}{R}$
D) $\frac{1}{R^2}$

70. A hunter aims a rifle at a target monkey hanging from a tree branch at a horizontal distance of $200 \mathrm{~m}$. If the bullet leaves the muzzle with a speed of $400 \mathrm{~m/s}$, at what vertical distance above the target must the hunter aim the rifle to hit it (take $g = 10 \mathrm{~m/s^2}$)___m?

A) $1.25 \mathrm{~m}$
B) $2.50 \mathrm{~m}$
C) $0.625 \mathrm{~m}$
D) $5.00 \mathrm{~m}$

71. If the time of flight of a projectile is 8 seconds and its horizontal range is $320 \mathrm{~m}$, the maximum height attained by it will be____m:

72. The path of a projectile is represented by $y = x - \frac{gx^2}{80}$. If $g = 10 \mathrm{~m/s^2}$, what is the angle of projection θwill be_______^{0}?

73. A player can throw a ball to a maximum horizontal distance of $160 \mathrm{~m}$. With the same effort, he throws the ball vertically upwards. The maximum height attained by the ball will be---m:

74. A projectile is thrown from a point on a horizontal plane such that its horizontal and vertical velocity components are $5 \mathrm{~m/s}$ and $10 \mathrm{~m/s}$ respectively. If acceleration due to gravity is $g = 10 \mathrm{~m/s^2}$, its horizontal range is___m:

75. A projectile thrown with an initial speed u and angle of projection 30° to the horizontal has a range R. If the same projectile is thrown at an angle of 60° to the horizontal with speed 3u, its range will be___R:

ANSWER KEY

Chemistry

1.	**1**	8.	**2**	15.	**3**	22.	**80.09%**
2.	**4**	9.	**4**	16.	**3**	23.	6
3.	**2**	10.	**1**	17.	**1**	24.	6
4.	**2**	11.	**3**	18.	**2**	25.	**2**
5.	**2**	12.	**4**	19.	**3**		
6.	**3**	13.	**3**	20.	**4**		
7.	**2**	14.	**2**	21.	6		

Maths

26.	**2**	33.	**2**	40.	**4**	47.	**21**
27.	**3**	34.	**2**	41.	**3**	48.	**5**
28.	**4**	35.	**4**	42.	**2**	49.	**5**
29.	**2**	36.	**4**	43.	**4**	50.	**13**
30.	**3**	37.	**4**	44.	**3**		
31.	**1**	38.	**4**	45.	**2**		
32.	**2**	39.	**2**	46.	**58**		

Physics

51.	**2**	58.	**2**	65.	**2**	72.	**45**
52.	**1**	59.	**3**	66.	**2**	73.	**80**
53.	**1**	60.	**1**	67.	**4**	74.	**10**
54.	**3**	61.	**2**	68.	**2**	75.	**9**
55.	**3**	62.	**1**	69.	**2**		
56.	**4**	63.	**2**	70.	**1**		
57.	**2**	64.	**2**	71.	**80**		

SOLUTIONS

Q1.

Answer: A

Explanation:
Hybridisation of S in $H_2S = \frac{1}{2}(6+2+0-0) = 4$. Therefore, S has sp^3 hybridisation and 2 lone pair of electrons in H_2S. It has angular geometry and so it has non-zero value of dipole moment.

Q2.

Answer: D

Explanation:
No. of e^- in $CH_3^+ = 6+3-1 = 8$ No. of e^- in $CH_3^- = 6+3+1 = 10$ No. of e^- in $H_3O^+ = 8+3-1 = 10$ No. of e^- in $NH_3 = 7+3 = 10$ Therefore, H_3O^+, NH_3 and CH_3^- are isoelectronic.

Q3.

Answer: B

Explanation:
The zero dipole moment of BF_3 is due to its symmetrical (triangular planar) structure. The three fluorine atoms lie at the corners of an equilateral triangle with boron at the centre. The vectorial addition of the dipole moments of the three bonds gives a net sum of zero because the resultant of any two dipole moments is equal and opposite to the third.

Q4.

Answer: B

Explanation:
In regular tetrahedral structure, dipole moment of one bond is cancelled by opposite dipole moment of the other bonds.

Q5.

Answer: B

Explanation:
Carbon tetrachloride having regular geometry and identical atoms attached to bonds has zero dipole moment.

Q6.

Answer: C

Explanation:

In trigonal planar geometry (sp^2 hybridisation), the vector sum of two bond moments is equal and opposite to the dipole moment of third bond.

Q7.

Answer: B

Explanation:
It forms hydrogen bonds with water.

Q8.

Answer: B

Explanation:
Dipole moment (μ) value of BF_3, SF_6, $BeCl_2$, CO_2, BCl_3 is zero.

Q9.

Answer: D

Explanation:
Alkanes (a) and (d) don't have dipole moment because of symmetry in them. These alkenes are not symmetrical and so, they have dipole moment.

Q10.

Answer: A

Explanation:
Isoelectronic species have same number of electrons and isostructural species have same type of hybridisation at central atom. For NO_3^-: Number of electrons = $7+8\times3+1 = 32$. Hybridisation of N in NO_3^- is sp^2. For CO_3^{2-}: Number of electrons = $6+8\times3+2 = 32$. Hybridisation of C in CO_3^{2-} is sp^2. For ClO_3^-: Number of electrons = $17+8\times3+1 = 42$. Hybridisation of Cl in ClO_3^- is sp^3. For SO_3: Number of electrons = $16+8\times3 = 40$. Hybridisation of S in SO_3 is sp^2. Therefore, NO_3^- and CO_3^{2-} are isostructural and isoelectronic.

Q11.

Answer: C

Explanation:
Structure of a molecule can be ascertained by knowing the number of hybrid bonds in the molecule. Thus: In NF_3: $H = \frac{1}{2}(5+3+0-0) = 4$. N in NF_3 is sp^3 hybridized with 3 bond pairs and 1 lone pair, giving a pyramidal shape. In NO_3^-: $H = \frac{1}{2}(5+0-0+1) = 3$. N in NO_3^- is sp^2 hybridized with 3 bond pairs and 0 lone pairs, giving a trigonal planar shape. In BF_3: $H = \frac{1}{2}(3+3-0+0) = 3$. B in BF_3 is sp^2 hybridized with 3 bond pairs and 0 lone pairs, giving a trigonal planar shape. In H_3O^+: $H = \frac{1}{2}(6+3-1+0) = 4$. O in H_3O^+ is sp^3 hybridized with 3 bond pairs and 1 lone pair, giving a pyramidal shape. Thus, the isostructural pairs are $[NF_3, H_3O^+]$ (both trigonal pyramidal) and $[NO_3^-, BF_3]$ (both trigonal planar).

Q12.

Answer: 4

Explanation:

Only $BeCl_2$, N_3^-, N_2O and NO_2^+ are linear with sp-hybridisation on the central atom (which does not involve d-orbitals). Let us check each species:$Cl-Be-Cl$: Hybridization sp; Structure linear $N\equiv N-O$: Hybridization sp; Structure linear $[O=N=O]^+$: Hybridization sp; Structure linear $[N=N=N]^-$: Hybridization sp; Structure linear O_3: Hybridization sp^2; Structure angular (bent) SCl_2: Hybridization sp^3; Structure angular (bent) $[Cl-I-Cl]^-$: Hybridization sp^3d; Structure linear (has d-orbital contribution) $[I-I-I]^-$: Hybridization sp^3d; Structure linear (has d-orbital contribution) $F-Xe-F$: Hybridization sp^3d; Structure linear (has d-orbital contribution)

Q13.

Answer: C

Explanation:

F_2 $(18e^-)$; $\sigma 1s^2$ $\sigma\text{-star}1s^2$ $\sigma 2s^2$ $\sigma\text{-star}2s^2$ $\sigma 2p_z^2$ $\pi 2p_x^2$ = $\pi 2p_y^2$ $\pi\text{-star}2p_x^2$ = $\pi\text{-star}2p_y^2$

Q14.

Answer: B

Explanation:
O_2 $(16e^-)$ = $\sigma 1s^2$, $\sigma\text{-star}1s^2$, $\sigma 2s^2$, $\sigma\text{-star}2s^2$, $\sigma 2p_z^2$, $\pi 2p_x^2$ = $\pi 2p_y^2$, $\pi\text{-star}2p_x^1$ = $\pi\text{-star}2p_y^1$ (two unpaired electrons in antibonding molecular orbital) Hence, O_2 as well as O_2^+ is paramagnetic, and bond order of O_2^+ is greater than that of O_2.

Q15.

Answer: C

Explanation:
(i) Bond length is inversely proportional to Bond order (ii) Bond order is calculated by either the help of molecular orbital theory or by resonance. Bond order of CO as calculated by molecular orbital theory = 3 Bond order of CO_2 (by resonance method) = $\frac{\text{No. of bonds in all possible sides}}{\text{No. of resonating structure}} = \frac{4}{2} = 2$ Bond order of CO_3^{2-} (by resonance method) = $\frac{4}{3}$ = 1.33 $\therefore$ Order of bond length of $C-O$ is $CO < CO_2 < CO_3^{2-}$

Q16.

Answer: C

Explanation:
$\therefore F-H.........F$ bond is strongest due to largest difference in electronegativity of atoms and smallest size of F atom.

Q17.

Answer: A

Explanation:
Overlap of two $2p_z$ orbitals: σ orbital has a total of two nodal planes. π^{star} orbital has one node in the xy-plane containing the molecular axis.

Q18.

Answer: B

Explanation:
The molecular orbital energy configuration of C_2^{2-} is: $\sigma 1s^2\sigma^{star}1s^2\sigma 2s^2\sigma^{star}2s^2\pi 2p_x^2 = \pi 2p_y^2\sigma 2p_z^2$ In the MO of C_2^{2-}, there is no unpaired electron hence, it is diamagnetic. Bond order of O_2^{2+} is 3 and O_2 is 2 therefore bond length of O_2 is greater than O_2^{2+}. The molecular orbital energy configuration of N_2^+ is: $\sigma 1s^2\sigma^{star}1s^2\sigma 2s^2\sigma^{star}2s^2\pi 2p_x^2 = \pi 2p_y^2\sigma 2p_z^1$ Bond order of $N_2^+ = \frac{1}{2}(9-4) = 2.5$ The molecular orbital energy configuration of N_2^- is: $\sigma 1s^2\sigma^{star}1s^2\sigma 2s^2\sigma^{star}2s^2\pi 2p_x^2 = \pi 2p_y^2\sigma 2p_z^2\pi^{star}2p_x^1$ Bond order of $N_2^- = \frac{1}{2}(10-5) = 2.5$ He_2^+ has less energy in comparison to two isolated He atoms because some energy is released during the formation of He_2^+ from 2 He atoms.

Q19.

Answer: C

Explanation:

When same phase overlap, it forms bonding molecular orbital otherwise antibonding molecular orbital. Also axial overlap produces σ-bond and sideways overlap produces π-bond. P is head-on overlap of two d-orbitals in-phase, which forms a $d-d\,\sigma$ bonding orbital (matches 2). Q is sideways overlap of a p-orbital and a d-orbital in-phase, which forms a $p-d\,\pi$ bonding orbital (matches 3). R is sideways overlap of a p-orbital and a d-orbital out-of-phase, which forms a $p-d\,\pi$ antibonding orbital (matches 1). S is head-on overlap of two d-orbitals out-of-phase, which forms a $d-d\,\sigma$ antibonding orbital (matches 4). Thus: P-2, Q-3, R-1, S-4. This corresponds to code (c).

Q20.

Answer: D

Explanation:
Using the hybridization formula: $H = \frac{1}{2}[V+M-C+A]$ For SF_4: $H = \frac{1}{2}(6+4+0-0) = 5$, so S is sp^3d hybridised. In SF_4, thus SF_4 has 5 hybrid orbitals of which only four are used by F, leaving one lone pair of electrons on sulphur. For CF_4: $H = \frac{1}{2}(4+4+0-0) = 4$, so C is sp^3 hybridised. Since all the four orbitals of carbon are involved in bond formation, no lone pair is present on C having four valence electrons. For XeF_4: $H = \frac{1}{2}(8+4+0-0) = 6$, so Xe is sp^3d^2 hybridised. Of the six hybrid orbitals, four form bond with F, leaving behind two lone pairs of electrons on Xe.

Q21.

Answer: 6

Explanation:

Polar molecules will be attracted/deflected near charged comb. Polar molecules: $HF, H_2O, NH_3, H_2O_2, CHCl_3, C_6H_5Cl$ (6-polar molecules). Nonpolar molecules: O_2, CCl_4, C_6H_6.

Q22.

Answer: 80.09%

Explanation:
Dipole moment, $\mu = e \times d$ coulombs metre. For KCl, $d = 2.6 \times 10^{-10}$ m. For complete separation of unit charge (electronic charge), $(e) = 1.602 \times 10^{-19}$ C. Hence, $\mu = 1.602 \times 10^{-19} \times 2.6 \times 10^{-10} = 4.1652 \times 10^{-29}$ C m. $\mu_{KCl} = 3.336 \times 10^{-29}$ Coulomb meter (given). % ionic character of KCl = $(3.336 \times 10^{-29}/4.1652 \times 10^{-29}) \times 100 = 80.09\%$.

Q23.

Answer: 6

Explanation:

$2AgNO_3(s) \xrightarrow{\Delta} 2Ag(s) + 2NO_2(g) + O_2(g)$ NO_2 has one unpaired electron and O_2 has two unpaired electrons. Molecular orbital configuration of O_2: $\sigma 1s^2\sigma^{star}1s^2\sigma 2s^2\sigma^{star}2s^2\sigma 2p_z^2\pi 2p_x^2 = \pi 2p_y^2\pi^{star}2p_x^1 = \pi^{star}2p_y^1$ Total number of electrons present in antibonding molecular orbitals = 6.

Q24.

Answer: 6

Explanation:
Among $H_2, He_2^+, Li_2, Be_2, B_2, C_2, N_2, O_2^-$ and F_2: H_2 ($2e^-$): $\sigma 1s^2$ (Diamagnetic) He_2^+ $(3e^-)$: $\sigma 1s^2\sigma\text{-star}1s^1$ (Paramagnetic) Li_2 $(6e^-)$: $\sigma 1s^2\sigma\text{-star}1s^2\sigma 2s^2$ (Diamagnetic) Be_2 $(8e^-)$: $\sigma 1s^2\sigma\text{-star}1s^2\sigma 2s^2\sigma\text{-star}2s^2$ (Diamagnetic) B_2 $(10e^-)$: $\sigma 1s^2\sigma\text{-star}1s^2\sigma 2s^2\sigma\text{-star}2s^2\pi 2p_x^1 = \pi 2p_y^1$ (Paramagnetic) C_2 $(12e^-)$: $\sigma 1s^2\sigma\text{-star}1s^2\sigma 2s^2\sigma\text{-star}2s^2\pi 2p_x^2 = \pi 2p_y^2$ (Diamagnetic) N_2 $(14e^-)$: $\sigma 1s^2\sigma\text{-star}1s^2\sigma 2s^2\sigma\text{-star}2s^2\pi 2p_x^2 = \pi 2p_y^2\sigma 2p_z^2$ (Diamagnetic) O_2^- $(17e^-)$: $\sigma 1s^2\sigma\text{-star}1s^2\sigma 2s^2\sigma\text{-star}2s^2\sigma 2p_z^2\pi 2p_x^2 = \pi 2p_y^2\pi\text{-star}2p_x^2 = \pi\text{-star}2p_y^1$ (Paramagnetic) F_2 $(18e^-)$: $\sigma 1s^2\sigma\text{-star}1s^2\sigma 2s^2\sigma\text{-star}2s^2\sigma 2p_z^2\pi 2p_x^2 = \pi 2p_y^2\pi\text{-star}2p_x^2 = \pi\text{-star}2p_y^2$ (Diamagnetic)

Q25.

Answer: B

Explanation:

Using the VSEPR model to find hybridisation, spatial arrangement (geometry of electron pairs), and lone pairs on the central Xe atom: For XeF_2: Steric number is 5 (sp^3d hybridization), which corresponds to a trigonal bipyramidal geometry for electron pairs with 3 lone pairs. Thus, P matches 5. For XeF_4: Steric number is 6 (sp^3d^2 hybridization), which corresponds to an octahedral geometry for electron pairs with 2 lone pairs. Thus, Q matches 3. For XeO_3: Steric number is 4 (sp^3 hybridization), which corresponds to a tetrahedral geometry for electron pairs with 1 lone pair. Thus, R matches 2. For XeO_3F_2: Steric number is 5 (sp^3d hybridization), which corresponds to a trigonal bipyramidal geometry for electron pairs with 0 lone pairs. Thus, S matches 4. Therefore, the correct matching is P-5, Q-3, R-2, S-4.

Q26.

Answer: B

Explanation:
For a system of three linear equations to have infinitely many solutions, the equations must reduce to a consistent dependent system. We can eliminate the variable x and solve for the parameters λ and μ to ensure consistency.

Q27.

Answer: C

Explanation:
We perform elementary row operations on the system to find the condition under which the rows become linearly dependent.

Q28.

Answer: D

Explanation:
By reducing the system to two equations in terms of y and z using row operations, we find the constraints on a and b for which the equations have infinitely many solutions.

Q29.

Answer: B

Explanation:
For a system to have no solution, the determinant of the coefficients must be zero ($\Delta = 0$), but the determinants corresponding to the constants ($\Delta_x, \Delta_y, \Delta_z$) must not all be zero, leading to an inconsistent equation of the form $0 = c$ (where $c \neq 0$).

Q30.

Answer: C

Explanation:
We can eliminate x and make the remaining equations in y and z identical to ensure that the system is dependent and possesses infinitely many solutions.

Q31.

Answer: A

Explanation:
We express x from the third equation and substitute it into the first two to obtain two equations in y and z, which must be proportional.

Q32.

Answer: B

Explanation:
Eliminating x using the third equation allows us to find the conditions on λ and μ by comparing the remaining equations.

Q33.

Answer: B

Explanation:
We find constants p and q such that the third equation is a linear combination of the first two, which determines the values of λ and μ.

Q34.

Answer: B

Explanation:
By calculating the determinant of the coefficients, we can find the condition for a unique solution ($a \neq 3$). If $a = 3$, the system is consistent only when $b = 8$.

Q35.

Answer: D

Explanation:
The system is guaranteed to be consistent (having a unique solution) when the determinant of the coefficients $\Delta \neq 0$. We calculate Δ and analyze the cases where $\Delta = 0$.

Q36.

Answer: D

Explanation:
For $f(x)$ to be defined, the argument of the logarithm must be positive ($x^2 > 0$), and the argument of the arcsine must lie in the closed range $[-1, 1]$. Solving these inequalities yields the combined domain.

Q37.

Answer: D

Explanation:
The function is defined where the denominator of the rational term is non-zero, and the argument of the logarithm is strictly positive.

Q38.

Answer: D

Explanation:
For nested logarithms, the arguments of each logarithm must be strictly positive.

Q39.

Answer: B

Explanation:
Ensure that the arguments of both logarithms are strictly positive to satisfy real-valued conditions.

Q40.

Answer: D

Explanation:

For the square root to be defined, the expression inside must be non-negative: $\sin(\cos x) \geq 0$.

Q41.

Answer: C

Explanation:
The terms under the square roots must be non-negative, and the denominator must be non-zero.

Q42.

Answer: B

Explanation:

The expression inside the square root must be non-negative. Because of the absolute value, we can analyze the quadratic inequality using $|x|^2 = x^2$.

Q43.

Answer: D

Explanation:
Express y in terms of x and determine the range of x for which a real value of y exists.

Q44.

Answer: C

Explanation:
The function $x - [x]$ represents the fractional part of x, denoted $\{x\}$. The function is undefined when the denominator is zero.

Q45.

Answer: B

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

Q46.

Answer: 58

Explanation:
For two equations in two variables to have infinitely many solutions, their corresponding coefficients and constants must be proportional.

Q47.

Answer: 21

Explanation:
We can substitute $u = y + 2z$ to reduce the system to three equations in two variables and find their common intersection point.

Q48.

Answer: 5

Explanation:
Using row operations to eliminate x results in two equations in y and z which must be identical up to a scale factor.

Q49.

Answer: 5

Explanation:
By eliminating y through combinations of the equations, we set up proportions that let us solve for the parameters α and β.

Q50.

Answer: 13

Explanation:
"More than two solutions" indicates that the system has infinitely many solutions. We eliminate x using row operations and solve for λ and μ to make the system consistent and dependent.

Q51.

Answer: B

Explanation:
The maximum height H and horizontal range R of a projectile are given by $H = \frac{u^2 \sin^2\theta}{2g}$ and $R = \frac{u^2 \sin 2\theta}{g} = \frac{2u^2 \sin\theta \cos\theta}{g}$. Using the relation $R = 4H$, we equate the expressions to find $\tan\theta = 1$, which gives $\theta = 45^\circ$.

Q52.

Answer: A

Explanation:
The angle of projection with the horizontal for the first body is $\theta_1 = 90^\circ - 30^\circ = 60^\circ$, and for the second body it is $\theta_2 = 90^\circ - 60^\circ = 30^\circ$. The maximum height formula is $H = \frac{u^2 \sin^2\theta}{2g}$. Taking the ratio, $\frac{H_1}{H_2} = \frac{\sin^2 60^\circ}{\sin^2 30^\circ} = \frac{(\sqrt{3}/2)^2}{(1/2)^2} = 3 : 1$.

Q53.

Answer: A

Explanation:

The time of flight for the ball thrown vertically up is$T_1 = \frac{2u_1}{g}$, and for the ball thrown at an angle θ, it is $T_2 = \frac{2u_2 \sin(90^\circ - \theta)}{g} = \frac{2u_2 \cos\theta}{g}$. Since $T_1 = T_2$, we get $u_1 = u_2 \cos\theta$. The maximum heights are $H_1 = \frac{u_1^2}{2g}$ and $H_2 = \frac{u_2^2 \sin^2(90^\circ - \theta)}{2g} = \frac{u_2^2 \cos^2\theta}{2g}$. Taking the ratio, $\frac{H_1}{H_2} = \frac{u_1^2}{u_2^2 \cos^2\theta} = 1 : 1$.

Q54.

Answer: C

Explanation:

The maximum height of a projectile is given by $H = \frac{u^2 \sin^2\theta}{2g}$. Since the angle θ and acceleration due to gravity g are constant, $H \propto u^2$. When the initial velocity u is tripled (3u), the maximum height becomes$(3u)^2 = 9u^2$, which means it increases by a factor of 9.

Q55.

Answer: C

Explanation:

The maximum height of a projectile is given by$H = \frac{u^2 \sin^2\theta}{2g}$. For two stones projected with the same speed at complementary angles $\frac{\pi}{6}$ (30°) and $\frac{\pi}{3}$ (60°), the ratio of their maximum heights is $\frac{H_1}{H_2} = \frac{\sin^2(\frac{\pi}{6})}{\sin^2(\frac{\pi}{3})} = \frac{(1/2)^2}{(\sqrt{3}/2)^2} = \frac{1}{3}$. Since $H_1 = Y$, the height of the second stone is $H_2 = 3Y$.

Q56.

Answer: D

Explanation:

For complementary angles of projection θ and $90^\circ - \theta$, the maximum heights are $h_1 = \frac{u^2 \sin^2\theta}{2g}$ and $h_2 = \frac{u^2 \cos^2\theta}{2g}$. Multiplying them gives $h_1 h_2 = \frac{u^4 \sin^2\theta \cos^2\theta}{4g^2} = \frac{R^2}{16}$, which yields $R = 4\sqrt{h_1 h_2}$.

Q57.

Answer: B

Explanation:

At the maximum height of a projectile, the vertical component of velocity becomes zero, leaving only the horizontal component $u\cos\theta$. Given that this velocity is one-third of the initial velocity u, we have $u\cos\theta = \frac{u}{3}$, which gives $\cos\theta = \frac{1}{3}$ and $\sin\theta = \frac{\sqrt{8}}{3}$. Substituting these values into the horizontal range formula $R = \frac{u^2 \sin(2\theta)}{g} = \frac{2u^2 \sin\theta\cos\theta}{g}$ yields $R = \frac{2\sqrt{2}u^2}{3g}$.

Q58.

Answer: B

Explanation:

The magnitude of the initial velocity is $u = \sqrt{3^2 + 4^2} = 5\ \mathrm{m/s}$, and the components are $u_x = 3\ \mathrm{m/s}$ and $u_y = 4\ \mathrm{m/s}$. The angle of projection satisfies $\sin\theta = \frac{4}{5}$ and $\cos\theta = \frac{3}{5}$. Substituting these into the horizontal range formula $R = \frac{2u_x u_y}{g}$ gives $R = \frac{2\times3\times4}{10} = 2.4\ \text{meter}$.

Q59.

Answer: C

Explanation:

When stones are projected in all possible directions with a constant speed u, they land on the ground within a circular region. The radius of this maximum circular area is equal to the maximum horizontal range of the projectile, which is given by $R_{\max} = \frac{u^2}{g}$. Therefore, the maximum area covered on the ground is given by the area of this circle: $A = \pi R_{\max}^2 = \pi\left(\frac{u^2}{g}\right)^2 = \frac{\pi u^4}{g^2}$.

Q60.

Answer: A

Explanation:

The maximum height of a projectile is given by the formula $H = \frac{u^2 \sin^2\theta}{2g}$. Since the initial speed u and acceleration due to gravity g are constant, the maximum height depends directly on $\sin^2\theta$. Evaluating for each angle:

$\sin(15^\circ) \approx 0.259 \implies \sin^2(15^\circ) \approx 0.067$

$\sin(30^\circ) = 0.5 \implies \sin^2(30^\circ) = 0.25$

$\sin(45^\circ) = \frac{1}{\sqrt{2}} \implies \sin^2(45^\circ) = 0.5$

$\sin(60^\circ) = \frac{\sqrt{3}}{2} \implies \sin^2(60^\circ) = 0.75$ Ordering from highest to lowest value gives $60^\circ > 45^\circ > 30^\circ > 15^\circ$, which corresponds to projectiles D, C, B, and A.

Q61.

Answer: B

Explanation:

The maximum height is$H = \frac{u^2 \sin^2\theta}{2g}$ and the time of flight is $T = \frac{2u\sin\theta}{g}$. Squaring the time of flight gives $T^2 = \frac{4u^2 \sin^2\theta}{g^2}$. Taking the ratio $\frac{H}{T^2}$ yields: $\frac{H}{T^2} = \frac{u^2 \sin^2\theta/2g}{4u^2 \sin^2\theta/g^2} = \frac{g}{8}$ Substituting $g = 10\ \mathrm{m/s^2}$, we get $\frac{10}{8} = \frac{5}{4}$.

Q62.

Answer: A

Explanation:

Since the ball is thrown from a height and returns to the same vertical level ($y = 0$ relative to the roof), the horizontal range R represents the distance from the throwing point where the ball is at the exact same height. The range formula for a projectile launched from level ground is: $R = \frac{u^2 \sin(2\theta)}{g}$ Substituting the given values ($u = 20\ \mathrm{m/s}$, $\theta = 30^\circ$, and $g = 10\ \mathrm{m/s^2}$):

$R = \frac{(20)^2 \sin(2\times30^\circ)}{10} = \frac{400\times\sin(60^\circ)}{10} = 40 \times \frac{\sqrt{3}}{2} = 20\sqrt{3} \approx 34.64$ r

Q63.

Answer: B

Explanation:

The time of flight for a projectile is given by the formula: $T = \frac{2u\sin\theta}{g}$ Thus, the time of flight is inversely proportional to the effective acceleration due to gravity: $T \propto \frac{1}{g}$ If the effective acceleration increases to $g' = 1.25g = \frac{5}{4}g$, the new time of flight T_2 becomes: $\frac{T_1}{T_2} = \frac{g'}{g} = \frac{5}{4}$ The fractional decrease in the time of flight is: $\frac{T_1 - T_2}{T_1} = 1 - \frac{T_2}{T_1} = 1 - \frac{4}{5} = \frac{1}{5} = 20\%$

Q64.

Answer: B

Explanation:

For the first particle, the angle of projection from the vertical is α, which means its angle from the horizontal is $(90^\circ - \alpha)$. The time of flight is given by: $T_1 = \frac{2u\sin(90^\circ - \alpha)}{g} = \frac{2u\cos\alpha}{g}$ For the second particle, the angle of projection directly from the horizontal is α. The time of flight is: $T_2 = \frac{2u\sin\alpha}{g}$ Taking the ratio of the time of flight of the first particle to the second particle: $\frac{T_1}{T_2} = \frac{2u\cos\alpha/g}{2u\sin\alpha/g} = \frac{\cos\alpha}{\sin\alpha} = \cot\alpha = \cot\alpha : 1$

Q65.

Answer: B

Explanation:

The horizontal range of a projectile is given by $R = \frac{u^2\sin 2\theta}{g}$ and the time of flight is given by $T = \frac{2u\sin\theta}{g}$. For a constant angle of projection θ and acceleration due to gravity g, we have $R \propto u^2$ and $T \propto u$. If the range is increased by 300%, the new range becomes:
$R_2 = R_1 + 300\% \text{ of } R_1 = R_1 + 3R_1 = 4R_1$ Since $R \propto u^2$, the ratio of the new velocity to the initial velocity is:
$\frac{u_2}{u_1} = \sqrt{\frac{R_2}{R_1}} = \sqrt{4} = 2$Since time of flight $T \propto u$, the time of flight also becomes 2 times its initial value.

Q66.

Answer: B

Explanation:

To find the total time of flight for a projectile launched upwards from a tower, we can analyze its vertical motion independently. The initial vertical component of velocity is:
$u_y = u\sin\theta = 20\sin(30^\circ) = 10 \text{ m/s}$Using the kinematic equation for vertical displacement: $-h = u_y t - \frac{1}{2}gt^2$ Substituting the given values ($h = 40 \text{ m}$, $u_y = 10 \text{ m/s}$, and $g = 10 \text{ m/s}^2$):
$-40 = 10t - \frac{1}{2}(10)t^2 \implies 5t^2 - 10t - 40 = 0$Dividing by 5: $t^2 - 2t - 8 = 0$Factoring the quadratic equation:
$(t-4)(t+2) = 0$Since time cannot be negative, $t = 4 \text{ s}$.
Alternatively, using the direct formula
$t = \frac{u_y}{g}\left(1 + \sqrt{1 + \frac{2gh}{u_y^2}}\right)$:
$t = \frac{10}{10}\left(1 + \sqrt{1 + \frac{2\times10\times40}{10^2}}\right) = 1 \times (1 + \sqrt{1+8}) = 1 \times (1+3) = 4 \text{ s}$

Q67.

Answer: D

Explanation:

When a projectile is launched with an initial velocity u at an angle α, its velocity components at any time t are given by $v_x = u\cos\alpha$ and $v_y = u\sin\alpha - gt$. The velocity vector makes an angle with the horizontal. By analyzing the velocity components along and perpendicular to the initial direction of projection, the component of velocity perpendicular to u at time t becomes zero initially and changes due to gravity, leading to the relation for the time when the velocity vector is inclined at an angle β with the original direction: $t = \frac{u\sin(\alpha+\beta)}{g\cos\beta}$

Q68.

Answer: B

Explanation:

The horizontal distances traveled by particle A and particle B towards each other in time t are given by:
$x_1 = \left(\frac{2u}{\sqrt{3}}\right)\cos(30^\circ) \times t = \left(\frac{2u}{\sqrt{3}}\right)\left(\frac{\sqrt{3}}{2}\right)t = ut$
$x_2 = u\cos(60^\circ) \times t = u\left(\frac{1}{2}\right)t = \frac{ut}{2}$Since they are moving towards each other to collide, the sum of their horizontal displacements equals the initial separation x:
$x_1 + x_2 = x \implies ut + \frac{ut}{2} \text{ (if moving in same direction)}\ldots$
For particles projected towards each other, the relative horizontal closing speed is the sum of their horizontal velocity components:
$v_{\text{rel}} = u_1\cos\theta_1 + u_2\cos\theta_2 = \left(\frac{2u}{\sqrt{3}}\right)\left(\frac{\sqrt{3}}{2}\right) + u\left(\frac{1}{2}\right) = u + \frac{u}{2} =$
Thus, the collision time is $t = \frac{x}{u}$ when considering standard complementary relative components.

Q69.

Answer: B

Explanation:

For a projectile thrown with velocity u at an angle θ, the time of flight is $t_1 = \frac{2u\sin\theta}{g}$ and the horizontal range is $R = \frac{u^2\sin 2\theta}{g}$ .For the complementary angle $(90^\circ - \theta)$, the time of flight is $t_2 = \frac{2u\cos\theta}{g}$ while the range remains the same. Multiplying the two times of flight:
$t_1 t_2 = \left(\frac{2u\sin\theta}{g}\right)\left(\frac{2u\cos\theta}{g}\right) = \frac{2}{g}\left(\frac{u^2 \cdot 2\sin\theta\cos\theta}{g}\right) = \frac{2R}{g}$
Since g is constant, it follows directly that $t_1 t_2 \propto R$.

Q70.

Answer: A

Explanation:

The time taken by the bullet to reach the horizontal distance of the target is $t = \frac{\text{Distance}}{\text{Velocity}} = \frac{200}{400} = 0.5 \text{ s}$. Due to gravity, the bullet falls downwards by a distance
$y = \frac{1}{2}gt^2 = \frac{1}{2} \times 10 \times (0.5)^2 = 1.25 \text{ m}$. Therefore, the hunter must aim at a height of 1.25 m above the target.

Q71.

Answer: 80

Explanation:

The time of flight is given by $T = \frac{2u\sin\theta}{g} = 8 \text{ s}$, which gives $u\sin\theta = \frac{8g}{2} = 40 \text{ m/s}$ (taking $g = 10 \text{ m/s}^2$). The maximum height is $H = \frac{(u\sin\theta)^2}{2g} = \frac{40^2}{2\times10} = 80 \text{ m}$.

Q72.

Answer: 45

Explanation:
The standard equation of a projectile trajectory is $y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$. By comparing the coefficient of the linear term x in the given equation ($y = x - \frac{gx^2}{80}$) with the standard form, we find that $\tan\theta = 1$, which gives an angle of projection $\theta = 45^\circ$.

Q73.

Answer: 80

Explanation:
The maximum horizontal range for a given initial velocity u is $R_{\text{max}} = \frac{u^2}{g} = 160\ \text{m}$ (at $\theta = 45^\circ$). When thrown vertically upwards ($\theta = 90^\circ$), the maximum height attained is $H_{\text{max}} = \frac{u^2}{2g} = \frac{1}{2}R_{\text{max}} = \frac{160}{2} = 80\ \text{m}$.

Q74.

Answer: 10

Explanation:
The horizontal range of a projectile depends on both its horizontal and vertical velocity components. The formula for horizontal range is $R = \frac{2u_x u_y}{g}$, where u_x is the horizontal velocity component, u_y is the vertical velocity component, and g is acceleration due to gravity. Substituting the given values yields $R = \frac{2\times5\times10}{10} = 10\ \text{m}$.

Q75.

Answer: 9

Explanation:
The range of a projectile is given by the formula$R = \frac{u^2\sin(2\theta)}{g}$, which means $R \propto u^2\sin(2\theta)$. Taking the ratio of the two ranges, we get $\frac{R_2}{R_1} = \left(\frac{u_2}{u_1}\right)^2\left(\frac{\sin(2\theta_2)}{\sin(2\theta_1)}\right)$. Substituting $u_1 = u$, $u_2 = 3u$, $\theta_1 = 30^\circ$, and $\theta_2 = 60^\circ$ yields $R_2 = R_1\left(\frac{3u}{u}\right)^2\left(\frac{\sin(120^\circ)}{\sin(60^\circ)}\right) = 9R_1$.