

Physics

1. 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°

2. A person can throw a stone to a maximum horizontal distance of 60 m. The maximum height to which he can raise the stone is:

- A) 30 m B) 15 m
 C) 45 m D) 60 m

3. If the time of flight of a projectile is 8 seconds and its horizontal range is 320 m, the maximum height attained by it will be:

- A) 80 m B) 64 m
 C) 100 m D) 120 m

4. 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) 1 : 3 B) 3 : 1
 C) 1 : 1 D) $1 : \sqrt{3}$

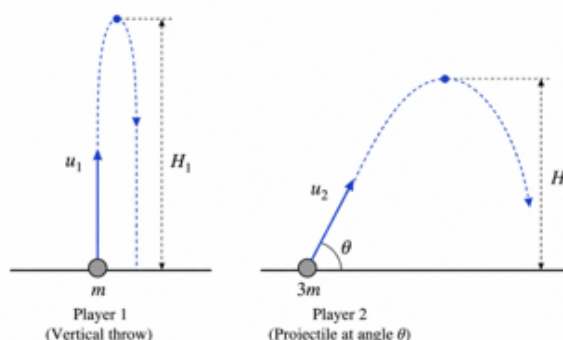
5. The maximum horizontal range of a projectile is 800 m. The maximum height attained by it will be:

- A) 200 m B) 400 m
 C) 800 m D) 1600 m

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

- A) 5.00m B) 2.50 m
 C) 0.625 m D) 1.25m

7. 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) $1 : \cos \theta$ B) $2 : 1$
 C) $1 : 1$ D) $1 : \sec \theta$

8. 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

9. 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) $\frac{Y}{3}$

10. A ball thrown by a player takes 4 s to return to the ground after being projected into the air. The maximum height attained by the ball above the point of projection will be:

- A) 20 m B) 10 m
 C) 15 m D) 40 m

11. A player can throw a ball to a maximum horizontal distance of 160 m. With the same effort, he throws the ball vertically upwards. The maximum height attained by the ball will be:

- A) 160 m B) 120 m
C) 80 m D) 40 m

12. If the maximum horizontal range of a projectile is R , the maximum height attained by the projectile for this range is:

- A) $\frac{R}{4}$ B) $\frac{R}{2}$
C) R D) $2R$

13. A grasshopper can jump to a maximum horizontal distance of 0.8 m. Assuming it spends negligible time on the ground, how far can it travel horizontally in 10 seconds?

- A) 5 m B) 10 m
C) 20 m D) 40 m

14. 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) $R = 4\sqrt{h_1 h_2}$

15. A particle is projected with a velocity v such that its horizontal range is equal to 4 times the greatest height attained by it. The range of the projectile is:

- A) $\frac{4v^2}{5g}$ B) $\frac{v^2}{g}$
C) $\frac{3v^2}{4g}$ D) $\frac{4v^2}{\sqrt{5}g}$

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

- A) 5 m B) 10 m
C) 15 m D) 20 m

17. 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) $\frac{\sqrt{3}u^2}{2g}$

18. 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:

- A) $3R$ B) $6R$
C) $9R$ D) $18R$

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

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

20. 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) $\frac{\pi u^4}{2g^2}$

21. A projectile is projected with an initial velocity u such that its speed at the highest point of its trajectory is equal to $\frac{1}{\sqrt{3}}$ times its initial speed. The horizontal range of the projectile will be:

- A) $\frac{u^2}{g}$ B) $\frac{\sqrt{3}u^2}{2g}$
C) $\frac{u^2}{\sqrt{3}g}$ D) $\frac{3u^2}{4g}$

22. A projectile is thrown into space so as to have a maximum horizontal range R . Taking the point of projection as origin, the coordinates of the point where the speed of the particle is $\frac{1}{\sqrt{2}}$ times its maximum speed during flight are:

- A) (R, R) B) $(R, \frac{R}{2})$
C) $(\frac{R}{2}, \frac{R}{4})$ D) $(R, \frac{R}{4})$

23. A projectile thrown with a speed v at an angle θ has a horizontal range R on the surface of a planet where the acceleration due to gravity is g . If it is thrown with the same speed and angle on another planet where the acceleration due to gravity is $4g$, its horizontal range will be:

- A) $4R$ B) $2R$
C) $\frac{R}{2}$ D) $\frac{R}{4}$

24. A projectile covers a horizontal distance of 80 m when projected with a certain initial speed. On the same surface, the distance it will cover when projected with triple the initial speed at the same angle is:

- A) 240 m B) 480 m
C) 720 m D) 960 m

- 25. A projectile is fired from a cannon with an initial velocity of 400 m/s. If the angle of projection is 15° and $g = 10 \text{ m/s}^2$, then the horizontal range of the projectile is:**

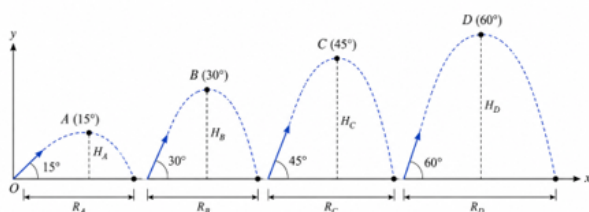
A) 10×10^3 m **B)** 8×10^3 m
C) 6.25×10^3 m **D)** 4×10^3 m

- 26. Four bodies P, Q, R and S are projected with equal velocities having angles of projection 18° , 36° , 45° and 54° with the horizontal respectively. The body having the maximum range is:**

A) P **B) Q**

C) R **D) S**

- 27. 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

28. If two bodies are projected with the same initial velocity at angles of 37° and 53° with the horizontal, which of the following quantities will be identical for both bodies?

A) Their maximum heights **B) Their horizontal ranges**
C) Their times of flight **D) Their maximum velocities**

- 29. A stone is thrown with a certain speed such that it covers a maximum horizontal distance of 200 m. The initial speed with which the stone is thrown is (to the nearest integer):**

A) 35 ms^{-1} **B)** 45 ms^{-1}
C) 50 ms^{-1} **D)** 60 ms^{-1}

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

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

31. Which of the following physical factors determine the maximum horizontal displacement of a projectile launched from level ground in a vacuum?

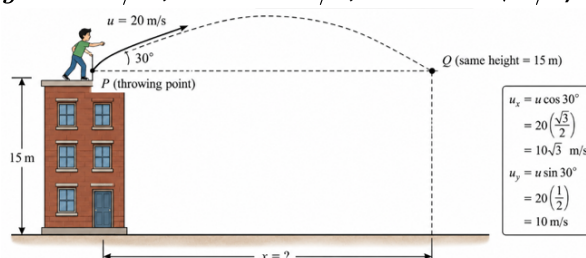
A) Mass of the projectile and initial speed

B) Initial launch speed and angle of projection

C) Acceleration due to gravity and mass of the projectile

D) Angle of projection and weight of the projectile

- 32. A boy playing on the roof of a 15 m high building throws a ball with a speed of 20 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 m from the ground ($g = 10 \text{ m/s}^2$, $\sin 30^\circ = 1/2$, $\cos 30^\circ = \sqrt{3}/2$)?**



A) 34.64 m **B)** 17.32 m
C) 8.66 m **D)** 4.33 m

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

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

34. 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)** $\cot 2\alpha : 1$

- 35. 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

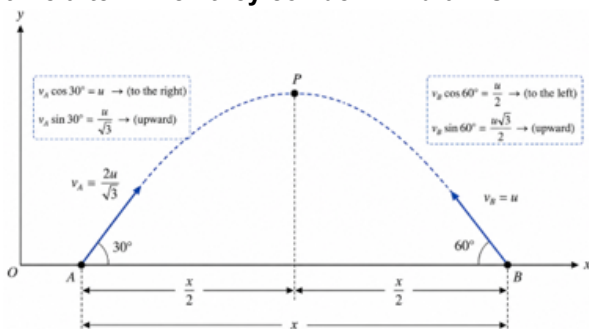
36. A ball is projected upwards from the top of a tower of height 40 m with a velocity of 20 m/s making an angle of 30° with the horizontal ($g = 10 \text{ m/s}^2$). The total time taken by the ball to reach the ground is:

- A) 3 s B) 4 s
C) 5 s D) 6 s

37. 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) $\frac{u \sin(\alpha + \beta)}{g \cos \beta}$

38. 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) $\frac{\sqrt{3}x}{u}$

39. A body is thrown with a velocity of 19.6 m/s making an angle of 60° with the horizontal. It will hit the ground after a time:

- A) $\sqrt{3}$ s B) $2\sqrt{3}$ s
C) $3\sqrt{3}$ s D) $4\sqrt{3}$ s

40. 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) $\frac{1}{R^2}$

41. The trajectory of a projectile is given by the equation $y = 12x - \frac{3x^2}{4}$. The horizontal range of the projectile is:

- A) 12 m B) 16 m
C) 9 m D) 8 m

42. The path followed by a body projected along the y -axis is given by $y = \sqrt{3}x - 2x^2$. If $g = 10 \text{ m/s}^2$, then the initial velocity of the projectile will be (where x and y are in meters):

- A) $3\sqrt{10}$ m/s B) $2\sqrt{10}$ m/s
C) $\sqrt{10}$ m/s D) $4\sqrt{10}$ m/s

43. The path of a projectile is represented by $y = x - \frac{gx^2}{80}$. If $g = 10 \text{ m/s}^2$, what is the angle of projection θ ?

- A) 30° B) 45°
C) 60° D) 90°

44. The path of a projectile is given by the equation $y = 2x - \frac{gx^2}{40}$. If $g = 10 \text{ m/s}^2$, what is the angle of projection θ ?

- A) 30° B) 45°
C) 60° D) $\tan^{-1}(2)$

45. The equation of a projectile trajectory is given by $y = 4x - 2x^2$, where x and y are in meters. The horizontal range of the projectile is:

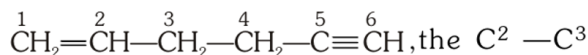
- A) 2 m B) 4 m
C) 1 m D) 8 m

Chemistry

46. In the protonation of H_2O , change occurs in:

- A) Hybridisation state of oxygen B) Shape of molecule
C) Hybridisation and shape both D) None

47. In the compound



, the $\text{C}_2 - \text{C}_3$ bond is formed by the overlapping of:

- A) $\text{sp} - \text{sp}^2$ B) $\text{sp}^3 - \text{sp}^3$
C) $\text{sp} - \text{sp}^3$ D) $\text{sp}^2 - \text{sp}^3$

48. Which of the following elements cannot exhibit sp^3d hybridisation state: (a) C (b) P (c) Cl (d) B ?

- A) a, c B) a, d
C) b, c D) b, d

49. Which of the following species are expected to be planar: (a) NH_3 (b) NH_2^+ (c) CH_3^+ (d) PCl_3 ?

- A) b and c B) c and d
C) b and d D) a and d

50. In which of the following sets does each compound/ion have a linear shape?

- A) CH_4 , NH_4^+ , BH_4^- B) CO_3^{2-} , NO_3^- , BF_3
C) NO_2^+ , CO_2 , XeF_2 D) BeCl_2 , BCl_3 , CH_4

51. Which of the following sets is not correct?

- A) SO_3 , O_3 , NH_4^+ all have coordinate bonds B) H_2O , NO_2 , ClO_2^- are all 'V' shaped molecules
C) I_3^- , ICl_2^- , NO_2^+ are all linear molecules D) SF_4 , SiF_4 , XeF_4 are all tetrahedral in shape

52. The shape of a molecule having 4 bond pairs and two lone pairs of electrons, will be:

- A) Square planar B) Tetrahedral
C) Linear D) Octahedral

53. The shape of IF_4^+ will be:

- A) Square planar B) Tetrahedral
C) Pentagonal bipyramidal D) Distorted tetrahedral

54. Which of the following has a pyramidal shape?

- A) BF_3 B) H_3O^+
C) NO_3^- D) CO_3^{2-}

55. A σ -bonded molecule MX_3 is T-shaped. The number of non-bonding pairs of electrons on the central atom is:

- A) 0 B) 2
C) 1 D) Can be predicted if atomic number of M is known

56. Which orbitals overlap to form bonds in OF_2 ?

- A) $\text{sp}^3 - 2\text{p}$ B) $\text{sp}^2 - 2\text{p}$
C) $\text{sp} - 2\text{p}$ D) $\text{p} - \text{p}$

57. Among the following orbitals/bonds, the angle is minimum between:

- A) sp^3 bonds B) p_x and p_y orbitals
C) $\text{H} - \text{O} - \text{H}$ bond in water D) sp bonds

58. The AsF_5 molecule is trigonal bipyramidal. The hybrid orbitals used by the As atoms for bonding are:

- A) $\text{d}_{x^2-y^2}$, d_{z^2} , s, p_x , p_y B) d_{xy} , s, p_x , p_y , p_z
C) s, p_x , p_y , p_z , d_{z^2} D) $\text{d}_{x^2-y^2}$, s, p_x , p_y

59. When the hybridization state of carbon atom changes from sp^3 , sp^2 and sp , the angle between the hybridized orbitals:

- A) Decreases considerably B) Increases progressively
C) Decreases gradually D) All of these

60. The hybridization states of the central atoms of the ions I_3^- , ICl_4^- and ICl_2^- are respectively:

- A) sp^2 , sp^3d , sp^3 B) sp^3d , sp^3d^2 and sp^3d
C) sp^3d , sp^3d , sp D) sp , sp , sp^2

61. Which of the following molecules has a zero dipole moment?

- A) BF_3 B) CH_2Cl_2
C) NF_3 D) SO_2

62. The dipole moment of NH_3 is:

- A) Less than the dipole moment of NCl_3 B) Higher than the dipole moment of NCl_3
C) Equal to the dipole moment of NCl_3 D) None of these

63. Which set of molecules is polar?

- A) XeF_4 , IF_7 , SO_3 B) PCl_5 , C_6H_6 , SF_6
C) SnCl_2 , SO_2 , NO_2 D) CO_2 , CS_2 , C_2H_6

64. Which of the following has a symmetrical structure?

- A) PCl_3 B) CH_2Cl_2
C) CHCl_3 D) CCl_4

65. Which species has a zero dipole moment?

- A) XeF_4 B) 1,2,4-trichlorobenzene
C) SF_4 D) CH_2Cl_2

66. What conclusion can be drawn from the fact that BF_3 has no dipole moment but PF_3 does?

- A) BF_3 is not symmetrical but PF_3 is B) BF_3 molecule must be linear
C) Atomic radius of P is larger than that of B D) BF_3 molecule must be planar triangular

67. PCl_5 is non polar because:

- A) P - Cl bond is non-polar B) Its dipole moment is zero
C) P - Cl bond is polar D) P & Cl have equal electronegativity

68. The dipole moment of CO_2 is zero, which implies that:

- A) Carbon and oxygen have equal electronegativities
B) Carbon has no polar bond
C) CO_2 is a linear molecule
D) Carbon has bond moments of zero value

69. The correct order of dipole moment is:

- A) $\text{CH}_4 < \text{NF}_3 < \text{NH}_3 < \text{H}_2\text{O}$
B) $\text{NF}_3 < \text{CH}_4 < \text{NH}_3 < \text{H}_2\text{O}$
C) $\text{NH}_3 < \text{NF}_3 < \text{CH}_4 < \text{H}_2\text{O}$
D) $\text{H}_2\text{O} < \text{NH}_3 < \text{NF}_3 < \text{CH}_4$

70. Which of the following has the highest value of dipole moment?

- A) HCl
B) HF
C) HI
D) HBr

71. Which of the following compounds has a permanent dipole moment? (A) BF_3 (B) SiF_4 (C) SF_4 (D) XeF_4 (E) XeF_2 (F) CHCl_3

- A) A & B
B) C & D
C) D, E & F
D) C & F

72. Which molecule has the largest dipole moment?

- A) CH_4
B) CHCl_3
C) CCl_4
D) CHI_3

73. Which of the following is the most polar?

- A) CCl_4
B) CHCl_3
C) CH_2Cl_2
D) CH_3Cl

74. The molecule that does not have a zero dipole moment is:

- A) CO_2
B) CCl_4
C) BF_3
D) HCl

75. Which of the following compounds possesses a dipole moment?

- A) Water
B) Boron trifluoride
C) Benzene
D) Carbon tetrachloride

76. Which of the following species will have the minimum bond energy?

- A) N_2
B) N_2^-
C) N_2^+
D) N_2^{2-}

77. Which of the following ions does not have a bond order of 2.5?

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

78. An electron is added to which of the following orbitals during the change of N_2 to N_2^- ?

- A) s orbital
B) σ^* orbital
C) π^* orbital
D) π orbital

79. In which of the following species does the removal of an electron result in a decrease in paramagnetic behavior?

- A) F_2
B) N_2
C) C_2
D) B_2

80. Pick the wrong statement with respect to molecular orbital theory (MOT):

- A) Participation of orbitals of comparable energies takes place.
B) The electron is under the influence of two or more than two nuclei.
C) The molecular orbital formed is equal to the number of atomic orbitals combined.
D) The probability of electron distribution in a molecule is given by atomic orbitals only.

81. Which of the following species does not exist?

- A) He_2^+
B) H_2^+
C) H_2^-
D) Be_2

82. Which of the given statements is not correct?

- A) Electron density in a bonding molecular orbital is located between the bonded atoms.
B) Electron cloud is located away from the space between the nuclei in anti-bonding molecular orbital.
C) In anti-bonding molecular orbital there is always a nodal plane.
D) The total energy of the molecular orbitals varies from the original energies of atomic orbitals.

83. The given species not having the same bond order as of the other three is:

- A) He_2^+
B) H_2^+
C) H_2^-
D) Li_2

84. The minimum bond length will be observed in:

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

85. Which among the given pairs of molecules consists only of $\text{Pi}(\pi)$ bonds?

- A) B_2 and F_2
B) B_2 and C_2
C) N_2 and O_2
D) C_2 and N_2

86. Which molecule does not exist?

- A) He_2
B) O_2
C) N_2
D) B_2

87. Which is the correct electronic configuration for the C_2 molecule according to M.O.T?

- A) $KK(\sigma 2s)^2(\sigma^* 2s)^2(\pi 2p_x)^2(\pi 2p_y)^2(\sigma^* 2s)^2(\pi 2p_x)^1(\pi 2p_y)^1$
 B) $KK(\sigma 2s)^2(\sigma^* 2s)^2(\pi 2p_x)^2(\pi 2p_y)^2(\sigma^* 2s)^2(\pi 2p_x)^1(\pi 2p_y)^1$
 C) $KK(\sigma^* 2s)^2(\sigma 2s)^2(\pi 2p_x)^2(\pi 2p_y)^2(\sigma^* 2s)^2(\pi 2p_x)^1(\pi 2p_y)^1$
 D) $KK(\sigma 2s)^2(\sigma^* 2s)^2(\pi 2p_x)^2(\pi 2p_y)^2(\sigma^* 2s)^2(\pi 2p_x)^1(\pi 2p_y)^1$

88. The molecule/species having the highest bond order is:

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

89. The calculated bond order in H_2^- ion is:

- A) 0
 B) $1/2$
 C) $-1/2$
 D) 1

90. The O_2 molecule is paramagnetic due to:

- A) it contains 2 unpaired electrons in $\pi^* 2p_x$ and $\pi^* 2p_y$ molecular orbitals
 B) it contains no unpaired electrons in $\pi^* 2p_x$ and $\pi^* 2p_y$ molecular orbitals
 C) it contains 2 paired electrons in $\sigma 2s$ orbital
 D) it contains 1 unpaired electron in $\sigma 2s$ orbital

Botany

91. Artificial systems of classification, such as the one proposed by Carolus Linnaeus, primarily focused on:

- A) Evolutionary relationships among organisms
 B) Internal anatomical and physiological traits
 C) Morphological characters and vegetative/androecium traits
 D) Cytological and biochemical characteristics

92. A natural system of classification takes into consideration:

- A) Only superficial vegetative characters
 B) Both external features and internal features like anatomy and embryology
 C) Evolutionary history exclusively
 D) Artificial criteria such as habitat and color

93. The natural system of classification for flowering plants was given by:

- A) Carolus Linnaeus
 B) Aristotle
 C) George Bentham and Joseph Dalton Hooker
 D) R.H. Whittaker

94. Phylogenetic systems assume that organisms belonging to the same taxa:

- A) Have similar habitats
 B) Shared a common ancestor
 C) Show similar nutritional demands
 D) Possess the same chromosome count

95. The classification of plants based on cytological information like chromosome number, structure, and behaviour is called:

- A) Chemotaxonomy
 B) Cytotaxonomy
 C) Numerical taxonomy
 D) Cladistics

96. Chemotaxonomy resolves taxonomic problems by using:

- A) Cellular structure and mechanics
 B) Chemical constituents of the plants (like DNA sequence or phytochemistry)
 C) Numerical code assignments to morphological traits
 D) Fossil structures embedded in rocks

97. Algae are characteristically:

- A) Non-phototrophic, simple, and thalloid
 B) Simple, thalloid, autotrophic, and largely aquatic
 C) Multicellular, jacketed, and terrestrial
 D) Heterotrophic and non-vascular

98. Vegetative reproduction in most algae takes place by:

- A) Zoospores
 B) Fragmentation
 C) Aplanospores
 D) Budding

99. Asexual reproduction in algae is predominantly by the production of flagellated motile spores called:

- A) Akinetes
 B) Zoospores
 C) Zygospores
 D) Conidia

100. Anisogamous reproduction involves the fusion of:

- A) Two structurally identical motile gametes
 B) Two gametes dissimilar in size
 C) One large static female gamete and one small motile male gamete
 D) Two non-motile identical gametes

101.

Oogamous sexual reproduction is characterized by:

- | | |
|--|---|
| A) Fusion of two non-flagellated similar-sized gametes | B) Fusion of a small, motile female gamete and large male gamete |
| C) Fusion between one large, non-motile female gamete and a smaller, motile male gamete | D) Fusion of two identical flagellated gametes |

102.

At least how much of the total carbon dioxide fixation on earth is carried out by algae through photosynthesis?

- | | |
|---------------|---------------|
| A) 10% | B) 25% |
| C) 50% | D) 90% |

103.

Certain marine brown and red algae produce large amounts of water-holding substances known as:

- | | |
|---------------------------|---|
| A) Pyrenoids | B) Hydrocolloids (phycocolloids) |
| C) Starch granules | D) Polysulphate esters |

104.

Which of the following marine algae are among the 70 species used as food?

- | | |
|---|--|
| A) Porphyra, Laminaria, and Sargassum | B) Volvox, Chara, and Ulothrix |
| C) Gelidium, Gracilaria, and Chlorella | D) Dictyota, Ectocarpus, and Polysiphonia |

105.

Algin and Carrageen are hydrocolloids extracted from:

- | | |
|--|--|
| A) Red algae and Brown algae respectively | B) Brown algae and Red algae respectively |
| C) Green algae and Brown algae respectively | D) Red algae and Green algae respectively |

106.

Commercial "Agar" used to grow microbes and in preparations of ice creams and jellies is obtained from:

- | | |
|-----------------------------------|-----------------------------------|
| A) Gelidium and Gracilaria | B) Chlorella and Spirulina |
| C) Laminaria and Sargassum | D) Ectocarpus and Dictyota |

107.

Which of the following is a unicellular alga exceptionally rich in proteins and used as a food supplement even by space travellers?

- | | |
|---------------------|------------------------|
| A) Spirogyra | B) Chlorella |
| C) Porphyra | D) Polysiphonia |

108.

The primary photosynthetic pigments found in the members of Chlorophyceae are:

- | | |
|-------------------------------|-------------------------------|
| A) Chlorophyll a and c | B) Chlorophyll a and d |
| C) Chlorophyll a and b | D) Chlorophyll b and c |

109.

Pyrenoids, the storage bodies found in the chloroplasts of green algae, contain:

- | | |
|---------------------------------|-------------------------------|
| A) Protein only | B) Starch only |
| C) Protein beside starch | D) Lipids and glycogen |

110.

Some green algae store food in the form of:

- | | |
|-----------------------------|------------------------------|
| A) Mannitol droplets | B) Oil droplets |
| C) Floridean starch | D) Laminarin granules |

111.

The rigid cell wall of green algae consists of:

- | | |
|---|---|
| A) An inner layer of pectose and an outer layer of cellulose | B) An inner layer of cellulose and an outer layer of pectose |
| C) Cellulose and algin layers | D) Chitin and peptidoglycan layers |

112.

Which type of flagellation is characteristic of the motile zoospores of Chlorophyceae?

- | | |
|--|---------------------------------|
| A) 2, unequal and lateral | B) 2–8, equal and apical |
| C) Flagella are entirely absent | D) 1, apical |

113.

Which of the following groups includes only members of Chlorophyceae?

- | | |
|---|--|
| A) Volvox, Chlamydomonas, Chara, Ulothrix, Spirogyra | B) Ectocarpus, Dictyota, Laminaria, Fucus |
| C) Porphyra, Polysiphonia, Gracilaria, Gelidium | D) Chlorella, Sargassum, Ulothrix, Fucus |

114.

The major photosynthetic pigments present in Phaeophyceae are:

- | | |
|---|---|
| A) Chlorophyll a, b, and carotenoids | B) Chlorophyll a, c, carotenoids, and xanthophylls |
| C) Chlorophyll a, d, and phycoerythrin | D) Chlorophyll a and d only |

115.

The variations in color of brown algae (from olive green to brown) depend upon the amount of which xanthophyll pigment?

- A) r-phycoerythrin
- B) Fucoxanthin
- C) Phycocyanin
- D) Lutein

116.

In Phaeophyceae, food is stored as complex carbohydrates, which are:

- A) Starch or glycogen
- B) Laminarin or mannitol
- C) Floridean starch
- D) Glucose or sucrose

117.

The cellulosic cell wall of brown algal vegetative cells is usually covered on the outside by a gelatinous coating of:

- A) Pectose
- B) Algin
- C) Agar
- D) Carrageen

118.

The plant body of a typical brown alga is differentiated into:

- A) Root, stem, and leaves
- B) Holdfast, stipe, and frond
- C) Rhizoid, cauloid, and phylloid
- D) Thallus and prothallus

119.

In brown algae, the leaf-like photosynthetic organ is called the:

- A) Stipe
- B) Holdfast
- C) Frond
- D) Rhizoid

120.

Zoospores of Phaeophyceae are characteristically:

- A) Spherical with 2–8 equal apical flagella
- B) Pear-shaped (pyriform) with 2 unequal laterally attached flagella
- C) Non-motile and structural copies of the parent thallus
- D) Multi-flagellated and disc-shaped

121.

Gametes of brown algae are typically pyriform and bear flagella that are:

- A) Equal and apical
- B) Absent
- C) Unequal and lateral
- D) Multiseriate and terminal

122.

Which of the following represents a filamentous, branched brown alga?

- A) Volvox
- B) Ectocarpus
- C) Porphyra
- D) Polysiphonia

123.

Which of the following groups includes only members of Phaeophyceae?

- A) Chlamydomonas, Volvox, Spirogyra
- B) Ectocarpus, Dictyota, Laminaria, Sargassum, Fucus
- C) Porphyra, Polysiphonia, Gelidium
- D) Chara, Fucus, Dictyota, Gracilaria

124.

The members of Rhodophyceae are commonly called red algae due to the predominance of which pigment?

- A) Fucoxanthin
- B) r-phycoerythrin
- C) r-phycoerythrin
- D) Chlorophyll c

125.

Which of the following chlorophyll pigments are present in class Rhodophyceae?

- A) Chlorophyll a and b
- B) Chlorophyll a and c
- C) Chlorophyll a and d
- D) Chlorophyll b and c

126.

The stored food material in red algae is:

- A) Starch
- B) Laminarin
- C) Floridean starch
- D) Mannitol

127.

Structurally, floridean starch is very similar to:

- A) Amylose and cellulose
- B) Amylopectin and glycogen
- C) Chitin and inulin
- D) Mannitol and laminarin

128.

Which of the following statements is true regarding flagella in Rhodophyceae?

- A) They possess 2, unequal, lateral flagella.
- B) They possess 2–8, equal, apical flagella.
- C) Flagellated/motile cells are completely absent in their life cycle.
- D) Only the male gametes are flagellated.

129.

Sexual reproduction in Rhodophyceae is strictly:

- A)** Isogamous
C) Oogamous
accompanied by complex post-fertilization developments
- B)** Anisogamous
D) Zoogamous with flagellated zygotes

130.

Which of the following groups includes only members of Rhodophyceae?

- A)** Polysiphonia, Porphyra, Gracilaria, Gelidium
C) Volvox, Spirogyra, Chara
- B)** Ectocarpus, Dictyota, Laminaria
D) Sargassum, Fucus, Porphyra

131.

Match Column I (Organism) with Column II (Cell Wall Components):

Column I	Column II
A. Green Algae	(i) Cellulose, pectin and polysulphate esters
B. Brown Algae	(ii) Inner cellulose and outer pectose
C. Red Algae	(iii) Cellulose and gelatinous algin

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

132.

Match Column I (Algae Genus) with Column II (Type of Sexual Fusion):

Column I	Column II
A. Spirogyra	(i) Oogamous
B. Volvox	(ii) Isogamous (Non-flagellated)
C. Ulothrix	(iii) Isogamous (Flagellated)

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

133.

Match Column I (Algal Body Form) with Column II (Example Genus):

Column I	Column II
A. Unicellular	(i) Ectocarpus
B. Colonial	(ii) Volvox
C. Filamentous	(iii) Chlamydomonas
D. Massive Kelp	(iv) Macrocystis

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

134.

Evaluate the following statements about algal biology: Statement I: Algae are chlorophyll-bearing, simple, thalloid, autotrophic, and largely aquatic organisms. Statement II: The sex organs in algae are generally multicellular and covered by a sterile jacket layer. Select the correct evaluation:

- A)** Both statements are correct.
C) Statement I is correct, Statement II is incorrect.
- B)** Both statements are incorrect.
D) Statement I is incorrect, Statement II is correct.

135.

Consider these two statements regarding sexual reproduction in algae: Statement I: In Spirogyra, sexual reproduction occurs via the fusion of two flagellated gametes of similar size. Statement II: Reproduction in Volvox and Fucus is oogamous, involving the fusion of a large, non-motile female gamete and a smaller, motile male gamete. Which option holds true?

- A)** Both statements are correct.
C) Statement I is incorrect but Statement II is correct.
- B)** Statement I is correct but Statement II is incorrect.
D) Both statements are incorrect.

Zoology

136.

To which type of barriers under innate immunity, do the saliva in the mouth and the tears from the eyes, belong?

- A)** Physical barriers
C) Cellular barriers
- B)** Cytokine barriers
D) Physiological barriers

137.

Which one of the following acts as a physiological barrier to the entry of micro organisms in human body?

- A) Skin
- B) Epithelium of urogenital tract
- C) Tears
- D) monocytes

138.

Immunoglobulins are

- A) antigen
- B) antibodies
- C) antiseptics
- D) antibiotics

139.

The letter T in T-lymphocyte refers to:

- A) thymus
- B) thyroid
- C) thalamus
- D) tonsil

140.

The exaggerated response of the immune system to certain antigens is called

- A) primary response
- B) secondary response
- C) immune suppression response
- D) allergy

141.

Passive immunity is defined as immunity

- A) inherited from the parents.
- B) achieved through vaccination.
- C) acquired through first exposure to the disease.
- D) achieved through the sera of other animals enriched in antibodies.

142.

When body cannot differentiate between its own and foreign matter it is referred to as

- A) passive immunity
- B) active immunity
- C) autoimmunity
- D) immunodeficiency

143.

Short-lived immunity acquired from mother to fetus across placenta or through mother's milk to the infant, is categorized as

- A) active immunity
- B) passive immunity
- C) cellular immunity
- D) innate non-specific immunity

144.

Organ transplant rejection may be prevented by using

- A) antibodies
- B) new T cells
- C) immunosuppressive drug
- D) immunostimulatory drug

145.

Antigen binding site in an antibody is found between

- A) two light chains
- B) two heavy chains
- C) one heavy and one light chain
- D) either between two light chains or between one heavy and one light chain depending upon the nature of antigen

146.

Inflammatory response in allergy is caused by

- A) histamines
- B) antigen
- C) prothrombin
- D) antibodies

147.

The foetus gets immunized after receiving antibodies from the mother through placenta. This type of immunization is called

- A) active immunity
- B) innate immunity
- C) passive immunity
- D) humoral immunity

148.

When a quick immune response is required due to infection of a deadly microbe, the patient is injected with

- A) protein of pathogen
- B) inactivated or weakened pathogen
- C) preformed antibodies
- D) vaccine

149.

B-lymphocytes are associated with

- A) humoral immunity
- B) production of heparin
- C) cell mediated immunity
- D) internal cleansing

150.

Which of the following lymphoid organ provides the site for the interaction of lymphocytes with the antigen?

- A) Bone marrow
- B) Thymus
- C) Spleen
- D) All of these

151.

Which of the following is an autoimmune disease?

- A) Asthma
- B) Rheumatoid arthritis
- C) Cirrhosis
- D) AIDS

152.

Which of the following statement is correct?

- A)** Injecting microbes during immunization induces passive immunity. **B)** Cell-mediated immune response is responsible for graft rejection.
- C)** Colostrum during initial days of lactation provides active immunity to infant. **D)** None of the above

153.

What is true about T-lymphocytes in mammals?

- A)** These are produced in thyroid. **B)** These originate in lymphoid tissues.
- C)** They scavenge damaged cells and cellular debris. **D)** There are three main types of T-lymphocytes - cytotoxic T cells, helper T cells and suppressor T cells.

154.

The following four statements (i - iv) kidney transplant. Identify the two correct statements.

(i) Even if a kidney transplant is proper the recipient may need to take immunosuppressants for a long time. (ii) The cell-mediated immune response is responsible for the graft rejection. (iii) The B-lymphocytes are responsible for rejection of the graft. (iv) The acceptance or rejection of a kidney transplant depends on the specific interferons.

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

155.

Select the correct statement with respect to diseases and immunization.

- A)** Certain protozoans have been used to produce hepatitis B vaccine. **B)** Injection of snake antivenom against snake bite is an example of active immunization.
- C)** If due to some reason B-and T-lymphocytes are damaged, the body will not produce antibodies against a pathogen. **D)** Injection of dead / inactivated pathogens causes passive immunity.

156.

Which of the following statement is incorrect?

- A)** Rheumatoid arthritis is an autoimmune disease. **B)** The use of drugs like antihistamine, adrenaline, and steroids quickly reduces the symptoms of bacterial infection.
- C)** Several genes (called cellular oncogenes) have been identified in normal cells which when activated under certain conditions, could lead to oncogenic transformation of the cells. **D)** The vaccine also generates memory – B and T cells that recognize the pathogen quickly on subsequent exposure and overwhelm the invader with a massive production of antibodies.

157.

Assertion: Virus-infected cells secrete proteins known as interferons. Reason: Interferons protect the non-infected cells from bacterial infection.

- A)** Both Assertion and Reason are true, and Reason is the correct explanation of Assertion. **B)** Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.
- C)** If Assertion is true, but Reason is false. **D)** Both Assertion and Reason are false.

158.

Assertion: Artificially acquired passive immunity results when antibodies or lymphocytes produced outside the host are introduced into a host. Reason: A bone marrow transplant given to a patient with genetic immunodeficiency is an example of artificially acquired passive immunity.

- A)** Both Assertion and Reason are true, and Reason is the correct explanation of Assertion. **B)** Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.
- C)** If Assertion is true, but Reason is false. **D)** Both Assertion and Reason are false.

159.

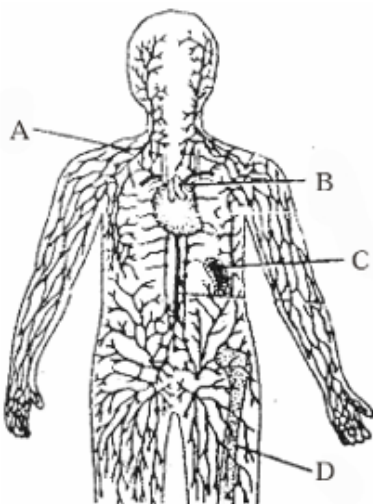
Column I lists the components of body defence and column II lists the corresponding descriptions. Match the two columns and choose the correct option.

Column-I (components of body defence)	Column-II (Description)
A. Active natural immunity	I. Injection of gamma globulins
B. First line of defence	II. Complement proteins and interferons
C. Passive natural immunity	III. Direct contact with the pathogens that have entered inside
D. Second line of defence	IV. Surface barriers
	V. Antibodies transferred through the placenta

A) A-IV; B-III; C-V; D-II
B) A-III; B-IV; C-II; D-V
C) A-III; B-IV; C-V; D-II
D) A-V; B-III; C-II; D-I

160.

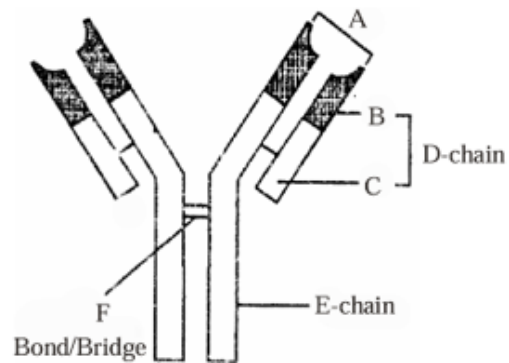
Given figure shows the human lymphatic system with some part marked as A, B, C and D identify the correct part.



- A)** A - lymph nodes (primary lymphoid organ), B - thymus (primary lymphoid organ), C - spleen (secondary lymphoid organ), D - bone marrow (secondary lymphoid organ)
B) A - lymph nodes (primary lymphoid organ), B - thymus (secondary lymphoid organ), C - spleen (primary lymphoid organ), D - bone marrow (primary lymphoid organ)
C) A - lymph nodes (secondary lymphoid organ), B - thymus (primary lymphoid organ), C - spleen (secondary lymphoid organ), D - bone marrow (primary lymphoid organ)
D) A - lymph nodes (primary lymphoid organ), B - thymus (secondary lymphoid organ), C - spleen (secondary lymphoid organ), D - bone marrow (secondary lymphoid organ)

161.

The diagram given below shows an antibody molecule with its parts labelled as A, B, C, D, E & F. Identify the parts marked as A, B, C, D, E and F.



- A)** A - Antigen binding site; B - Variable region (of L-chain); C - Constant region (of L-chain); D - Light polypeptide chain (L-Chain); E - Heavy polypeptide chain (H-Chain); F - Disulfide bond.
B) A - Antigen binding site; B - Constant region (of L-Chain); C - Variable region (of L-Chain); D - Light polypeptide chain (L-Chain); E - Heavy polypeptide chain (H-Chain); F - Disulfide bond.
C) A - Antigen binding site; B - Variable region (of L-Chain); C - Constant region (of L-Chain); D - Heavy polypeptide chain (H-Chain); E - Light polypeptide chain (L-Chain); F - Hydrogen bond.
D) A - Antigen binding site; B - Variable region (of L-Chain); C - Constant region (of L-Chain); D - Light polypeptide chain (L-Chain); E - Heavy polypeptide chain (H-Chain); F - Hydrogen bond.

162.

A person is injected with globulin against hepatitis. This is

- A)** naturally acquired active immunity.
B) naturally acquired passive immunity.
C) artificially acquired active immunity.
D) artificially acquired passive immunity.

163.

Damage to thymus in a child may lead to

- A)** reduction in haemoglobin content of blood.
B) reduction in stem cell production.
C) loss of antibody mediated immunity.
D) loss of cell mediated immunity.

164.

The best HLA (human leucocyte antigen) match for transplants in order of preference is

- A)** sibling > twin > parent > unrelated donor
B) twin > unrelated donor > parent > sibling
C) twin > sibling > parent > unrelated donor
D) sibling > parent > twin > unrelated donor

165.

Which of the following vaccine has been produced from yeast by recombinant DNA technology?

- A) Hepatitis A
- B) Hepatitis B
- C) Hib
- D) Oral polio

166.

Which of the following combinations correctly represents the components of innate immunity ?

- A) Antibodies, memory cells, vaccination and immunological memory
- B) Physical barriers, physiological barriers, cellular barriers and cytokine barriers
- C) B-lymphocytes, T-lymphocytes, antibodies and memory cells
- D) Plasma cells, antibodies, vaccines and complement proteins

167.

A microorganism successfully crosses the physical barriers of the human body and enters the alimentary canal. However, it encounters an environment that is unfavourable for the survival of many pathogens. Considering the different components of innate immunity, which of the following correctly explains the protection provided at this site?

- A) Antibodies present in the stomach specifically recognise every pathogen entering through food.
- B) Hydrochloric acid in the stomach acts as a physiological barrier against pathogens.
- C) Memory B-cells immediately destroy pathogens entering the stomach.
- D) T-helper cells neutralise all microorganisms before they enter the intestine.

168.

A pathogen manages to breach the skin and mucosal barriers and enters the tissues. Various cells of the immune system can recognise and eliminate invading microorganisms without requiring prior exposure to that particular pathogen. Which of the following represents the cellular barriers of innate immunity?

- A) Neutrophils, monocytes, natural killer cells and macrophages
- B) Plasma cells, memory B-cells and memory T-cells
- C) B-lymphocytes and antibody-producing plasma cells only
- D) Helper T-cells and cytotoxic T-cells only

169.

A person is infected with a virus. Cells infected by the virus release certain proteins that can protect neighbouring cells from further viral infection. These substances do not function like antibodies but are an important component of the body's non-specific defence mechanism. Which of the following correctly identifies these substances and their role?

- A) Antibodies; they provide passive immunity to neighbouring cells
- B) Interferons; they protect non-infected cells from viral infection
- C) Histamines; they directly destroy virus-infected cells
- D) Immunoglobulins; they stimulate formation of memory cells

170.

A child is exposed to a particular pathogen for the first time. The immune response develops gradually, and the concentration of antibodies increases relatively slowly. Several years later, the same pathogen enters the body again, and the immune system produces a much stronger and faster response. Which characteristic of acquired immunity best explains this observation?

- A) Acquired immunity lacks specificity but possesses physical barriers.
- B) Acquired immunity is characterised by specificity and immunological memory.
- C) Acquired immunity operates only through the action of skin and mucous membranes.
- D) Acquired immunity always produces the same response during first and subsequent exposure.

171.

Two individuals are exposed to the same antigen. Individual X encounters it for the first time, whereas Individual Y had encountered the antigen several years earlier. Although both individuals develop an immune response, the response in Y is considerably faster and stronger. Which of the following statements best explains this difference?

- A) Y has developed immunological memory due to the earlier exposure.
- B) X possesses memory cells whereas Y possesses only innate immunity.
- C) Y has lost antigen specificity due to previous exposure.
- D) X develops only a cellular response while Y develops only an innate response.

172.

A newborn receives antibodies from its mother through breast milk. These antibodies provide protection to the infant, but the infant's own immune system has not produced these antibodies in response to an antigen. Which type of immunity is represented?

- | | |
|---|--|
| A) Naturally acquired active immunity | B) Artificially acquired active immunity |
| C) Naturally acquired passive immunity | D) Artificially acquired passive immunity |

173.

A patient is bitten by a venomous animal and requires immediate protection. Since there is insufficient time to wait for the patient's immune system to produce its own antibodies, a preparation containing antibodies obtained from another source is administered. Which statement correctly describes this type of protection?

- | | |
|--|--|
| A) It is active immunity because the patient's immune system produces antibodies immediately. | B) It is passive immunity because ready-made antibodies are directly provided to the patient. |
| C) It is innate immunity because antibodies are part of the physical barrier. | D) It is immunological memory because the administered antibodies permanently remain in the body. |

174.

A healthy individual receives a vaccine containing an antigenic preparation that does not cause the full-blown disease but stimulates the immune system. On subsequent exposure to the actual pathogen, the individual is able to mount a rapid and effective immune response. Which of the following best explains the basis of vaccination?

- | | |
|---|--|
| A) Vaccine directly supplies a permanent supply of antibodies to the individual. | B) Vaccine stimulates the immune system to generate antibodies and memory cells against the pathogen. |
| C) Vaccine destroys all microorganisms present in the environment. | D) Vaccine suppresses the immune system so that pathogens cannot recognise host cells. |

175.

Which of the following statements most appropriately describes the principle behind vaccination ?

- | | |
|--|---|
| A) Vaccination exposes the individual to a harmless or attenuated form/component of the pathogen to stimulate an immune response and generate memory. | B) Vaccination introduces only antibiotics so that the pathogen is destroyed before entering the body. |
| C) Vaccination permanently increases the number of RBCs, thereby improving resistance to infection. | D) Vaccination prevents all microorganisms from entering the body by strengthening the skin. |

176.

A foreign substance enters the human body and is recognised as an antigen. A specific immune response is generated against it. Certain lymphocytes differentiate into cells that produce large quantities of antibodies specifically directed against the antigen. Which cells are primarily responsible for antibody production?

- | | |
|--------------------------------|---|
| A) Memory T-cells | B) Plasma cells derived from B-lymphocytes |
| C) Natural killer cells | D) Neutrophils |

177.

A virus infects cells of the human body. The immune system must not only recognise foreign molecules but also deal with infected host cells. Two broad forms of acquired immune response participate in defence against pathogens. Which statement correctly distinguishes the two?

- | | |
|---|--|
| A) Humoral immunity is mediated mainly by antibodies, whereas cell-mediated immunity involves T-lymphocytes. | B) Humoral immunity is mediated by RBCs, whereas cell-mediated immunity is mediated by platelets. |
| C) Both humoral and cell-mediated immunity are exclusively mediated by antibodies. | D) Cell-mediated immunity operates only through gastric HCl and skin barriers. |

178.

A person develops sneezing, watery eyes and breathing difficulty after exposure to a particular substance that is otherwise harmless to most individuals. The symptoms are produced because the immune system mounts an exaggerated response against the substance. Which combination correctly identifies the phenomenon and the major mediators involved?

- | | |
|---|---|
| A) Autoimmunity; antibodies against self-antigens only | B) Allergy; IgE antibodies and chemicals such as histamine and serotonin |
| C) Passive immunity; IgG antibodies and interferons | D) Innate immunity; gastric HCl and mucous membranes |

179.

A person develops progressive muscle weakness because the immune system mistakenly recognises a component of the individual's own body as foreign and mounts an immune response against it. This represents a failure of the immune system to distinguish self from non-self. Which of the following is an example of such an autoimmune disorder mentioned in NCERT?

- | | |
|-------------------|-----------------------------|
| A) AIDS | B) Myasthenia gravis |
| C) Malaria | D) Typhoid |

180.

In which one of the following options the two examples (given in column I) are correctly matched with their particular type of immunity (given in column II)?

Column I (Examples)	Column II (Type of immunity)
(a) Saliva in mouth and tears in eyes	– Physical barriers
(b) Mucus coating of epithelium, urogenital tract and HCl in stomach	– Physiological barriers
(c) Polymorphonuclear leucocytes and monocytes	– Cellular barriers
(d) Anti-tetanus and anti-snake bite injections	– Active immunity

A) a

B) b

C) c

D) d

ANSWER KEY

Physics

1.	2	13.	3	25.	2	37.	4
2.	1	14.	4	26.	3	38.	2
3.	1	15.	2	27.	1	39.	2
4.	2	16.	2	28.	2	40.	2
5.	1	17.	2	29.	2	41.	2
6.	4	18.	3	30.	2	42.	3
7.	3	19.	2	31.	2	43.	2
8.	3	20.	3	32.	1	44.	4
9.	3	21.	2	33.	2	45.	1
10.	1	22.	3	34.	2		
11.	3	23.	4	35.	2		
12.	1	24.	3	36.	2		

Chemistry

46.	2	58.	3	70.	2	82.	4
47.	4	59.	2	71.	4	83.	4
48.	2	60.	2	72.	2	84.	3
49.	1	61.	1	73.	4	85.	2
50.	3	62.	2	74.	4	86.	1
51.	4	63.	3	75.	1	87.	1
52.	1	64.	4	76.	4	88.	3
53.	4	65.	1	77.	1	89.	2
54.	2	66.	4	78.	3	90.	1
55.	2	67.	2	79.	4		
56.	1	68.	3	80.	4		
57.	2	69.	1	81.	4		

Botany

91.	3	103.	2	115.	2	127.	2
92.	2	104.	1	116.	2	128.	3
93.	3	105.	2	117.	2	129.	3
94.	2	106.	1	118.	2	130.	1
95.	2	107.	2	119.	3	131.	1
96.	2	108.	3	120.	2	132.	1
97.	2	109.	3	121.	3	133.	1
98.	2	110.	2	122.	2	134.	3
99.	2	111.	2	123.	2	135.	3
100.	2	112.	2	124.	3		
101.	3	113.	1	125.	3		
102.	3	114.	2	126.	3		

Zoology

136.	4	148.	3	160.	3	172.	3
137.	3	149.	1	161.	1	173.	2
138.	2	150.	3	162.	3	174.	2
139.	1	151.	2	163.	4	175.	1
140.	4	152.	2	164.	3	176.	2
141.	3	153.	4	165.	2	177.	1
142.	3	154.	1	166.	2	178.	2
143.	2	155.	3	167.	2	179.	2
144.	3	156.	2	168.	1	180.	3
145.	3	157.	3	169.	2		
146.	1	158.	2	170.	2		
147.	3	159.	3	171.	1		

SOLUTIONS

Q1.

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 $\theta = 45^\circ$.

Q2.

Answer: A

Explanation:

The maximum horizontal range for a given initial velocity u is achieved at an angle of 45° and is given by

$R_{\max} = \frac{u^2}{g} = 60 \text{ m}$. The maximum height attained when projected vertically upward ($\theta = 90^\circ$) is $H_{\max} = \frac{u^2}{2g} = \frac{1}{2} R_{\max} = 30 \text{ m}$.

Q3.

Answer: A

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 $H = \frac{(u \sin \theta)^2}{2g} = \frac{40^2}{2 \times 10} = 80 \text{ m}$.

Q4.

Answer: B

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, $\frac{H_1}{H_2} = \frac{\sin^2 60^\circ}{\sin^2 30^\circ} = \frac{(\sqrt{3}/2)^2}{(1/2)^2} = 3 : 1$.

Q5.

Answer: A

Explanation:

The maximum horizontal range is $R_{\max} = \frac{u^2}{g} = 800 \text{ m}$, which occurs at an angle of $\theta = 45^\circ$. Using the relation between range and maximum height $R = 4H \cot \theta$, we get $800 = 4H \cot 45^\circ$, which yields $H = 200 \text{ m}$.

Q6.

Answer: D

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.

Q7.

Answer: C

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, $\frac{H_1}{H_2} = \frac{u_1^2}{u_2^2 \cos^2 \theta} = 1 : 1$.

Q8.

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.

Q9.

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 $H_2 = 3Y$.

Q10.

Answer: A

Explanation:

The time of flight is $T = \frac{2u \sin \theta}{g} = 4 \text{ s}$, which gives the vertical component of the initial velocity as $u \sin \theta = \frac{Tg}{2} = \frac{4 \times 10}{2} = 20 \text{ m/s}$ (taking $g = 10 \text{ m/s}^2$). The maximum height is $H = \frac{(u \sin \theta)^2}{2g} = \frac{20^2}{2 \times 10} = 20 \text{ m}$.

Q11.

Answer: C

Explanation:

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

Q12.

Answer: A

Explanation:

The maximum horizontal range is $R = \frac{u^2}{g}$ (at $\theta = 45^\circ$). The maximum height attained at this angle is $H = \frac{u^2 \sin^2(45^\circ)}{2g} = \frac{u^2}{4g} = \frac{R}{4}$.

Q13.

Answer: C

Explanation:

The maximum range of a projectile is $R_{\max} = \frac{u^2}{g} = 0.8 \text{ m}$, which gives the initial speed $u = \sqrt{0.8g}$. The horizontal component of velocity for maximum range ($\theta = 45^\circ$) is

$v_x = u \cos 45^\circ = \sqrt{\frac{0.8g}{2}} = \sqrt{0.4g} = \sqrt{0.4 \times 10} = 2 \text{ m/s}$. The total horizontal distance traveled in 10 seconds is $d = v_x \times t = 2 \times 10 = 20 \text{ m}$.

Q14.

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 $R = 4\sqrt{h_1 h_2}$.

Q15.

Answer: B

Explanation:

Given $R = 4H$. Using the relation $R = 4H \cot \theta$, we get $4H = 4H \cot \theta \Rightarrow \cot \theta = 1$, which means $\theta = 45^\circ$. Substituting $\theta = 45^\circ$ into the range formula

$$R = \frac{v^2 \sin(2 \times 45^\circ)}{g} = \frac{v^2}{g}.$$

Q16.

Answer: B

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 $R = \frac{2 \times 5 \times 10}{10} = 10 \text{ m}$.

Q17.

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

$$R = \frac{u^2 \sin(2\theta)}{g} = \frac{2u^2 \sin \theta \cos \theta}{g} \text{ yields } R = \frac{2\sqrt{2}u^2}{3g}.$$

Q18.

Answer: C

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 $R_2 = R_1 \left(\frac{3u}{u}\right)^2 \left(\frac{\sin(120^\circ)}{\sin(60^\circ)}\right) = 9R_1$.

Q19.

Answer: B

Explanation:

The magnitude of the initial velocity is

$u = \sqrt{3^2 + 4^2} = 5 \text{ m/s}$, and the components are

$u_x = 3 \text{ m/s}$ and $u_y = 4 \text{ m/s}$. 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

$$R = \frac{2 \times 3 \times 4}{10} = 2.4 \text{ meter}.$$

Q20.

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:

$$A = \pi R_{\max}^2 = \pi \left(\frac{u^2}{g}\right)^2 = \frac{\pi u^4}{g^2}.$$

Q21.

Answer: B

Explanation:

At the highest point of a projectile's trajectory, the vertical component of velocity becomes zero, and only the horizontal component remains, which is given by $u \cos \theta$. According to the problem, this speed is equal to $\frac{u}{\sqrt{3}}$. Therefore,

$$\cos \theta = \frac{1}{\sqrt{3}}, \text{ which gives } \sin \theta = \sqrt{1 - \left(\frac{1}{\sqrt{3}}\right)^2} = \sqrt{\frac{2}{3}}.$$

Using the horizontal range formula

$$R = \frac{u^2 \sin(2\theta)}{g} = \frac{2u^2 \sin \theta \cos \theta}{g}, \text{ substituting the values gives}$$

$$R = \frac{\sqrt{3}u^2}{2g}.$$

Q22.

Answer: C

Explanation:

For a projectile with maximum horizontal range, the angle of projection is $\theta = 45^\circ$. The speed of the particle is minimum at the highest point of its trajectory, where its value is

$v_{\min} = u \cos \theta = \frac{u}{\sqrt{2}}$ (which is $\frac{1}{\sqrt{2}}$ times the initial speed u).

The coordinates of this highest point are given by $x = \frac{R}{2}$

and $y = H_{\max} = \frac{R}{4}$ (since $R = 4H \cot \theta = 4H$ for $\theta = 45^\circ$).

Q23.

Answer: D

Explanation:

The horizontal range of a projectile is given by the formula $R = \frac{v^2 \sin(2\theta)}{g}$. For a constant initial speed v and angle of projection θ , the range is inversely proportional to the acceleration due to gravity ($R \propto \frac{1}{g}$). When the gravity becomes $4g$, the range becomes one-fourth of the original range, which is $\frac{R}{4}$.

Q24.

Answer: C

Explanation:

The horizontal range of a projectile is given by $R = \frac{u^2 \sin(2\theta)}{g}$, which implies that for a constant angle and acceleration due to gravity, the range is directly proportional to the square of the initial speed ($R \propto u^2$). Therefore, when the initial speed is tripled ($u_2 = 3u_1$), the new range becomes $R_2 = (3)^2 R_1 = 9 \times 80 \text{ m} = 720 \text{ m}$.

Q25.

Answer: B

Explanation:

The horizontal range of a projectile is given by $R = \frac{u^2 \sin(2\theta)}{g}$. Substituting $u = 400 \text{ m/s}$, $\theta = 15^\circ$, and $g = 10 \text{ m/s}^2$, we get $R = \frac{(400)^2 \sin(30^\circ)}{10} = \frac{160000 \times 0.5}{10} = 8000 \text{ m} = 8 \times 10^3 \text{ m}$.

Q26.

Answer: C

Explanation:

The horizontal range of a projectile is given by $R = \frac{u^2 \sin(2\theta)}{g}$. For equal initial velocities, the range depends directly on $\sin(2\theta)$. Among the given angles, an angle of projection of $\theta = 45^\circ$ yields $2\theta = 90^\circ$, which gives the maximum possible value for $\sin(2\theta)$ (i.e., $\sin(90^\circ) = 1$). Therefore, body R has the maximum range.

Q27.

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:
 $\sin(15^\circ) \approx 0.259 \Rightarrow \sin^2(15^\circ) \approx 0.067$
 $\sin(30^\circ) = 0.5 \Rightarrow \sin^2(30^\circ) = 0.25$
 $\sin(45^\circ) = \frac{1}{\sqrt{2}} \Rightarrow \sin^2(45^\circ) = 0.5$
 $\sin(60^\circ) = \frac{\sqrt{3}}{2} \Rightarrow \sin^2(60^\circ) = 0.75$ Ordering from highest to lowest value gives $60^\circ > 45^\circ > 30^\circ > 15^\circ$, which corresponds to projectiles D, C, B, and A.

Q28.

Answer: B

Explanation:

The angles 37° and 53° are complementary angles because $37^\circ + 53^\circ = 90^\circ$. For a given initial velocity u , the horizontal range of a projectile is given by $R = \frac{u^2 \sin(2\theta)}{g}$. Since $\sin(2 \times 37^\circ) = \sin(74^\circ)$ and $\sin(2 \times 53^\circ) = \sin(106^\circ) = \sin(180^\circ - 106^\circ) = \sin(74^\circ)$, the ranges are equal.

Q29.

Answer: B

Explanation:

The maximum horizontal range of a projectile is given by $R_{\max} = \frac{u^2}{g}$. Rearranging for initial speed u , we get $u = \sqrt{R_{\max} \cdot g}$. Substituting $R_{\max} = 200 \text{ m}$ and $g = 10 \text{ ms}^{-2}$: $u = \sqrt{200 \times 10} = \sqrt{2000} \approx 44.72 \text{ ms}^{-1}$. Rounding to the nearest integer gives 45 ms^{-1} .

Q30.

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 $g = 10 \text{ m/s}^2$, we get $\frac{10}{8} = \frac{5}{4}$.

Q31.

Answer: B

Explanation:

The horizontal range R of a projectile is given by the formula $R = \frac{u^2 \sin(2\theta)}{g}$. Since acceleration due to gravity g is constant for a given location, the range depends exclusively on the initial speed u and the angle of projection θ . Mass and weight do not affect projectile trajectory in a vacuum.

Q32.

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 ($u = 20 \text{ m/s}$, $\theta = 30^\circ$, and $g = 10 \text{ m/s}^2$):
 $R = \frac{(20)^2 \sin(2 \times 30^\circ)}{10} = \frac{400 \times \sin(60^\circ)}{10} = 40 \times \frac{\sqrt{3}}{2} = 20\sqrt{3} \approx 34.64$

Q33.

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: $\frac{T_1 - T_2}{T_1} = 1 - \frac{T_2}{T_1} = 1 - \frac{4}{5} = \frac{1}{5} = 20\%$

Q34.

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: $\frac{T_1}{T_2} = \frac{2u \cos \alpha / g}{2u \sin \alpha / g} = \frac{\cos \alpha}{\sin \alpha} = \cot \alpha = \cot \alpha : 1$

Q35.

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.

Q36.

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: $-h = u_y t - \frac{1}{2} g t^2$. 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

$$t = \frac{u_y}{g} \left(1 + \sqrt{1 + \frac{2gh}{u_y^2}} \right):$$

$$t = \frac{10}{10} \left(1 + \sqrt{1 + \frac{2 \times 10 \times 40}{10^2}} \right) = 1 \times (1 + \sqrt{1 + 8}) = 1 \times (1 + 3) = 4 \text{ s}$$

Q37.

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:

$$t = \frac{u \sin(\alpha + \beta)}{g \cos \beta}$$

Q38.

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 :

$$x_1 + x_2 = x \implies ut + \frac{ut}{2} \text{ (if moving in same direction). . .}$$

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.

Q39.

Answer: B

Explanation:

The time of flight for a projectile launched from the ground is given by the formula: $T = \frac{2u \sin \theta}{g}$. Substituting the given

values ($u = 19.6 \text{ m/s}$, $\theta = 60^\circ$, and $g = 9.8 \text{ m/s}^2$):

$$T = \frac{2 \times 19.6 \times \sin(60^\circ)}{9.8} = 2 \times 2 \times \frac{\sqrt{3}}{2} = 2\sqrt{3} \text{ s}$$

Q40.

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

$$R = \frac{u^2 \sin 2\theta}{g}. \text{ For the complementary angle } (90^\circ - \theta), \text{ the}$$

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 $t_1 t_2 \propto R$.

Q41.

Answer: B

Explanation:

The standard trajectory equation of a projectile in range form is: $y = x \tan \theta \left(1 - \frac{x}{R}\right)$ Given the equation: $y = 12x - \frac{3x^2}{4}$ We can rewrite it by factoring out $12x$ to match the standard form: $y = 12x \left(1 - \frac{3x}{4 \times 12}\right) = 12x \left(1 - \frac{x}{16}\right)$ Comparing this with the standard equation, the horizontal range is $R = 16 \text{ m}$.

Q42.

Answer: C

Explanation:

By comparing the coefficient of x^2 in the given equation with the standard trajectory equation $y = x \tan \theta - \frac{gx^2}{2u^2 \cos^2 \theta}$, we equate the x^2 coefficients: $\frac{g}{2u^2 \cos^2 \theta} = 2$. Given that $\tan \theta = \sqrt{3}$ implies $\theta = 60^\circ$ and $\cos \theta = \frac{1}{2}$, substituting these values yields $u = \sqrt{10} \text{ m/s}$.

Q43.

Answer: B

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 $\theta = 45^\circ$.

Q44.

Answer: D

Explanation:

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

Q45.

Answer: A

Explanation:

Rewriting the given equation in the standard range form $y = x \tan \theta \left(1 - \frac{x}{R}\right)$ by factoring out $4x$, we get $y = 4x \left(1 - \frac{2x}{4}\right) = 4x \left(1 - \frac{x}{2}\right)$. Comparing this with the standard form yields a range $R = 2 \text{ m}$.

Q46.

Answer: B

Explanation:

Protonation of H_2O to H_3O^+ changes the molecular shape from bent (angular) to pyramidal, while the hybridisation of the oxygen atom remains sp^3 .

Q47.

Answer: D

Explanation:

Carbon-2 is involved in a double bond and is sp^2 hybridised, whereas Carbon-3 is single-bonded and is sp^3 hybridised. Thus, the $\text{C}_2 - \text{C}_3$ σ -bond is formed by $\text{sp}^2 - \text{sp}^3$ orbital overlap.

Q48.

Answer: B

Explanation:

Carbon (a) and Boron (d) belong to the second period of the periodic table and do not possess vacant d-orbitals in their valence shell, preventing them from undergoing octet expansion or sp^3d hybridisation.

Q49.

Answer: A

Explanation:

Both NH_2^+ (steric number 3 with 1 lone pair, angular shape in a single plane) and CH_3^+ (central carbon is sp^2 hybridised with 0 lone pairs, trigonal planar) are planar.

Q50.

Answer: C

Explanation:

All species in this set have a linear geometry: NO_2^+ and CO_2 are sp hybridised with no lone pairs, while XeF_2 is sp^3d hybridised with 3 equatorial lone pairs.

Q51.

Answer: D

Explanation:

This set is incorrect because these three molecules have different shapes: SF_4 is see-saw, SiF_4 is tetrahedral, and XeF_4 is square planar.

Q52.

Answer: A

Explanation:

A central atom with 4 bond pairs and 2 lone pairs has a steric number of 6 (sp^3d^2 hybridisation). To minimise lone pair-lone pair repulsions, the lone pairs occupy trans positions, resulting in a square planar geometry.

Q53.

Answer: D

Explanation:

IF_4^+ has a steric number of 5 with 4 bond pairs and 1 lone pair, resulting in a see-saw or distorted tetrahedral shape.

Q54.

Answer: B

Explanation:

H_3O^+ has sp^3 hybridisation on the oxygen atom with 3 bond pairs and 1 lone pair, adopting a trigonal pyramidal shape.

Q55.

Answer: B

Explanation:

A T-shaped molecule of formula MX_3 arises from sp^3d hybridisation of the central atom with 3 bond pairs and 2 lone pairs (non-bonding pairs).

Q56.

Answer: A

Explanation:

The central Oxygen atom in OF_2 undergoes sp^3 hybridisation, and its sp^3 hybrid orbitals overlap with the unhybridised 2p orbitals of Fluorine to form the covalent bonds.

Q57.

Answer: B

Explanation:

Pure p_x and p_y orbitals are mutually perpendicular, making the angle between them exactly 90° , which is smaller than the angles found in sp^3 bonds (109.5°), water (104.5°), and sp bonds (180°).

Q58.

Answer: C

Explanation:

Trigonal bipyramidal geometry corresponds to sp^3d hybridisation. The specific orbitals mixed are one s, three p (p_x, p_y, p_z), and the d_{z^2} orbital.

Q59.

Answer: B

Explanation:

The angle between hybrid orbitals increases progressively from 109.5° (sp^3) to 120° (sp^2) and finally to 180° (sp).

Q60.

Answer: B

Explanation:

The steric numbers for the central iodine in these species are 5, 6, and 5 respectively, corresponding to sp^3d , sp^3d^2 , sp^3d hybridisations.

Q61.

Answer: A

Explanation:

BF_3 is a highly symmetrical trigonal planar molecule (sp^2 hybridized). The three highly polar B-F bond vectors cancel each other out completely, resulting in a net dipole moment of zero.

Q62.

Answer: B

Explanation:

In NH_3 , the highly polar bond dipoles and the nitrogen lone-pair dipole point in the same direction, reinforcing each other. In NCl_3 , the electronegative chlorine atoms pull electron density away, meaning the bond dipoles oppose the lone-pair dipole and result in a much smaller net dipole moment.

Q63.

Answer: C

Explanation:

The molecules in Set C (SnCl_2 , SO_2 , NO_2) are all polar because they possess bent, asymmetrical structures with central atoms bearing lone pairs or unpaired electrons.

Q64.

Answer: D

Explanation:

Carbon tetrachloride (CCl_4) possesses a highly symmetrical regular tetrahedral shape with four identical surrounding chlorine atoms. This symmetrical geometry causes all individual bond dipoles to cancel completely, yielding a net dipole moment of zero.

Q65.

Answer: A

Explanation:

XeF_4 has a highly symmetrical square planar geometry where the four polar Xe-F bond vectors and the two axial lone pairs cancel each other out completely, resulting in a net dipole moment of zero.

Q66.

Answer: D

Explanation:

The absence of a dipole moment in BF_3 indicates that its three polar B-F bonds are arranged symmetrically in a trigonal planar (planar triangular) configuration, allowing their individual dipoles to cancel.

Q67.

Answer: B

Explanation:

While the individual P-Cl bonds are highly polar, the symmetrical trigonal bipyramidal geometry of PCl_5 causes all individual bond dipoles to cancel out completely, yielding a net dipole moment of zero.

Q68.

Answer: C

Explanation:

The oxygen atoms in CO_2 are highly electronegative, making each $\text{C}=\text{O}$ bond polar. The fact that its net dipole moment is zero proves that the two polar bonds point in opposite directions (180°) in a linear molecular geometry, canceling each other out.

Q69.

Answer: A

Explanation:

CH_4 is non-polar ($\mu = 0$). In NF_3 , the bond dipoles oppose the lone-pair moment ($\mu = 0.24 \text{ D}$). In NH_3 , they reinforce the lone-pair ($\mu = 1.47 \text{ D}$). H_2O has the largest dipole moment ($\mu = 1.85 \text{ D}$).

Q70.

Answer: B

Explanation:

In diatomic hydrogen halides, the dipole moment is directly proportional to the electronegativity difference (ΔEN) between the bonded atoms. Fluorine is the most electronegative element, giving HF the highest dipole moment.

Q71.

Answer: D

Explanation:

SF_4 (C, see-saw geometry with 1 equatorial lone pair) and CHCl_3 (F, asymmetrical tetrahedral geometry) both have asymmetrical structures and permanent dipole moments.

Q72.

Answer: B

Explanation:

CH_4 and CCl_4 are completely non-polar ($\mu = 0$). Between the polar molecules CHCl_3 and CHI_3 , Chlorine is significantly more electronegative than Iodine, giving CHCl_3 a larger dipole moment.

Q73.

Answer: D

Explanation:

In the chlorinated methane series, the dipole moment increases as the number of chlorine atoms decreases from 4 to 1. Therefore, methyl chloride (CH_3Cl) is the most polar.

Q74.

Answer: D

Explanation:

CO_2 , CCl_4 , and BF_3 are highly symmetrical molecules whose bond dipoles cancel out completely. HCl is an unsymmetrical diatomic molecule with a permanent dipole moment.

Q75.

Answer: A

Explanation:

Water (H_2O) has an unsymmetrical bent shape, preventing its polar bond dipoles from canceling and giving it a strong permanent dipole moment.

Q76.

Answer: D

Explanation:

Bond energy is directly proportional to bond order. Since N_2^{2-} has the lowest bond order of 2, it has the minimum bond energy among the given species.

Q77.

Answer: A

Explanation:

The superoxide ion (O_2^-) has 17 electrons and a bond order of 1.5, while the other three species all have a bond order of 2.5.

Q78.

Answer: C

Explanation:

The molecular orbital configuration of N_2 has all its bonding orbitals filled up to $\sigma 2p_z$. The incoming 15th electron of N_2^- must enter the next vacant, higher-energy orbital, which is the antibonding π^* orbital.

Q79.

Answer: D

Explanation:

B_2 has 2 unpaired electrons. Removing 1 electron to form B_2^+ leaves it with only 1 unpaired electron, decreasing its paramagnetic behavior.

Q80.

Answer: D

Explanation:

According to MOT, once a molecule is formed, its electrons belong to the entire molecule. The probability of electron distribution is given by molecular orbitals, not atomic orbitals.

Q81.

Answer: D

Explanation:

Be_2 has 8 electrons. According to molecular orbital theory, its bonding and antibonding electrons cancel out, resulting in a bond order of zero, meaning the molecule cannot exist.

Q82.

Answer: D

Explanation:

The total energy of the generated molecular orbitals is equal to the total energy of the combining atomic orbitals, in accordance with the law of conservation of energy.

Q83.

Answer: D

Explanation:

Li_2 has a bond order of 1, whereas the other three species (He_2^+ , H_2^+ , and H_2^-) all have a bond order of 0.5.

Q84.

Answer: C

Explanation:

O_2^+ has the highest bond order of 2.5 among the given oxygen species. Since bond length is inversely proportional to bond order, it has the shortest (minimum) bond length.

Q85.

Answer: B

Explanation:

According to molecular orbital theory, both B_2 and C_2 have their valence electrons filled only in the bonding $\pi 2p$ molecular orbitals, meaning their bonding consists exclusively of π bonds.

Q86.

Answer: A

Explanation:

He_2 has 4 electrons. According to molecular orbital theory, its bonding and antibonding electrons cancel out, resulting in a bond order of zero, meaning the molecule cannot exist.

Q87.

Answer: A

Explanation:

C_2 has 12 electrons. Due to s-p mixing, the degenerate $\pi 2p$ orbitals are lower in energy than the $\sigma 2p_z$ orbital, and are completely filled first.

Q88.

Answer: C

Explanation:

O_2^+ has a bond order of 2.5, which is the highest among all the given oxygen species.

Q89.

Answer: B

Explanation:

H_2^- has 3 electrons. With 2 electrons in the bonding orbital and 1 in the antibonding orbital, its bond order is 0.5.

Q90.

Answer: A

Explanation:

According to molecular orbital theory, the last two valence electrons of the 16-electron O_2 molecule occupy the degenerate antibonding $\pi^* 2p_x$ and $\pi^* 2p_y$ orbitals singly with parallel spins, making it paramagnetic.

Q91.

Answer: C

Q92.

Answer: B

Q93.

Answer: C

Q94.

Answer: B

Q95.

Answer: B

Q96.

Answer: B

Q97.

Answer: B

Q98.

Answer: B

Q99.

Answer: B

Q100.

Answer: B

Q101.

Answer: C

Q102.

Answer: C

Q103.

Answer: B

Q104.

Answer: A

Q105.

Answer: B

Q106.

Answer: A

Q107.

Answer: B

Q108.

Answer: C

Q109.

Answer: C

Q110.

Answer: B

Q111.

Answer: B

Q112.

Answer: B

Q113.
Answer: A

Q114.
Answer: B

Q115.
Answer: B

Q116.
Answer: B

Q117.
Answer: B

Q118.
Answer: B

Q119.
Answer: C

Q120.
Answer: B

Q121.
Answer: C

Q122.
Answer: B

Q123.
Answer: B

Q124.
Answer: C

Q125.
Answer: C

Q126.
Answer: C

Q127.
Answer: B

Q128.
Answer: C

Q129.
Answer: C

Q130.
Answer: A

Q131.
Answer: A

Q132.
Answer: A

Q133.
Answer: A

Q134.
Answer: C

Q135.
Answer: C

Q136.
Answer: D

Q137.
Answer: C

Q138.
Answer: B

Q139.
Answer: A

Q140.
Answer: D

Q141.
Answer: C

Q142.
Answer: C

Q143.
Answer: B

Q144.
Answer: C

Q145.
Answer: C

Q146.
Answer: A

Q147.
Answer: C

Q148.
Answer: C

Q149.
Answer: A

Q150.
Answer: C

Q151.
Answer: B

Q152.
Answer: B

Q153.
Answer: D

Q154.
Answer: A

Q155.
Answer: C

Q156.
Answer: B

Q157.
Answer: C

Q158.
Answer: B

Q159.
Answer: C

Q160.
Answer: C

Q161.
Answer: A

Q162.
Answer: C

Q163.
Answer: D

Q164.
Answer: C

Q165.
Answer: B

Q166.
Answer: B

Q167.
Answer: B

Q168.
Answer: A

Q169.
Answer: B

Q170.
Answer: B

Q171.
Answer: A

Q172.
Answer: C

Q173.
Answer: B

Q174.
Answer: B

Q175.
Answer: A

Q176.
Answer: B

Q177.
Answer: A

Q178.
Answer: B

Q179.
Answer: B

Q180.
Answer: C